SIDREA Series in Accounting and Business Administration

Maria Serena Chiucchi
Rosa Lombardi
Daniela Mancini *Editors*

Intellectual Capital, Smart Technologies and Digitalization

Emerging Issues and Opportunities

Springer

SIDREA Series in Accounting and Business Administration

This is the official book series of SIDREA – the Italian Society of Business Economics and Accounting. The books highlight contributions by SIDREA's thematic research groups, operating at the national and international levels. In particular, the series aims to disseminate specialized findings on several topics – classical and cutting-edge alike – that are currently being discussed by the accounting and business administration communities. The series authors are respected researchers and educators in the fields of business valuation; governance and internal control; financial accounting; public accounting; management control; gender; turnaround predictive models; non-financial disclosure; intellectual capital, smart technologies, and digitalization; and university governance and performance measurement.

More information about this series at http://www.springer.com/series/16571

Maria Serena Chiucchi • Rosa Lombardi •
Daniela Mancini
Editors

Intellectual Capital, Smart Technologies and Digitalization

Emerging Issues and Opportunities

Springer

Editors
Maria Serena Chiucchi
Department of Management
Università Politecnica delle Marche
Ancona, Italy

Rosa Lombardi
Department of Law and Economics
of Productive Activities
Sapienza University of Rome
Rome, Italy

Daniela Mancini
Faculty of Law
University of Teramo - Campus "Aurelio
Saliceti"
Teramo, Italy

ISSN 2662-9879 ISSN 2662-9887 (electronic)
SIDREA Series in Accounting and Business Administration
ISBN 978-3-030-80736-8 ISBN 978-3-030-80737-5 (eBook)
https://doi.org/10.1007/978-3-030-80737-5

This Springer imprint is published by the registered company Springer Nature Switzerland AG.
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

This volume is promoted by the Italian Association of Scholars in Accounting and Business Administration (SIDREA). It is the result of the joint studies conducted by the research group on Smart Technologies, Digitalization and Intellectual Capital (STEDIC). The SIDREA STEDIC research group is composed of more than one hundred scholars and was born in 2019 with the aims to diffuse and promote the culture of corporate intangibles, among which intellectual capital, smart technologies, and digitalization assume a prominent role. It was a long research journey, which was characterized by strong interaction among scholars and exchange of ideas, and, finally, after two years of study by the research group, this led to the results collected in this volume.

This edited book is directed to widely discover emerging issues in intellectual capital, smart technologies, and digitalization landscape. Particularly, this volume aims to investigate in depth all the nuances of the meaning and characteristics of intellectual capital, smart technologies, and digital processes, delving into their interactions and also defining new thrilling research paths and opportunities. In this scenario, the investigation of this multifaceted research topic intends to propose new insights both from a theoretical and from an empirical point of view to scholars, offering new evidence and advancing literature.

In recent years, the advent of the digital revolution has emphasized the relevance of the traditional intangible assets and has caused the insurgence of new corporate intangibles through which to achieve competitive advantages and foster value creation. Intangible assets need to be addressed in the perspective of intellectual capital (e.g., human capital, structural capital, and relational capital). Meanwhile, new intangibles follow innovative definitions focusing on smart technologies (e.g., artificial intelligence, Internet of things, blockchain, big data, and data analytics) and corporate digitalization processes and models.

Thus, the motivation for this volume is to fix corporate challenges related to the measurement and management of these traditional and new intangibles, in the current and future scenario. To this aim we have collected qualitative and quantitative studies, theoretically based on the fields of business administration and accounting. Results of this edited book are based on several perspectives of analysis useful for a wide range of readers including the academic community.

Ancona, Italy Maria Serena Chiucchi
Rome, Italy Rosa Lombardi
Teramo, Italy Daniela Mancini

Contents

The Debate on IC, Smart Technologies, and Digitalization

Donatella Busso, Daniela Di Berardino, and Alberto Tonelli

1 Introduction

Intellectual Capital (IC) literature has developed over 20 years, attracting many scholars and generating several contaminations across business economics, accounting, and management studies. Recently, many literature reviews have been provided, with the aim of systematizing the main areas of IC literature, contributing to grasp the state of the art, and in identifying emerging research trends of specific IC clusters. Also relevant are the conceptual papers that aim to develop new frameworks to manage IC, both in private and in public domains, following multiple dimensions of value (economic, social, environmental) and multiple levels of analysis (firms, ecosystems, networks). These contributions reveal that the IC debate needs to refocus on new directions, attempting to explore new critical ways to interpret future issues in accounting and management fields derived by new technologies and new accounting information systems.

Big data, smart technologies, and digitalization have been extensively investigated in management and business studies. The intersection between digitization, smart technologies, and IC seems to be partially explored in the extant literature and mainly focused on strategic dimension. Recent studies explore the link between IC,

Di Berardino has developed paragraphs 2 and 3. Busso and Tonelli have developed paragraphs 4. Paragraphs 1 and 5 have involved all the authors.

D. Busso · A. Tonelli
Department of Management, University of Turin, Turin, Italy
e-mail: donatella.busso@unito.it; alberto.tonelli@unito.it

D. Di Berardino (✉)
Department of Business Administration and Management, University of Chieti-Pescara, Pescara, Italy
e-mail: daniela.diberardino@unich.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_1

technology, and sustainable development, IC and big data, analyzing both managerial implications and disclosure aspects.

This chapter provides an overview of the extant debate on IC literature, big data, smart technologies, and digitalization to highlight the emerging trends in business and management studies. Section 2 describes the main stages of IC research, the research findings, and the open questions; Section 3 introduces the possible intersection between IC and big data research; Section 4 provides a systematic literature review on big data, smart technologies, and digitalization applied to business and management topics.

2 The Evolution of Intellectual Capital Research

Understanding the IC research development is essential to systematize the contemporary debate around the new strategic drivers for the sustainable development of organizations, for managing efficiently the new technologies and providing comprehensive accounting information for stakeholders. As is well known, research on IC has gone through four stages of development and recently a fifth stage has been proposed, with the aim to revolutionize the scientific debate on IC by moving away from pre-established conceptual frameworks and traditional accounting models.

During the *first stage*, included between 1980s and 1990s, the aim was to find a common definition of the concept and a shared taxonomy for the components, following the hypothesis that IC is the main basis for value creation (Petty & Guthrie, 2000). A workable definition, coherent with the complexity theory of the system, unveils the *dynamic* nature of IC: it is a system of intangible resources combined thought processes and activities and embedded in the people (human capital), in the structure of a firm (structural capital), and in the firm's relationships (relational capital) with external stakeholders (Petrash, 1996).

Conversely, Stewart (1997, p. x) defines the IC as "the *sum* of everything everybody in a company knows that gives it a competitive edge [. . .] that can be put to create wealth," emphasizing a property of linearity between the IC components (Bratianu, 2018).

Two main approaches of analysis flow from these definitions: static or external; dynamic or internal. The *static* view investigates the quality and quantity of IC resources, observing how they could be measured and visualized in a comprehensive reporting model. While the *dynamic* perspective investigates the IC in action, exploring how it could be managed and what are the intangible activities, the knowledge flows, and the internal processes that lead the strategy and the value creation (Cuganesan, 2005). The dynamic approach is closer to cognitivist perspective, to the resource-based view of the firm and the dynamic-capabilities theory; according to this perspective, IC does not exist in nature, but it emerges by the knowledge flows across people, processes, and relationships, so the same stock of resources might produce different ICs and different performance during the time (Giuliani, 2015; Kianto et al., 2020).

During the first and the *second stage*, the following theoretical assumptions have been used, jointly with other consolidated theories, to describe the relationship between the IC and the value, however, without the adequate empirical validation:

(a) IC could justify the gap between market and book value of a company (Mouritsen et al., 2001). This theory provides a residual dimension of the value generated by IC, overlooking the value creation process and the relevant differences between the measurement methods of the market value. The anomalies in the financial market, the absence of a re-evaluation of IC components, and the limits of historical cost accounting for assets reduce the validity of this theory. Some authors, observing the high volatility of share price of public companies and the evaluation process in some M&A operations, identify the intellectual liabilities. They may reduce the value, arising from "weak strategic planning processes, dangerous work conditions, potential environmental clean-up, potential product tampering, [. . .] poor corporate reputation" (Harvey & Lusch, 1999). Few studies verify empirically this hypothesis (Caddy, 2002; Cuganesan, 2005; Stam, 2009; Giuliani, 2015), finding that the intellectual liabilities generate negative effects faster than the value creation process. The limited exploration of intellectual liabilities is a weakness. Intellectual liabilities could explain some failure in knownledge-intensive firms and they could explain the fragile relationship between IC, ethics and value (Gowthorpe, 2009).

(b) Appropriate disclosure about IC improves investors' decision-making, secures funding at a lower cost of capital, improving the profitability (Bismuth & Tojo, 2008), enhancing the competitive advantage (Bontis et al., 1999), and contributing to success and financial performance (Youndt et al., 2004). This theory, used extensively, has generated controversial findings discussed by Dumay (2012).

Following these theories, the evaluation methods of intangible assets and the reporting models became the focus of IC literature, generating a *second stage* of research between 1990 and 2010. This stage is the most productive and the most interdisciplinary and the Intellectual Capital Accounting (ICA) emerges. ICA is "a management, accounting and reporting technology towards understanding, measuring and reporting knowledge resources such as employee competencies, customer relationships, brands, financial relationships and information and communication technologies" (Guthrie et al., 2012, p. 70). ICA literature focuses greater attention on publicly listed companies, analyzing the content and the effects of IC disclosure in the capital market. Academics and practitioners develop a wide range of methods for measuring and reporting the IC at an organizational level. Many governments provide general Guidelines for IC reporting and the accounting standards referred to as intangibles are revised or approved (e.g., IFRS 3), to reduce the distance between ICA and financial accounting.

In the mid-2000s, IC research extended the focus on the public entities, nations, and non-profit organizations (NPOs) and, consequently, the concept of value changes. Many articles refer to the Higher Education system, covering issues both on IC reporting and on IC management (Leitner, 2004; Cañibano & Sánchez, 2009).

Few papers analyze hospitals (Habersam & Piber, 2003; Cavicchi & Vagnoni, 2017), national and local governments (Bontis, 2004; Dumay & Guthrie, 2007), cultural organizations (Donato, 2008), and third sector (Fletcher et al., 2003; Kong, 2003), observing issues related to management control, strategy, corporate governance, corporate reporting, and accountability. The intensive focus on *ostensive approach* leads the ICA literature toward the "*evaluatory trap*" (Humphrey et al., 2001; Dumay & Garanina, 2013): many papers, providing assumptions derived by documents not generated for the IC disclosure, generate new frameworks and measurement models, without a clear empirical evidence of their usefulness for the value creation process. Considering the heterogeneous information goals, several reports have been investigated during the time: the Sustainability Report, the Performance Plan for the public institutions, the Knowledge Balance-sheet for the universities, the Intellectual Capital Statements. Behind the meticulous representation of the indicators collected in these reports, the missing information is how organizations create value managing IC over time and a dilemma persists: high quantity of numbers may reduce the transparency and increase the risk to serve specific interests (Nielsen & Madsen, 2009).

A *third critical stage* begins since 2004 (Marr & Chatzkel, 2004; Mouritsen & Roslender, 2009), leading the scientific debate toward the managerial implications of IC across different organizations, promoting the integration of IC disclosure into corporate reporting and following a bottom-up approach, in order to develop a self-management of IC than the top-down imposition of this policy inside the organization (Dumay, 2016). Third stage places the debate on IC toward the integrated reporting <IR> research, maintaining a strict linkage with the second stage (Cuozzo et al., 2017). The <IR> research provides a new opportunity to explore the nature and the effects of IC in the value creation process and the interplay between intangible and tangible assets, considering that many intersections exist between the six capitals conceived in the <IR> and the three IC components (de Villiers & Sharma, 2020). Although the value concept evolves, including the ethical, social, and environmental impacts, the <IR-IC> research maintains the focus inside the organization boundaries, remaining anchored, predominantly, at financial dimension and sometimes to the first stage of IC research.

Gradually, the focus shifts on how IC could be developed on a wider scale (*fourth stage*), switching from a managerial to an ecosystem perspective (Dumay & Garanina, 2013), expanding the Bounfour's thought (2005) about the transition from capitalist focus toward a community perspective. Some studies show that managing IC on a wider scale generates a positive impact in the local economy, enabling innovation, creating social capital (Borin & Donato, 2015) promoting societal and economic development (Secundo et al., 2017a). The levers of IC in action in private firms, public entities, NPOs, and in the ecosystem have been analyzed in detail in Guthrie et al. (2018), remarking the following: the implementation of IC involves many agents across and beyond the organizations; the value creation process is collective; nonfinancial indicators and the interventionist research approach are more appreciated to investigating the IC mobilized in the ecosystem, also exploring the sustainability issues.

The relationship between the IC and sustainability has received low attention and it has been focused on these research questions systematized in the literature review provided by Secundo et al. (2020): (a) understanding if and how the IC promote sustainability, analyzing both IC management and IC disclosure in private and in public sectors; (b) exploring the role of IC for the sustainable development of countries and communities. The concept of *Sustainable Intellectual Capital* emerges, to describe those intangible resources that affect the implementation of sustainable technologies, strategies, and processes (Lopez-Gamero et al., 2011). Research findings remark the relevance of these resources for the sustainable growth: organizational culture, human competences, technology innovation, and partnerships in the private and public sectors (Secundo et al., 2020; Cavicchi & Vagnoni, 2017); stakeholder's engagement, high level of education and technology innovation for the local development and the smart cities (Lopez-Ruiz et al., 2014; Matos et al., 2019). A wide range of these studies remains linked to the prior research question in IC literature: how IC could create value.

Recently, Dumay et al. (2018) and Harlow (2018) suggest the evolution of a potential *fifth stage*, refocusing the scientific debate on these issues: enhancing the critical perspective; verify whether managing IC is fruitful; expanding the IC boundaries, moving beyond the narrow definition of IC and providing a comprehensive vision of value across international settings.

3 IC and the Digital Revolution

The potential of new digital technologies, to bring societal and economic renewal and development, arises recently in IC debate. Literature attempts to explore new emerging trends, promoted by smart technologies evolution and Big Data paradigm (Secundo et al., 2017b). Digitalization and datafication of activities influence the structure of IC and the value creation process: technical skills, data capital, integrated information systems, cybersecurity, and organizational resilience became crucial; the organizations became more vulnerable, given the greater information dependency and the greater network exposition; many institutional and contingent variables may influence the knowledge flows, the utilization of information and the decision-making processes (Kianto et al., 2020). Consequently, IC measurement and IC management perspectives might consider these multiple relationships between organizations and networks or ecosystems, balancing quantitative with qualitative approaches.

Many papers provide theoretical frameworks to support strategic actors to detect processes and resources that could generate value for the organizations and their ecosystem, following the hypothesis that Big Data becomes the new critical assets of IC with high potential for value creation. If this assumption considers the data strategy an IC in action is not clear. Secundo et al. (2017b) suggest the following conceptual research paths: (a) analyzing how data capital impacts on IC components and which resources it creates; (b) verifying how Big Data might contribute to IC strategy and value creation for the ecosystem; (c) exploring what is the value generating by the inclusion of Big Data in IC management; (d) analyzing who are the stakeholders involved in Data strategy connected to IC management. Other frameworks have been proposed in literature to connect IC and Big Data (De Santis & Presti, 2018; Uden & Del Vecchio, 2018), following this theoretical assumption: the value creation depends on how Big Data is managed and incorporated in IC practice. These considerations reproduce, in some way, the first IC stage issues, focusing the debate about the relevance of data capital for IC research. However, the possible inhibitors and risks (intellectual liabilities) related to extraction and analysis of Big Data, should be addressed before exploring the positive effect, integrating the IC debate with the future research trends in management and business studies.

4 Big Data, Smart Technologies, and Digitalization: The State of Art of Business and Management Studies

The objective of this section is to investigate how big data, smart technologies, and digitalization have been incorporated in business and management studies, starting from the definition of big data, smart technologies, and digitalization.

4.1 Definition

An incredible amount of data has been gaining ground so far (Fawcett & Waller, 2014; Surbakti et al., 2020), arising *Big Data (BD)* such a phenomenon that needs to be considered and managed despite its complexity. Indeed, widespread adoption and continuous improvement of technology are revolutionizing the way data is generated, collected, transmitted, and stored, contributing to such BD breakthroughs (Günther et al., 2017). Both academic and practitioner-oriented literatures are still trying to frame this phenomenon, but there is not a unique definition and a precise evaluation of BD at the moment (Gandomi & Haider, 2015; Surbakti et al., 2020).

The current literature defines BD through a growing list of characteristics, firstly starting from "Volume," "Velocity," and "Variety" identified (Laney, 2001). Then, two further features have been added, namely "Value" and "Veracity" (Yin & Kaynak, 2015). More recently, have been included "Variability" and "Visualization" as well (Mishra et al., 2017), referring to possible insights from data analysis.

A further classification of BD has been put in place according to (1) structured data with precise length and format, (2) semi-structured data, and (3) unstructured data that cannot be framed within a specific format or formula (Torrecilla & Romo, 2018).

Moreover, they are different from data usually adopted and generated for business uses (Arnaboldi et al., 2017) because they are often collected without a pre-defined purpose, promoting a bottom-up, inductive approach to their exploration (Constantiou & Kallinikos, 2015).

For what concerns *digitalization*, it can be defined as "the integration of the analogue and digital worlds with new technologies that enhance customer interaction, data availability and business processes" (Eling & Lehmann, 2018, p. 363). The integration of the "analog" and "digital worlds" with new technologies has already profoundly changed many sectors (Caputo et al., 2020; Simon, 2020; Öberg, 2020).

Smart technologies have been profoundly changing the way in conducting the organizations' business. It is not possible to find a unique definition of smart technologies, but the application of smart technologies to different industries, services, and so on. Among such smart technologies, Artificial Intelligence (AI) and Blockchain are considered to be the most disruptive ones (Panetta, 2018; Carson et al., 2018).

4.2 Research Method

A systematic literature review (SLR) (Massaro et al., 2016) has been set up by the authors, which is a research method that exploits collection and analysis of data of previous research in order to draw what has been conducted so far in the field of business and management. In fact, since the topics under-analysis have been gaining ground during the last two decades, and especially in the last 10 years, the authors, through this research, have decided to identify the state-of-the-art of them by collecting and analyzing the scholarly literature referred to "big data," "smart technologies," and "digitalization."

The selected database is Web of Science (WoS), which offers updated documents, covers archived records starting in 1900, and evaluates the importance and the influence of specific publications (Falagas et al., 2008).

In order to draw the lines of the research, it has been conducted a pilot test with the aim of identifying the most suitable keywords. The result of the research query string is as follows:

TOPIC: ("Big Data") OR TOPIC: ("Digitalization") OR TOPIC: ("Smart Technolog*").

The first search has been conducted in November 2020 and considering only the WoS categories: *Management*, *Business*, and *Business Finance*, the screening has got 5246 articles, namely 2707 for Management, 2110 for Business, and 429 for Business Finance.

In order to consider only the latest conducted research, it has been covered as timespan, a narrow period, namely, years from 2001 to 2020, getting 4225 articles.

Moreover, in proceeding with a more in-depth analysis, the authors only selected articles published in appertaining journals classified in 2019 ranking—Top

20 journals SCImago published from the following fields: "*business, management and accounting*," "*accounting*", "*business and international management*" and "*finance*."

This led to 241 articles and, after reading each article's abstract, the authors have eliminated the ones that were not related to the core issue. During this process, 162 articles have been removed to ensure substantive alignment with study's core topic while the other 5 articles have not been considered due to their unavailability; this resulted in 74 academic articles (included in Table 1).

Table 2 shows the screening process used.

Tightening the focus only on the 74 selected papers by further splitting the articles by the years, 61.84% of the papers refer to 2019–2020 and almost 91% to the timespan 2015–2020 as shown in Table 3.

4.3 Results

The closely related articles have been split into different categories according to their related topics, as shown in Table 4.

As shown in Table 4 some papers refer to more than one topic. However, it clearly emerges that big data is the most frequent topic examined since more than half of the selected papers refer to big data alone or together with smart technology.

Further analysis has been conducted by the authors: all the articles have been classified more in-depth, considering the following category: finance, innovation, management, marketing, and others in order to understand which field was more investigated. We used the category "finance" for papers referring to banks and financial markets and category "innovation" when the paper was focused on the innovation process. "Management" is the broad category and includes a variety of papers about, among the others, analysis on supply chain, entrepreneurship, business model, organization. Under the category "marketing" we classified all the papers referring to the relationship between the company and the customers, varying from the service personalization to digital advertising. Some papers were not classifiable within one of the above categories and so they were included in a residual category ("other").

Findings clearly highlight that almost half of the papers refer to the category "management" and this is a logical consequence due to its broad content. Eleven papers are specifically dedicated to the supply chain of which 10 investigated the impact on big data and smart technologies affect the supply chain. Six papers are in the same way linked to the impact of big data, digitalization, and smart technologies on companies' business models. Five papers are in the field of entrepreneurship: 2 of them tried to understand how to use big data and smart technologies in evolving research about entrepreneurship. Five papers are about online platforms and how they can change the way "bricks and mortars" companies can move to digital platforms. International business is another topic investigated (4 papers) as well as

Table 1 Academic articles analyzed

Article	Category	Topic
Aguinis, H; Cascio, WF; Ramani, RS, (2017), Science's reproducibility and replicability crisis: International business is not immune, Journal Of International Business Studies, Vol. 48, pages 653–663	Other	Other
Aguinis, H; Ramani, RS; Cascio, WF, (2020), Methodological practices in international business research: An after-action review of challenges and solutions, Journal Of International Business Studies, Volume 51, pages 1593–1608	Management	International Business
Araujo, T; Copulsky, JR; Hayes, JL; Kim, SJ; Srivastava, J, (2020), From Purchasing Exposure to Fostering Engagement: Brand-Consumer Experiences in the Emerging Computational Advertising Landscape, Journal Of Advertising, Vol. 49, Issue 4, Pages 428–445	Marketing	Advertising
Balog, K, (2020), The concept and competitiveness of agile organization in the fourth industrial revolution's drift, Strategic Management, Vol. 25, No. 3	Management	Organization
Banalieva, ER; Dhanaraj, C, (2019), Internalization theory for the digital economy, Journal Of International Business Studies, Vol. 50, pages 1372–1387	Management	International Business
Begenau, J, Farboodi, M, Veldkamp, L, (2018), Big data in finance and the growth of large firms, Journal Of Monetary Economics, vol. 97(C), pages 71–87	Finance	Cost of financing
Belk, RW (2017), Qualitative Research in Advertising, Journal Of Advertising, vol. 46, pages 36–47	Marketing	Advertising
Benoit, S, Klose, S, Wirtz, J, Andreassen, TW, Keiningham, TL, (2019), Bridging the data divide between practitioners and academics Approaches to collaborating better to leverage each other's resources Journal Of Service Management, Vol. 30 No. 5, pp. 524–548	Management	Data divide
Beverungen, D, Kundisch, D, Wunderlich, N, (2020), Transforming into a platform provider: strategic options for industrial smart service providers, Journal Of Service Management, DOI: 10.1108/JOSM-03-2020-0066	Management	Online Platforms
Bourreau, M, Gensollen, M, Moreau, F, (2012), The Impact of a Radical Innovation on Business Models: Incremental Adjustments or Big Bang?, Industry And Innovation, vol. 19, issue 5, pages 415–435	Management	Business Model
Breidbach, CF, Maglio, P, (2020), Accountable algorithms? The ethical implications of data-driven business models, Journal Of Service Management, DOI: 10.1108/JOSM-03-2019-0073	Management	Business Model

(continued)

Table 1 (continued)

Article	Category	Topic
Buhalis, D; Harwood, T; Bogicevic, V; Viglia, G; Beldona, S; Hofacker, C, (2019), Technological disruptions in services: lessons from tourism and hospitality, Journal Of Service Management, Vol. 30 No. 4, pp. 484–506	Management	Business Model
Cassetta, E, Monarca, U, Dileo, I, Di Berardino, C, Pini, M, (2020), The relationship between digital technologies and internationalisation. Evidence from Italian SMEs, Industry And Innovation, vol. 27, issue 4, pages 311–339	Management	International Business
Chen, G, Xie, PH, Dong, J, Wang, TF, (2019), Understanding Programmatic Creative: The Role of AI, Journal Of Advertising, vol 48, issue 4, pages 347–355	Marketing	Advertising
Coad, A; Srhoj, S, (2020, Catching Gazelles with a Lasso: Big data techniques for the prediction of high-growth firms, Small Business Economics, Vol. 55, pages 541–565	Other	Other
Cong, LW, He, ZG, (2019), Blockchain Disruption and Smart Contracts, Review Of Financial Studies	Other	Other
De Keyser, A, Kocher, S, Alkire, L, Verbeeck, C, Kandampully, J, (2019), Frontline Service Technology infusion: conceptual archetypes and future research directions, Journal Of Service Management, Volume 32, Issue 5, Pages 1754–1797	Management	Organization
Durach, CF, Blesik, T, von During, M, Bick, M, (2020), Blockchain Applications in Supply Chain Transactions, Journal Of Business Logistics, https://doi.org/10.1111/jbl.12238	Management	Supply Chain
Fawcett, SE, Waller, MA, (2014a), Supply Chain Game Changers-Mega, Nano, and Virtual Trends-And Forces That Impede Supply Chain Design (i.e., Building a Winning Team), Journal Of Business Logistics, vol. 35, issue 3, pages 157–164	Management	Supply Chain
Fawcett, SE, Waller, MA, (2014b), Can We Stay Ahead of the Obsolescence Curve? On Inflection Points, Proactive Preemption, and the Future of Supply Chain Management, Journal Of Business Logistics, Vol. 35 No. 1, 2014	Management	Supply Chain
Ferrer-Serrano, M, Latorre-Martinez, MP, Fuentelsaz, L, (2020), The European research landscape under the Horizon 2020 Lenses: the interaction between science centers, public institutions, and industry, Journal Of Technology Transfer, https://doi.org/10.1007/s10961-020-09816-3	Innovation	Innovation
Fosic, I; Trusic, A; Sebalj, D, (2017), Digital Organizational Strategy - Ticket for Competitiveness on the International Market, Strategic Management, Vol. 23, No. 3	Other	Other

(continued)

Table 1 (continued)

Article	Category	Topic
Goncalves, L, Patricio, L, Teixeira, JG, Wunderlich, NV, (2020), Understanding the customer experience with smart services, Journal Of Service Management, Vol. 31 No. 4, pp. 723–744	Marketing	Customers' experience
Gordon, BR, Zettelmeyer, F, Bhargava, N, Chapsky, D, (2019), A Comparison of Approaches o Advertising Measurement: Evidence from Big Field Experiments at Facebook, Marketing Science, Volume 38, Issue 2, Pages 193–364	Marketing	Advertising
Griffith, DA; Chen, QM, (2004) The influence of virtual direct experience (VDE) on on-line ad message effectiveness, Journal Of Advertising, Vol. 33, Issue 1, Pages 55–68	Marketing	Customers' experience
Gupta, S, Leszkiewicz, A, Kumar, V, Bijmolt, T, Potapov, D, (2020), Digital Analytics: Modeling for Insights and New Methods, Journal Of Interactive Marketing, Volume 51, Pages 26–43	Marketing	Marketing strategies
Hamister, JW, Magazine, MJ, Polak, GG, (2018), Integrating Analytics Through the Big Data Information Chain: A Case From Supply Chain Management, Journal Of Business Logistics, Volume39, Issue3, Pages 220–230	Management	Supply Chain
Hazee, S, Zwienenberg, TJ, Van Vaerenbergh, Y, Faseur, T, Vandenberghe, A, Keutgens, O, (2020), Why customers and peer service providers do not participate in collaborative consumption, Journal Of Service Management, Vol. 31 No. 3, pp. 397–419	Management	Business Model
Herhausen, D, Emrich, O, Grewal, D, Kipfelsberger, P, Schoegel, M, (2020), Face Forward: How Employees' Digital Presence on Service Websites Affects Customer Perceptions of Website and Employee Service Quality, Journal Of Marketing Research, Vol. 57, Issue 5	Marketing	Customers' experience
Hornuf, L, Klus, MF, Lohwasser, TS, Schwienbacher, A, (2020), How do banks interact with fintech startups? Small Business Economics, https://doi.org/10.1007/s11187-020-00359-3	Finance	Fintech
Ilyes, C, Szekeres, B, (2017), The Impact of the Digital Economy on Controlling, Strategic Management, vol. 22, issue 3, pages 44–51	Management	Business Model
Kabadayi, S; Ali, F; Choi, H; Joosten, H; Lu, C, (2019), Smart service experience in hospitality and tourism services A conceptualization and future research agenda, Journal Of Service Management, Vol. 30 No. 3, pp. 326–348	Marketing	Personalized services
Karolyi, GA; Van Nieuwerburgh, S, (2020), New Methods for the Cross-Section of Returns, Review Of Financial Studies, Volume 33, Issue 5, Pages 1879–1890)	Finance	Asset price

(continued)

Table 1 (continued)

Article	Category	Topic
Kellogg, KC, Valentine, MA, Christin, A (2020), Algorithms At Work: The New Contested Terrain Of Control Academy Of Management Annals, Vol. 14, No. 1	Management	Organization
Kenney, M; Rouvinen, P; Seppala, T; Zysman, J, (2019), Platforms and industrial change, Industry And Innovation, Vo. 26, Issue 8, Pages 871–879	Management	Online Platforms
Kher, R, Terjesen, S, Liu, C, (2020), Blockchain, Bitcoin, and ICOs: a review and research agenda, Small Business Economics, https://doi.org/10.1007/s11187-019-00286-y	Other	Other
Kostin, KB, (2018), Foresight of the Global Digital Trends, Strategic Management, Vol. 23, Issue 2, Pages 11–19	Management	International Business
Krafft, M, Sajtos, L, Haenlein, M, (2020), Challenges and Opportunities for Marketing Scholars in Times of the Fourth Industrial Revolution, Journal Of Interactive Marketing, Volume 51, Pages 1–8	Marketing	Impact of marketing on research and scholars
Kunz, WH, Walsh, G, (2020) After the revolution – new chances for service research in a digital world, Journal Of Service Management, Vol. 31, No. 3, pp. 597–607	Marketing	Impact of marketing on research and scholars
Liebregts, W, Darnihamedani, P, Postma, E, Atzmueller, M, (2020), The promise of social signal processing for research on decision-making in entrepreneurial contexts, Small Business Economics, Vol. 55, pages 589–605	Management	Entrepreneurship
Lim, C, Kim, MJ, Kim, KH, Kim, KJ, Maglio, P, (2019), Customer process management A framework for using customer-related data to create customer value, Journal Of Service Management, Vol. 30 No. 1, pp. 105–131	Marketing	Personalized services
Liu, X, Burns, AC, Hou, YJ, (2017), An Investigation of Brand-Related User-Generated Content on Twitter, Journal Of Advertising, Volume 46, Issue 2, Pages 236–247	Marketing	Advertising
Malthouse, EC, Buoye, A, Line, N, El-Manstrly, D, Dogru, T, Kandampully, J, (2019), Beyond reciprocal: the role of platforms in diffusing data value across multiple stakeholders, Journal Of Service Management, Vol. 30 No. 4, pp. 507–518	Management	Online Platforms
Malthouse, EC, Haenlein, M, Skiera, B, Wege, E, Zhang, M, (2013), Managing Customer Relationships in the Social Media Era: Introducing the Social CRM House, Journal Of Interactive Marketing. Volume 27, Issue 4, Pages 270–280	Marketing	Customers' experience
Malthouse, EC, Li, HR, (2017), Opportunities for and Pitfalls of Using Big Data in Advertising Research, Journal Of Advertising, Volume 46, Issue 2, Pages 227–235	Marketing	Advertising

(continued)

Table 1 (continued)

Article	Category	Topic
Mazzucato, M, (2016), From market fixing to market-creating: a new framework for innovation policy, Industry And Innovation, Volume 23, Issue 2, Pages 140–156	Innovation	Innovation
Miller, JW, Ganster, DC, Griffis, SE, (2018), Leveraging Big Data to Develop Supply Chain Management Theory: The Case of PanelData, Journal Of Business Logistics, Volume 39, Issue 3, September 2018, Pages 182–202	Management	Supply Chain
Nair, HS; Misra, S; Hornbuckle, WJ; Mishra, R; Acharya, (2017), A Big Data and Marketing Analytics in Gaming: Combining Empirical Models and Field Experimentation, Marketing Science, Volume 36, Issue 5, Pages 645–812	Marketing	Customers' experience
Obschonka, M, Audretsch, DB, (2020), Artificial intelligence and big data in entrepreneurship: a new era has begun, Small Business Economics, Volume 55, pages 529–539	Management	Entrepreneurship
Obschonka, M, Lee, N, Rodriguez-Pose, A, Eichstaedt, JC, Ebert, T, (2020), Big data methods, social media, and the psychology of entrepreneurial regions: capturing cross-county personality traits and their impact on entrepreneurship in the USA, Small Business Economics, DOI: 10.1007/s11187-019-00204-2	Management	Entrepreneurship
Ojala, A, Evers, N, Rialp, A, (2018), Extending the international new venture phenomenon to digital platform providers: A longitudinal case study, Journal Of World Business, Volume 53, Issue 5, Pages 725–739	Management	Online Platforms
Ordenes, FV, Ludwig, S, De Ruyter, K, Grewal, D, Wetzels, M, (2017), Unveiling What Is Written in the Stars: Analyzing Explicit, Implicit, and Discourse Patterns of Sentiment in Social Media, Journal Of Consumer Research, Volume 43, Issue 6, Pages 875–894	Marketing	Customers' experience
Prufer, J, Prufer, P, (2020), Data science for entrepreneurship research: studying demand dynamics for entrepreneurial skills in the Netherlands, Small Business Economics, Volume 55, pages 651–672	Management	Entrepreneurship
Rao, S, Ellis, SC, Goldsby, TJ, Raju, D, (2019), On the Invisible Inventory Conundrum in RFID-Equipped Supply Chains: A Data Science Approach to Assessing Tag Performance, Journal Of Business Logistics, Volume40, Issue4, Pages 339–358	Management	Supply Chain
Routledge, BR, (2018), Comments on: Big data in finance and the growth of large firms, by Juliane Begenau & Maryam Farboodi & Laura Veldkamp, Journal Of Monetary Economics, Volume 97, Pages 88–90	Finance	Cost of financing

(continued)

Table 1 (continued)

Article	Category	Topic
Roy, A; Huh, J; Pfeuffer, A; Srivastava, J, (2017), Development of Trust Scores in Social Media (TSM) Algorithm and Application to Advertising Practice and Research, Journal Of Advertising, Vol. 46, Issue 2, Pages 269–282	Marketing	Advertising
Sanders, NR, Boone, T, Ganeshan, R, Wood, JD, (2019), Sustainable Supply Chains in the Age of AI and Digitization: Research Challenges and Opportunities, Journal Of Business Logistics, Volume 40, Issue 3, September 2019**,** Pages 229–240	Management	Supply Chain
Schoenherr, T, Speier-Pero, C, (2015), Data Science, Predictive Analytics, and Big Data in Supply Chain Management: Current State and Future Potential, Journal Of Business Logistics, Volume 36, Issue 1, Pages 120–132	Management	Supply Chain
Slavic, A; Bjekic, R; Berber, N, (2017), The Role of the Internet and Social Networks in Recruitment and Selection Process, Strategic Management, 2017, Vol. 22, No. 3, Pages 36–43	Other	Other
Smyth, KB, Croxton, KL, Franklin, R, Knemeyer, AM, (2018), Thirsty in an Ocean of Data? Pitfalls and Practical Strategies When Partnering With Industry on Big Data Supply Chain Research, Journal Of Business Logistics, Volume 39, Issue 3, Pages 203–219	Management	Supply Chain
Stein, MK; Wagner, EL; Tierney, P; Newell, S; Galliers, RD, (2019), Datification and the Pursuit of Meaningfulness in Work, Journal Of Management Studies, Volume 56, Issue 3, Pages 685–717	Other	Other
Steinberg, E, (2020), Big Data and Personalized Pricing, Business Ethics Quarterly, Volume 30, Issue 1, pp. 97–117	Marketing	Personalized prices
Thakor, AV, (2020), Fintech and banking: What do we know?, Journal Of Financial Intermediation, Vol. 41	Finance	Fintech
Vives, X, (2019), Digital Disruption in Banking, Annual Review Of Financial Economics, Vol. 11, pages 243–272	Finance	Fintech
Vojvodic, K, (2019), Brick-and-Mortar Retailers: Becoming Smarter with Innovative Technologies, Strategic Management, Vol. 24, No. 2, pp. 003–011	Management	Business Model
Von Bloh, J, Broekel, T, Ozgun, B, Sternberg, R, (2020), New(s) data for entrepreneurship research? An innovative approach to use Big Data on media coverage, Small Business Economics, vol. 55(3), pages 673–694	Management	Entrepreneurship
Waller, MA, Fawcett, SE, (2013b), Data Science, Predictive Analytics, and Big Data: A Revolution That Will Transform Supply Chain Design and Management, Journal Of Business Logistics, Volume 34, Issue 2, Pages 77–84	Management	Supply Chain

(continued)

Table 1 (continued)

Article	Category	Topic
Waller, MA; Fawcett, SE, (2013a), Click Here for a Data Scientist: Big Data, Predictive Analytics, and Theory Development in the Era of a Maker Movement Supply Chain, Journal Of Business Logistics, Volume 34, Issue 4, Pages 249–252	Management	Supply Chain
Wedel, M, Kannan, PK, (2016), Marketing Analytics for Data-Rich Environments, Journal Of Marketing, Vol 80, Issue 6	Marketing	Impact of marketing on research and scholars
Wirtz, J, Patterson, PG, Kunz, WH, Gruber, T, Lu, VN, Paluch, S, Martins, A, (2018), Brave new world: service robots in the frontline, Journal Of Service Management, Vol. 29 No. 5, pp. 907–931	Innovation	Innovation
Yoon, G, Li, C, Ji, Y, North, M, Hong, C, Liu, JM, (2018), Attracting Comments: Digital Engagement Metrics on Facebook and Financial Performance, Journal Of Advertising, Volume 47, Issue 1, pages 24–37	Marketing	Advertising
Zhang, LL, Chung, DJ, (2020), Price Bargaining and Competition in Online Platforms: An Empirical Analysis of the Daily Deal Market, Volume 39, Issue 4, Pages 669–848	Management	Online Platforms
Zhong, N, Schweidel, DA, (2020), Capturing Changes in Social Media Content: A Multiple Latent Changepoint Topic Model, Marketing Science, Volume 39, Issue 4, Pages 669–848	Marketing	Social media metrics
Zhu, C, (2020), Big Data as a Governance Mechanism, Review Of Financial Studies, Volume 32, Issue 5, Pages 2021–2061	Finance	Asset price

Table 2 Journal screening

Search strategy	No. of papers
Query string of keywords	
TOPIC: ("Big Data") OR TOPIC: ("Digitalization") OR TOPIC: ("Smart Technolog*")	68,252
Refined by: WoS categories—“Management,” “Business,” and “Business finance”	5404
Refined by: timespan 2001–2020	4225
Refined by: Top 20 Journals—2019 SCImago ranking (fields: “business, management and accounting,” “accounting” and “business and international management” and “finance”)	241
Refined by: Abstract screening manually conducted by the researchers	74

Source: Authors’ elaboration

Table 3 74 selected papers by year

Year	# paper	%	Cumulative frequencies (%)
2020	28	37.84	37.84
2019	17	22.97	60.81
2018	10	13.51	74.32
2017	9	12.16	86.49
2016	2	2.70	89.19
2015	1	1.35	90.54
2014	2	2.70	93.24
2013	3	4.05	97.30
2012	1	1.35	98.65
2011	0	0.00	98.65
2010	0	0.00	98.65
2009	0	0.00	98.65
2008	0	0.00	98.65
2007	0	0.00	98.65
2006	0	0.00	98.65
2005	0	0.00	98.65
2004	1	1.35	100.00
2003	0	0.00	100.00
2002	0	0.00	100.00
2001	0	0.00	100.00
Total	74	100.00	100.0

Source: Authors' elaboration

Table 4 Investigated research's topics

Topic	# papers	%
Big data	35	47.30
Digitalization and smart technology	10	13.51
Smart technology	14	18.92
Big data and smart technology	4	5.41
Digitalization	11	14.86
Total	74	100.00

Source: Authors' elaboration

organization (3 papers). One paper is a proposal on how academics and managers could collaborate in order to reduce the data divide.

The second most investigated category is marketing. Smart technologies and digitalization have affected companies' marketing strategies: 8 papers are dedicated to change in advertising whereas 6 have investigated customers' experience and how it has been changed due to new technologies. Big data and smart technologies allow companies to personalize services and price: 2 papers are dedicated to how to personalize services whereas 1 paper is dedicated to use big data to personalize price and another paper to social media metrics. Digitalization can be used also to obtain insights from customers and obtain information to be used in marketing strategies, whereas 3 papers explore the impact on research and scholars.

Finance counts 7 papers of which 3 dedicated to fintech and their relationship with incumbents. The big amount of data and the smart technologies allow new analysis about asset price: 2 papers are dedicated to this topic. Other 2 papers are dedicated to big data, their use by large companies and firms' cost of financing.

Three papers are specifically dedicated to innovation, whereas 7 papers cover different topics (human resources, application of blockchain in different fields, use of digital technologies in different countries).

In conclusion, big data, smart technologies, and digitalization have become a hot topic in the last 2 years, in particular in the management and marketing fields. These topics are fundamental for companies and regulators in the next few years because of their importance for competitiveness of both firms and countries. There is room for scholars to explore the countless consequences of big data, smart technologies, and digitalization in management, business, finance, and accounting.

5 Conclusions

The debate on IC shifts toward the main challenges of firms: digital revolution; sustainability; integration of processes, management approaches, and reporting models. Although the digital revolution seems to confirm the strategic role of human competences, technologies, know-how, and relationships, few papers investigate how IC contributes to exploit the potential of digital revolution and how firms disclose their digital capital in the reporting model.

Literature review shows that in business and management studies the digital revolution has been widely explored in marketing and strategy studies, while few papers deal with the accounting implications and the enterprise risk management. Future research could explore deeply the followings issues: (a) how digitalization, smart technologies, and BD impact on IC components or generate new strategic resources, following an integrated managerial approach; (b) how these technologies and these processes might contribute to value creation for the ecosystem; (c) how this phenomenon changes the corporate disclosure, integrating the tangible, financial, and intangible nature of resources and processes.

Considering the high economic impact of digital companies and the increasing datafication of business models, the traditional financial accounting requests new models to visualize, measure, and interpret the impact of the intangible resources, especially those related to smart technologies and datafication of processes. To emancipate the ICA, bridging the gap between information and knowledge, the contemporary accounting needs more descriptions and narrative than measures (Rooney & Dumay, 2016), more critical, sociological, and ethical debate over the accounting technique and no boundaries, as suggested for the progress of IC research.

References

Arnaboldi, M., Busco, C., & Cuganesan, S. (2017). Accounting, accountability, social media and big data: Revolution or hype? *Accounting, Auditing & Accountability Journal, 30*(4), 762–776.

Bismuth, A., & Tojo, Y. (2008). Creating value from intellectual assets. *Journal of Intellectual Capital, 9*(2), 228–245.

Bontis, N. (2004). National intellectual capital index: A United Nations initiative for the Arab region. *Journal of Intellectual Capital, 5*(1), 13–39.

Bontis, N., Dragonetti, N. C., Jacobsen, K., & Roos, G. (1999). The knowledge toolbox: A review of the tools available to measure and manage intangible resources. *European Management Journal, 17*, 391–402.

Borin, E., & Donato, F. (2015). Unlocking the potential of IC in Italian cultural ecosystems. *Journal of Intellectual Capital, 16*(2), 285–304.

Bounfour, A. (2005). *Intellectual capital for communities. Research and policy agenda*. Elsevier Butterworth-Heinemann.

Bratianu, C. (2018). Intellectual capital research and practice: 7 myths and one golden rule, Management & Marketing. *Challenges for the Knowledge Society, 12*(2), 859–879.

Caddy, I. (2002). Issues concerning intellectual capital metrics and measurement of intellectual capital. *Singapore Management Review, 24*(3), 77–83.

Cañibano, L., & Sánchez, M. P. (2009). Intangibles in universities: Current challenges for measuring and reporting. *Journal of Human Resource Costing & Accounting, 13*(2), 93–104.

Caputo, A., Pizzi, S., Pellegrini, M. M., & Dabić, M. (2020). Digitalization and business models: Where are we going? A science map of the field. *Journal of Business Research, 123*, 489–501.

Carson, B., Romanelli, G., Walsh, P., & Zhumaev, A. (2018). *Blockchain beyond the hype: What is the strategic business value?* McKinsey Digital.

Cavicchi, C., & Vagnoni, E. (2017). Does intellectual capital promote the shift of healthcare organizations towards sustainable development? *Evidence from Italy, Journal of Cleaner Production, 153*, 275–286.

Constantiou, I. D., & Kallinikos, J. (2015). New games, new rules: Big data and the changing context of strategy. *Journal of Information Technology, 30*(1), 44–57.

Cuganesan, S. (2005). Intellectual capital-in-action and value creation: A case study of knowledge transformation in an innovation process. *Journal of Intellectual Capital, 6*(3), 357–373.

Cuozzo, B., Dumay, J., Palmaccio, M., & Lombardi, R. (2017). Intellectual capital disclosure: A structured literature review. *Journal of Intellectual Capital, 18*(1), 9–28.

De Santis, F., & Presti, C. (2018). The relationship between intellectual capital and big data: A review. *Meditari Accountancy Research, 26*(3), 361–380.

de Villiers, C., & Sharma, U. (2020). A critical reflection on the future of financial, intellectual capital, sustainability and integrated reporting. *Critical Perspectives on Accounting, 70*, 101999–102011.

Donato, F. (2008). Managing IC by antennae: Evidence from cultural organizations. *Journal of Intellectual Capital, 9*(3), 380–394.

Dumay, J. (2012). Grand theories as barriers to using IC concepts. *Journal of Intellectual Capital, 13*(1), 4–15.

Dumay, J. (2016). A critical reflection on the future of intellectual capital: From reporting to disclosure. *Journal of Intellectual Capital, 17*(1), 168–184.

Dumay, J., & Garanina, T. (2013). Intellectual capital research: A critical examination of the third stage. *Journal of Intellectual Capital, 14*(1), 10–25.

Dumay, J., & Guthrie, J. (2007). Disturbance and implementation of IC practice: A public sector organisation perspective. *Journal of Human Resource Costing and Accounting, 11*(2), 104–121.

Dumay, J., Guthrie, J., & Rooney, J. (2018). The critical path of intellectual capital. In J. Guthrie, J. Dumay, F. Ricceri, & C. Nielsen (Eds.), *The Routledge companion to intellectual capital: Frontiers of research, practice and knowledge* (pp. 21–39). Routledge.

Eling, M., & Lehmann, M. (2018). The impact of digitalization on the insurance value chain and the insurability of risks. *The Geneva Papers on Risk and Insurance-Issues and Practice, 43*(3), 359–396.

Falagas, M. E., Pitsouni, E. I., Malietzis, G. A., & Pappas, G. (2008). Comparison of PubMed, Scopus, web of science, and Google scholar: Strengths and weaknesses. *The FASEB Journal, Federation of American Societies for Experimental Biology, 22*(2), 338–342.

Fawcett, S. E., & Waller, M. A. (2014). Supply chain game changers—Mega, nano, and virtual trends—And forces that impede supply chain design (ie, building a winning team). *Journal of Business Logistics, 35*(3), 157–164.

Fletcher, A., Guthrie, J., Steane, P., Roos, G., & Pike, S. (2003). Mapping stakeholder perceptions for a third sector organization. *Journal of Intellectual Capital, 4*(4), 505–527.

Gandomi, A., & Haider, M. (2015). Beyond the hype: Big data concepts, methods, and analytics. *International Journal of Information Management, 35*(2), 137–144.

Giuliani, M. (2015). Rome wasn't built in a day ... reflecting on time, intellectual capital and intellectual liabilities. *Journal of Intellectual Capital, 16*(1), 2–19.

Gowthorpe, C. (2009). Wider still and wider? A critical discussion of intellectual capital recognition, measurement and control in a boundary theoretical context. *Critical Perspectives on Accounting, 20*(7), 823–834.

Günther, W. A., Mehrizi, M. H. R., Huysman, M., & Feldberg, F. (2017). Debating big data: A literature review on realizing value from big data. *The Journal of Strategic Information Systems, 26*(3), 191–209.

Guthrie, J., Riccieri, F., & Dumay, J. (2012). Reflections and projections: A decade of intellectual capital accounting research. *British Accounting Review, 44*(2), 68–82.

Guthrie, J., Dumay, J., Ricceri, F., & Nielsen, C. (Eds.). (2018). *The Routledge companion to intellectual capital*. Routledge.

Habersam, M., & Piber, M. (2003). Exploring intellectual capital in hospitals: Two qualitative case studies in Italy and Austria. *European Accounting Review, 12*(4), 753–779.

Harlow, H. D. (2018). Developing a knowledge management strategy for data analytics and intellectual capital. *Meditari Accountancy Research, 26*(3), 400–419.

Harvey, M. G., & Lusch, R. F. (1999). Balancing the intellectual capital books: Intangible liabilities. *European Management Journal, 17*(1), 85–92.

Humphrey, C., Olson, O., & Guthrie, J. (2001). Caught in an evaluatory trap: A dilemma for public services under NPFM. *European Accounting Review, 10*(3).

Kianto, A., Ritala, P., Vanhala, M., & Hussinki, H. (2020). Reflections on the criteria for the sound measurement of intellectual capital: A knowledge-based perspective. *Critical Perspectives on Accounting, 70*, 102046–102060.

Kong, E. (2003). Using intellectual capital as a strategic tool for non-profit organisations. *The International Journal of Knowledge, Culture and Change Management, 3*, 467–474.

Laney, D. (2001). 3D data management: Controlling data volume, velocity and variety. *META Group Research Note, 6*(70), 1.

Leitner, K. A. (2004). Intellectual capital reporting for universities: Conceptual background and application for Austrian universities. *Research Evaluation, 13*(2), 129–140.

Lopez-Gamero, M. D., Zaragoza-Saez, P., Claver-Cortes, E., & Molina-Azorin, J. F. (2011). Sustainable development and intangibles: Building sustainable intellectual capital. *Business Strategy and Environment, 20*(1), 18–37.

Lopez-Ruiz, V. R., Alfaro-Navarro, J. L., & Nevado-Pena, D. (2014). Knowledge-city index construction: An intellectual capital perspective. *Expert Systems with Applications, 41*(12), 5560–5572.

Marr, B., & Chatzkel, J. (2004). Intellectual capital at the crossroads: Managing, measuring, and reporting of IC. *Journal of Intellectual Capital, 5*(2), 224–229.

Massaro, M., Dumay, J., & Guthrie, J. (2016). On the shoulders of giants: Undertaking a structured literature review in accounting, accounting. *Auditing & Accountability Journal, 29*(5), 767–801.

Matos, F., Vairinhos, V., Selig, P., & Edvinsson, L. (Eds.). (2019). *Intellectual capital management as a driver of sustainability* (pp. 49–66). Springer.

Mishra, D., Luo, Z., Jiang, S., Papadopoulos, T., & Dubey, R. (2017). A bibliographic study on big data: Concepts, trends and challenges. *Business Process Management Journal, 23*(3), 555–573.

Mouritsen, J., Larsen, H. T., & Bukh, P. N. D. (2001). Intellectual capital and the 'capable firm': Narrating, visualising and numbering for managing knowledge. *Accounting Organizations and Society, 26*(7–8), 735–762.

Mouritsen, J., & Roslender, R. (2009). Critical intellectual capital. *Critical Perspectives on Accounting, 20*, 801–803.

Nielsen, C., & Madsen, M. T. (2009). Discourses of transparency in the intellectual capital reporting debate: Moving from generic reporting models to management defined information. *Critical Perspectives on Accounting, 20*(7), 847–857.

Öberg, C. (2020). Disruptive and paradoxical roles in the sharing economies. *International Journal of Innovation Management* (in press).

Panetta, K. (2018). *5 trends emerge in the Gartner hype cycle for emerging technologies, smarter with Gartner*. Gartner.

Petrash, G. (1996). Dow's journey to a knowledge value management culture. *European Management Journal, 14*(4), 365–373.

Petty, P., & Guthrie, J. (2000). Intellectual capital literature review: Measurement, reporting and management. *Journal of Intellectual Capital, 1*(2), 155–175.

Rooney, J., & Dumay, J. (2016). Intellectual capital, calculability and qualculation. *The British Accounting Review, 48*, 1–16.

Secundo, G., De Beer, C., Schutte, C. S. L., & Passiante, G. (2017a). Mobilising intellectual capital to improve European universities' competitiveness. The technology transfer offices' role. *Journal of Intellectual Capital, 18*(3), 607–624.

Secundo, G., Del Vecchio, P., Dumay, J., & Passiante, G. (2017b). Intellectual capital in the age of big data: Establishing a research agenda. *Journal of Intellectual Capital, 18*(2), 242–261.

Secundo, G., Ndou, V., Del Vecchio, P., & De Pascale, G. (2020). Sustainable development, intellectual capital and technology policies: A structured literature review and future research agenda. *Technological Forecasting and Social Change, 153*, 1119917.

Simon, J. P. (2020). The global internet market(s): A reconstruction of the views of the industry. *Digital Policy, Regulation and Governance, 22*(2), 109–133.

Stam, C. D. (2009). Intellectual liabilities: Lessons from the decline and fall of the Roman empire. *VINE: The Journal of Information and Knowledge Management Systems, 39*(1), 92–104.

Stewart, T. A. (1997). *Intellectual capital: The wealth of new organisations*. Nicholas Brealey Publishing.

Surbakti, F. P. S., Wang, W., Indulska, M., & Sadiq, S. (2020). Factors influencing effective use of big data: A research framework. *Information & Management, 57*(1), 103146.

Torrecilla, J. L., & Romo, J. (2018). Data learning from big data. *Statistics & Probability Letters, 136*, 15–19.

Uden, L., & Del Vecchio, P. (2018). Transforming the stakeholders' big data for intellectual capital management. *Meditari Accountancy Research, 26*(3), 420–442.

Yin, S., & Kaynak, O. (2015). Big data for modern industry: Challenges and trends. *Proceedings of the IEEE, 103*(2), 143–146.

Youndt, Subramanian, & Snell. (2004). Intellectual capital profiles: An examination of investments and returns. *Journal of Management Studies, 41*(2), 335–361.

Intellectual Capital Measurement, Management, and Valuation

Giovanni Bronzetti, Graziella Sicoli, Maria Serena Chiucchi, and Marco Giuliani

1 Introduction

In actual markets, companies have to develop specific internal knowledge related to the—so-called soft values, i.e., intangible assets to face the new challenges. The intangible assets are the main drivers of value (Lev, 2001) and the critical success factors of companies.

Intangible assets represent the accumulated knowledge of a company and include not only the know-how of people, but also the knowledge related to the organizational system and all the information that outlines the culture and reputation of the company on the market (Sicoli, 2018).

Scholars have recognized that economic wealth comes from knowledge resources—IC—and their useful application as an integration of material resources (Dean & Kretschmer, 2007); the emphasis on this idea is relatively new and the management of a company's IC has become one of the main tasks of management.

Giovanni Bronzetti has developed Sects. 1 and 2, Graziella Sicoli Sects. 3 and 4 while Maria Serena Chiucchi and Marco Giuliani have written Sect. 5. Section 6 has involved all the authors.

G. Bronzetti
Department of Economics, Management and Statistics, University of Palermo, Palermo, Italy
e-mail: giovanni.bronzetti@unipa.it

G. Sicoli
Department of Business Administration and Law, Università della Calabria, Rende, Italy
e-mail: graziella.sicoli@unical.it

M. S. Chiucchi · M. Giuliani (✉)
Department of Management, Universita' Politecnica delle Marche, Ancona, Italy
e-mail: m.s.chiucchi@univpm.it; m.giuliani@univpm.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_2

It is in this perspective that companies are changing their strategies and rethinking their organization, structures, and processes in order to obtain a better detection and measurement of intangible assets.

Knowledge is considered a basic resource for value creation. Managing knowledge and IC create opportunities and competitive advantages.

First, the IC of a company can be defined as the sum of the knowledge of its members and the practical translation of this knowledge (Edvinsson & Malone, 1997).

In the light of these premises, this chapter is developed. In fact, after a narrative review on IC, it illustrates its individual components (human capital, relational capital, and structural capital). Subsequently, it focuses on the main measurement and evaluation models and on the role, potential, and limits they have in the business economy (Sicoli et al., 2015, 2017).

2 Knowledge and IC

Starting from the consideration that knowledge is an essential resource for establishing competitive advantage, management should obviously attempt to identify, generate, and develop knowledge within the firm.

Knowledge-Based Capital (KBC) encompasses a number of assets that create future intangible benefits for businesses. This is the largest form of corporate investment and is a key driver of competitive growth in advanced economies.

In this era of knowledge, the IC has become an indispensable element; global competition takes place on intangible (intellectual) assets rather than on traditional tangible assets of the industrial economy (physical and financial resources). It is in this perspective that the intangible has acquired a central role and acts as a key element of corporate value (Edvinsson & Malone, 1997; Lev, 2001; Stewart, 1997).

In the knowledge economy, the value of countries, regions, organizations, and individuals is directly related to their knowledge and CI.

At the same time, knowledge management (KM) is recognized as the fundamental activity for obtaining, growing, and sustaining IC in organizations. This means that successful management of the IC is closely related to the KM processes that an organization has in place; which in turn implies that the successful implementation and use of KM ensures the acquisition and growth of IC.

For this reason, it is important to identify, analyze, measure, and manage IC as it seems that there is a close link between the value of the company and the investment in the IC components (Brooking, 1997; Edvinsson & Malone, 1997; Sveiby, 1997).

3 Intellectual Capital: A Literature Review

The study methodology is a literature review on IC from the 1990s, with studies aimed at describing intellectual resources, their impact, behavior at different stages of the life of the organization and their interaction. Initially, the selection of articles was performed through the narrative review of numerous studies (Andriessen, 2004; Roos & Roos, 1997), which confirm IC potential to create value in the company. Later in another section, the authors analyzed the quantitative research that tried to confirm the value of the resource by defining the measurement methodologies.

The IC, from a qualitative point of view, as defined by the Bontis model (Bontis, 1998) can be divided into three categories: structural capital, human capital, and relational capital.

A variety of classification schemes and models have been used regarding the IC theoretical framework (e.g., Brooking, 1997; Petty & Guthrie, 2000). We have adopted the widely established Bontis model because has been generally accepted in the current literature (Bontis, 1998), which divides the CI into three main components: (a) Human capital: knowledge and skills of individuals; (b) Structural capital: internal processes and information owned by the organization; and (c) Relational Capital: customer satisfaction, loyalty and engagement, and also because for the explicit theoretical relevance regarding the CI and for the understanding of how businesses can measure and manage their own IC, providing information on each of the different components and sizes (Atrill, 1998; Dzinkowski, 2000; Lynn, 1998).

Dividing intellectual capital into components, however, is a rather didactic strategy as there is an inherent difficulty in isolating capital in its various forms due to the convertibility and overlapping nature of different types of capital.

Many scholars have placed their attention on the role of the IC as the main driver of corporate performance (Stewart, 1997; Sveiby, 1997).

The first known instance of IC is from Thomas Stewart's article which was released in 1991.

According to Pulic (2000), despite the importance of tangible assets in the production of goods and services in modern economy, economic value, and wealth is often generated by development and application of IC rather than management of tangible assets and IC is a part of knowledge that gives value-added contribution to a company and will result in a competitive advantage.

In 1997, Leif Edvinsson and Hubert Saint-Onge made interesting theoretical contributions aimed at measuring a company's CI and appreciation of the ways it creates value (Edvinsson & Malone, 1997; Saint-Onge, 1996). Other contributions are certainly due to Hiroyuki Itami, Richard Hall, Baruch Lev, who together with Leif Edivnsson are the first authors to address the issue of the IC.

IC is anything that can provide a competitive advantage for a company in the form of intangible assets such as knowledge, technologies used by the company, financial information, and human resources experiences that result in the creation of added value for the company.

Sveiby (1997) notes that intellectual resources should be divided into three categories: external structure, internal structure, and employee competence. Stewart defines the IC as the most valuable asset for a company, being represented by the wealth of knowledge, information, intellectual property, and experience to be used to achieve a position of well-being. Stewart broadens the focus and shares the CI into three categories: human capital, structural capital, and customer capital. These three components are not independent, but complementary, with the result that the value is not generated directly by the individual factors, but by the interaction between them. Bontis, however, replaces the third customer component with the relational component (Bontis, 2001).

The triple division of IC into human capital, structural capital, and relational capital is one of the few fixed points on which scholars agree. It remains, however, difficult to identify universally recognized standards for corporate IC reporting.

In particular, by defining the components of IC we can say that the approach identifies IC in human capital, relational capital, and structural capital (Edvinsson & Malone, 1997).

Based on the proposal of Edvinsson and Malone (Edvinsson & Malone, 1997), the CI is a two-level construct: human capital (the knowledge created and stored by the employees of a company) and structural capital (the embodiment, empowerment, and "human capital support infrastructure"). Then, they divide structural capital into organizational capital (knowledge created and stored in a company's computer systems and processes) and customer capital (the value of relationships between a company and its customers).

IC has been defined in many ways: Hall (1992) states that IC can be classified as an asset (such as a brand) or skills (such as technical knowledge of personnel or organizational culture).

Ross in 1997 theorizes that the IC is the result of a value creation process fueled by the interaction between the human component and the structural component and, therefore, aimed at transforming the knowledge of individuals into knowledge of the entire organization (Roos & Roos, 1997).

Below, we briefly report the contribution of the IC components.

4 IC Components

As regards the first of the three dimensions that make up the IC, we must refer to human capital, or the human resources available to the company. Human capital refers to processes related to training, education, and other professionalization programs created to improve the knowledge, skills, values, and social resources of employees, which can strengthen workers and improve the performance of their company (Abramovitz & David, 2000; Galor & Moav, 2004).

The management of human resources is a very delicate aspect of the company organization as it can affect the correct functioning of the company itself. Every person in the company must be able to value what they know in order to give the best of themselves. Lin (Lin et al., 2017) reported that human capital development is positively associated with employee value, indicating that practices such as training and job design increase worker utility. In this sense, distinct employee profiles provide different components of human capital, adding value to organizational assets. Human capital is a source of tacit knowledge and is acquired through experience and explicit knowledge. It can be empowered by social relationships, human worth improvement, and organizational commitment (Tamayo et al., 2001).

Human capital represents the collection of skills and abilities that are embedded in the members of the organization and can be exploited to expand intangible assets at the firm level (Bontis & Fitzenz, 2002; Nerdrum & Erikson, 2001). In this sense, therefore, the more a company has a highly educated workforce, the more we must expect the company to have the managerial and innovative skills necessary to expand its intangible assets.

Human capital is considered the most complex dimension because it is difficult to imitate or replace (Walsh et al., 2008).

Human resources are essential to successfully compete on the market: honesty, loyalty, ability, professionalism, and technical skills are the conditions for achieving the objectives. Human capital through the development of ideas and knowledge positively affects business innovation. Human capital is also a source of competitive advantage.

The second dimension of the CI concerns the structural capital which, similarly to human capital, can influence the process of accumulation of intangible assets. It is made up of a set of knowledge such as procedures, patents, organizational models, information and communication tools, organizational structure, operating procedures, and company databases.

According to some authors, in fact, the firm's intangible stock includes assets that directly increase what has come to be known as the firm's organization capital (Kaplan & Norton, 2004; Lev & Radhakrishnan, 2003; Bontis, 2001). Organization capital was also defined as a set of information assets that the firm uses in order to coordinate the material factors of production, namely physical capital and labor.

In particular, structural capital includes everything that still exists after working hours, such as relationships with suppliers, customers, local commodities, government, and shareholders (Edvinsson & Malone, 1997).

In relation to the structural capital, managers should pay particular attention to the aforementioned aspects, building a set of indicators that allow their measurement. The variables used to evaluate structural capital are corporate culture, the capacity for change and innovation, the Internet, and the network. Structural capital analysis is able to capture the company's ability to innovate, the acquired know-how and the management's ability to manage the business. Companies and organizations in general, as groups of people, produce corporate culture. Change and innovation become components of intangible heritage when they are translated in organizational learning.

The third component of IC is made up of relational capital, described by the relationships maintained by the company with its stakeholders.

Relational capital is defined as a set of intangible assets linked to the external operations of companies, including a large variety of resources deriving from relationships with stakeholders, customers, suppliers, communities, public administrations, and financial entities, among others.

The life of a company is made up of multiple relationships with the outside world and the quality of relationships is the basis for future development and for the creation of value. The quality in relations with external parties improves the trust and reputation enjoyed by a company, thus contributing to increasing the value of relational capital. The company must focus its efforts on relationships with customers and suppliers not only when purchasing raw materials or selling them but, through consolidated actions, must try to stabilize these relationships in the long term.

With customers, who are one of the most important external interlocutors, various actions can be taken to increase their trust. These include continuity of contacts, clarity of communication, and sharing of any problems. Policies can also be implemented to create barriers to entry by acting on prices and products or to strengthen barriers to exit with contractual or guarantee constraints. Finally, strategies for strengthening customer relationships include advertising messages aimed at strengthening the brand or corporate image and pricing policies. The company must understand the needs of users well and, therefore, must create a good system of relationships and communication. Consequently, it is possible to create services to build customer loyalty and meet their needs. Only through relational capital, the company increases its reputation and strengthens over time (Fombrun & Shanley, 1990; Fombrun, 1996).

Relational capital, defined also as client capital, is considered a market asset that is obtained through affiliation with a brand. It deals with the external environment and consists of knowledge of marketing, customer attractiveness, and distribution channels. The brand name itself is considered one of the biggest contributors to the customer's capital. The main goal for improving this dimension is to attract new customers and retain existing ones.

5 IC Measurement, Valuation, and Reporting

As some argue (Stewart, 1997), the identification of IC as a "new" object has brought forward the idea that there is the need to develop new measurement and valuation methods and tools. Thus, scholars and practitioners have proposed a plethora of IC accounting systems, which differ from one another by hypotheses, objects, and formulas considered and which, to date, appear to have been implemented in very few organizations (Andriessen, 2004; Sveiby, 2010).

Among the reasons for measuring and valuing IC, it is possible to mention the needs related to the improvement of internal management and external reporting as well as transactional and statutory motives (Andriessen, 2004).

From the analysis of the extant literature, it is possible to identify two different (although related) perspectives on IC accounting: IC measurement and IC valuation (Andriessen, 2004; Sveiby, 2010).

5.1 IC Measurement

Measurement occurs when the adopted framework "does not include a criterion for value but involves a metrical scale that relates to an observable phenomenon" (Andriessen, 2004).

An IC measurement system consists of a system of indicators (monetary and non-monetary) that permits the monitoring of those qualitative and quantitative features of intangibles and their dynamics over time as well as the effectiveness and efficiency of actions undertaken for their development. Therefore, an IC measurement system must allow visualizing, understanding, and controlling the stock and flows of intangibles.

Several classifications have been proposed for this type of model. Andriessen (2004) distinguishes the models useful (mainly) for managerial purposes from the ones for disclosure aims or statutory purposes. Ricceri and Guthrie (2009) classify the measurement models into the stock approach and the flow approach. Abhayawansa (2014) identifies three types of models: (a) the ones focused on value creation; (b) the ones that do not particularly explain the firm value creation process but highlight the importance of IC indicators concerning corporate objectives and strategies, and (c) the ones that recommend the disclosure of IC indicators without linking them to corporate objectives and business strategies, such as the invisible balance sheet.

Focusing on the distinction between the stock- and flow-based models, the stock models have the ambition to "make invisible visible," i.e., to report the value of IC and its components. Thus, the idea is to represent the "size" of IC. These models tend to rely strongly on the IC tri-part model (human capital, structural capital, and relational capital) and to be developed moving from practice to theory, i.e., developed in a specific organizational context and then (more or less) generalized.

The measurement models based on the flow approach aim to contextualize knowledge resources and to focus on knowledge flows or IC dynamics. The focus is on the value creation process and on the activities carried out to create and develop IC. Here, the idea is that IC measurement should enable learning processes (managerial perspective) and make it possible to the stakeholders to realize the organizational value creation process.

The process for measuring IC is generally defined as a multiple-step approach. The first step is the definition of the organizational strategy. Then, the strategic intangibles, i.e., the ones that are crucial in the organizational value creation process and play a relevant role in the company's business model, should be identified. The third step consists in the identification of the linkages between intangibles and the financial capital. In this step, the design of a causal-value creation map can be useful.

Accordingly, a panel of indicators should be designed. The indicators should be focused both on the performance of the intangibles and on the activities carried out to create or develop them. The fifth step consists of the implementation of the panel of indicators. Here it is important to consider not only one period but, at least, two periods to identify a trend. The last step is represented by IC reporting. In the report, the IC indicators should be systematized and analyzed to make the value creation process visible and understandable.

5.2 IC Valuation

Valuation, instead, is as an accounting practice useful to represent a phenomenon to compare it with other phenomena. Three different types of valuation can occur: financial valuation, when the value is expressed in monetary terms, value measurement, when the value is expressed in nonmonetary terms, and value assessment, when the valuation is not based on a framework but instead depends on the personal judgment of the evaluator (Andriessen, 2004).

Concerning IC valuation, some argue that even if it has been debated for a decade, it is still an open issue. The reasons for this can be the following: First, valuation underlies a comparison and this contrasts with the absence of generally accepted guidelines and with the firm-specific nature of IC. Second, the valuation methods and tools proposed are often problematic, unrecognized, and untested. Third, as mentioned above, the role played by IC in the value creation process is not linear, it is difficult to map completely and is not clear and therefore, it is difficult to translate in a valuation formula (Andriessen, 2004).

According to Sveiby (2010), the approaches used for valuing IC fall into three categories: Direct IC Methods (DIC), Market Capitalization Methods (MCM), and Return on Assets Methods (ROA). The first models are the ones that try to identify directly the market value of specific intangibles or the whole IC. The MCMs, instead, estimate the IC value as the difference between a company's market capitalization and its stockholders' equity. The ROA methods value IC considering the expected profits generated by intangibles.

Independently from the method chosen, a valuation cannot be carried out in a single step: it is a rigorous process with several phases between gathering information and obtaining the value (Penman, 2007). In general, the IC valuation process can be described as follows (Andriessen, 2004; Lev, 2001): (1) visualizing, (2) understanding, and (3) valuing. The first step is related to the identification of IC, i.e., the choice of a definition to refer to and the consequent definition of its boundaries. Understanding relates to the diagnosis of IC or, in other words, the investigation of how IC "works" and creates value. The last step is the choice and application of the valuation formula and the reporting of the value. IC value can be reported in "stand-alone" documents where the core is the result of the valuation or in other reports where the IC value is presented among other elements (e.g., management commentary and integrated reports).

5.3 Levers and Barriers for IC Measurement and Valuation

Measuring and valuing IC is a complex and challenging process. The degree of success of this process depends on several technical and organizational issues considerable as levers and barriers (Chiucchi et al., 2018).

Regarding the technical levers, it is possible to mention the following:

– The ambiguity of the IC concept which makes it is more likely that managers will make sense of IC and engage with it by applying it to corporate concerns. In this way, IC can be enacted and used as a solution to issues (Dumay & Rooney, 2016; Giuliani et al., 2016).
– The involvement of managers in designing the IC frameworks so that they engage with IC (Chiucchi & Dumay, 2015).
– The creation of tailor-made solutions and the rejection of the one-size-fits-all approach (Dumay, 2009).
– The "dramatization" of IC indicators (Catasús & Gröjer, 2006; Giuliani et al., 2016).
– The visualization of the value creation and destruction processes (Cuganesan & Dumay, 2009; Giuliani, 2013).
– The use of grand theories (Dumay, 2012) that can support the necessary motivation for the implementation of these reports.
– All elements that permit to speed and smooth the collection and calculation processes related to IC accounting (Chiucchi et al., 2018; Giuliani et al., 2016).

Moving to the technical barriers, the extant studies have suggested the ones that follow:

– The misleading potential of grand theories (Dumay, 2012).
– The fact that IC indicators may be perceived as "provocative" (Vaivio, 2004), or "rapidly obsolete" (Chiucchi, 2013; Dumay & Rooney, 2011), or as "fragile" (Chiucchi & Montemari, 2016).
– Specific qualities of IC measurements (not self-evident, ambiguity, not fully comparable, etc.) (Giuliani, 2014; Giuliani et al., 2016).
– The fact that IC scores may not confirm the users' perceptions or expectations (Chiucchi & Montemari, 2016).
– The "lock in" or "accountingisation" phenomenon (Chiucchi & Dumay, 2015).

With regard to the organizational dimension, levers and barriers are related to the actors involved in the process of production and use of IC measurements and to their engagement (Dumay & Rooney, 2011). In particular, several studies underline the relevance of project leaders and project sponsors as key roles in undertaking IC accounting projects, in determining their aims, in carrying out the projects, in continuing and/or in abandoning them. In addition, some argue that also external partners (consultants and in few cases university researchers) can play a relevant role (Giuliani & Chiucchi, 2019).

6 Conclusions

IC issues have undergone an extraordinary development since the beginning of the 1990s. Even if IC is still considered as a strategic resource, after the enthusiasm of the 1990s, IC measurement and valuation have experienced a demise in the last decades. This is witnessed by the fact that several companies have abandoned these practices.

Nevertheless, now there is a resurging interest on IC as the European Union Directive on reporting nonfinancial and diversity information (2014/95/EU) as well as the 2021 EU Proposal for a Corporate Sustainability Reporting Directive prompt more IC disclosures. In addition, from a managerial perspective, even if an IC report is not existing anymore, in several organizations IC indicators are still existing and used as a part of the broader strategic control system or of the performance measurement system. This suggests that IC reporting is almost no more existing as a stand-alone phenomenon but it is continuing as part of broader accounting systems, both for managerial and for disclosure purposes. In all, it seems that a new stage of the IC discourse is going to come: research avenues can be related to IC reporting according to the actual and the proposed EU directive and to the examination of the use of IC measurement and valuation methods.

References

Abramovitz, M., & David, P. A. (2000). American macroeconomic growth in the era of knowledge-based progress: The long-run perspective. In S. L. Engermana & R. E. Gallman (Eds.), *The Cambridge economic history of the United States, Cambridge*. Cambridge University Press.

Andriessen, D. (2004). *Making sense of intellectual capital: Designing a method for the valuation of intangibles*.

Atrill, P. (1998). Intellectual assets: The new frontier. *ACCA Students' Newsletter, 34*, 56–59.

Bontis, N. (2001). Assessing knowledge assets: A review of the models used to measure intellectual capital. *International Journal of Management Reviews, 3*(1), 41–60.

Bontis, N. (1998). Intellectual capital: An exploratory study that develops measures and models. *Management Decision, 36*(2), 63–76. https://doi.org/10.1108/00251749810204142.

Bontis, N., & Fitzenz, J. (2002). Intellectual capital ROI: A causal map of human capital antecedents and consequents. *Journal of Intellectual Capital, 3*(3), 223–247.

Brooking, A. (1997). *El capital intelectual: el principal activo de las empresas del tercer milenio* [Intellectual capital: Core asset for the third millennium enterprise]. Paidós Ibérica.

Catasús, B., & Gröjer, J.-E. (2006). Indicators: On visualizing, classifying and dramatizing. *Journal of Intellectual Capital, 7*(2), 187–203.

Chiucchi, M. S. (2013). Measuring and reporting intellectual capital: lessons learnt from some interventionist research projects. *Journal of Intellectual Capital, 14*(3), 395–413.

Chiucchi, M. S., & Dumay, J. (2015). Unlocking intellectual capital. *Journal of Intellectual Capital, 16*(2), 305–330.

Chiucchi, M. S., & Montemari, M. (2016). Investigating the "fate" of intellectual capital indicators: A case study. *Journal of Intellectual Capital, 17*(2), 238–254.

Chiucchi, M. S., Giuliani, M., & Marasca, S. (2018). Levers and barriers to the implementation of intellectual capital reports: A field study. In J. Guthrie, J. Dumay, F. Ricceri, & C. Nielsen (Eds.), *The Routledge companion to intellectual capital* (pp. 332–346). Routledge.

Cuganesan, S., & Dumay, J. (2009). Reflecting on the production of intellectual capital visualisations. *Accounting, Auditing and Accountability Journal, 22*(8), 1161–1186.

Dean, A., & Kretschmer, M. (2007). Can ideas be capital? Factors of production in the postindustrial economy: A review and critique. *Academy of Management Review, 32*, 573–594.

Dumay, J., & Rooney, J. (2011). "Measuring for managing?" An IC practice case study. *Journal of Intellectual Capital, 12*(3), 344–355.

Dumay, J., & Rooney, J. (2016). Numbers versus narrative: An examination of a controversy. *Financial Accountability and Management, 32*(2), 202–231.

Dumay, J. (2009). Intellectual capital measurement: A critical approach. *Journal of Intellectual Capital, 10*(2), 190–210.

Dumay, J. (2012). Grand theories as barriers to using IC concepts. *Journal of Intellectual Capital, 13*(1), 4–15.

Dzinkowski, R. (2000). The measurement and management of intellectual capital: An introduction. *Management Accounting, 78*(2), 32–36.

Edvinsson, L., & Malone, M. S. (1997). *Intellectual capital*. Harper Business.

Fombrun, C., & Shanley, M. (1990). What's in a name? Reputation building and corporate strategy. *Academy of Management Journal, 33*(2), 233–258.

Fombrun, C. J. (1996). *Reputation: Realizing value from the corporate image*. Harvard Business School Press.

Galor, O., & Moav, O. (2004). From physical to human capital accumulation: Inequality and the process of development. *Review of Economic Studies, 71*, 1001–1026.

Giuliani, M., & Chiucchi, M. S. (2019). Guess who's coming to dinner: The case of IC reporting in Italy. *Journal of Management and Governance, 23*(2), 403–433.

Giuliani, M. (2013). Not all sunshine and roses: Discovering intellectual liabilities "in action". *Journal of Intellectual Capital, 14*(1), 127–144.

Giuliani, M. (2014). Accounting for intellectual capital: Investigating reliability. *International Journal of Finance and Accounting, 3*(6), 341–348.

Giuliani, M., Chiucchi, M. S., & Marasca, S. (2016). A history of intellectual capital measurements: From production to consumption. *Journal of Intellectual Capital, 17*(3), 590–606.

Hall. (1992). The strategic analysis of intangible resources. *Strategic Management Journal, 13*, 135–144.

Kaplan, R. S., & Norton, D. P. (2004). The strategy map: Guide to aligning intangible assets. *Strategy and Leadership, 32*(5), 10–17.

Lev, B., & Radhakrishnan, S. (2003). *The measurement of firm-specific organization capital*. NBER working paper, N. 9581.

Lev, B. (2001). *Intangibles: Management, measurement and reporting*. Brookings Institution Press.

Lin, C., Yu-Ping Wang, C., Wang, C. Y., & Jaw, B. S. (2017). The role of human capital management in organizational competitiveness. *Social Behavior and Personality, 2017*(45), 81–92.

Lynn, B. (1998). Intellectual capital. *CMA Management, 72*, 10–15.

Nerdrum, L., & Erikson, T. (2001). Intellectual capital: A human capital perspective. *Journal of Intellectual Capital, 2*(2), 127–135.

Penman, S. H. (2007). *Financial statement analysis and security valuation, 3/e*. Mc Graw Hill.

Petty, R., & Guthrie, J. (2000). Intellectual capital literature review: Measurement, reporting and management. *Journal of Intellectual Capital, 1*(2), 155–176. https://doi.org/10.1108/14691930010348731.

Pulic, A. (2000). VAICTM – An accounting tool for IC management. *International Journal Technology Management, 20*, 702–714.

Ricceri, F., & Guthrie, J. (2009). Critical analysis of international guidelines for the management of knowledge resources. In D. Jemielnaik & J. Kociatkiewicz (Eds.), *Handbook on research on knowledge-intensive organisations* (pp. 375–392). Information Science Press.

Roos, G., & Roos, J. (1997). Measuring your company's intellectual performance. *Long Range Planning, 30*(3), 413–426.

Saint-Onge, H. (1996). Tacit knowledge: The key to the strategic alignment of intellectual capital. *Strategy and Leadership, 24*, 2.

Sicoli, G. (2018). The role of intangible in the creation of company value. *International Journal of Business and Management, 13*, 9.

Sicoli, G., Baldini, M. A., & Bronzetti, G. (2017). The measurement of human Capital in Family Firms. In *Handbook of research on human resources strategies for the new millennial workforce*, (a cura di) Patricia Ordóñez de Pablos (Universidad de Oviedo, Spain), Robert Tennyson (University of Minnesota, USA), 2017.

Sicoli, G., Bronzetti, G., & Baldini, M. (2015). A new proposal for identifying and measuring intellectual capital. In *Proceedings of the 17th Eurasia Business and Economics Society (EBES) Conference, Venezia*. ISSN: 2364–5067 ISSN 2364-5075.

Stewart, T. (1997). *Intellectual capital: The new wealth of organizations*. Doubleday/Currency.

Sveiby, K. E. (1997). The intangible assets monitor. *Journal of Human Resource Costing and Accounting, 2*(1), 73–97.

Sveiby, K. E. (2010). *Methods for measuring intangible assets*. Available at www.sveiby.com

Tamayo, A., Souza, M. G., Vilar, L. S., Ramos, J. L., Albernaz, J. V., & Pereira, N. P. (2001). Prioridades axiológicas e comprometimento organizacional. *Psicologia: Teoria e Pesquisa, 17* (1), 27–35.

Vaivio, J. (2004). Mobilizing local knowledge with 'provocative' non-financial measures. *European Accounting Review, 13*(1), 39–71.

Walsh, K., Enz, C. A., & Canina, L. (2008). The impact of strategic orientation on intellectual capital investments in customer service firms. *Journal of Service Research, 10*(4), 300–317.

The Evaluation of the “Third Mission” in Italian Universities as a Partial Report of the Intellectual Capital

Natalia Aversano, Giuseppe Nicolò, Giuseppe Sannino, and Paolo Tartaglia Polcini

1 Introduction

Over the past several decades, the pressure on universities to become more involved in society and increase their contribution to economic growth has increased significantly. These activities—included in the wider concept of “Third Mission” (TM)—have progressively become an integral part of university strategies.

University’s third mission activities are related to the generation, use, application, and exploitation of knowledge with external stakeholders and society in general, and the problem to find adequate performance criteria for measuring the third mission stream of universities have now become crucial (Etzkowitz, 2017; Secundo et al., 2017; Di Berardino & Corsi, 2018; Della Volpe & Esposito, 2020).

Universities employ several rankings and methods to assess their teaching and research activities. However, these rankings and methodologies rarely account for the third activity of the mission as well. Therefore, there is a broad debate on which measures are most appropriate for evaluating the university’s third mission (Della Volpe & Esposito, 2020).

The call for performance measures is also driven by the European policy framework, such as the definition of Smart Specialisation Strategies (RIS3), which highlights the key role of universities in regional development.

This scenario has inspired several scholars to focus their attention on the Intellectual Capital framework to measure third mission activities of universities

N. Aversano (✉) · G. Nicolò · P. Tartaglia Polcini
Department of Management and Innovation Systems, University of Salerno, Fisciano, Italy
e-mail: naversano@unisa.it; gnicolo@unisa.it; ptpolcini@unisa.it

G. Sannino
Economics Department, University of Campania “Luigi Vanvitelli”, Caserta, Italy
e-mail: giuseppe.sannino@unicampania.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_3

(Etzkowitz, 2017; Secundo et al., 2017; Di Berardino & Corsi, 2018; Frondizi et al., 2019; Della Volpe & Esposito, 2020; Giacosa et al., 2020). It is based on the idea that each third mission activity is, by nature, closely linked with at least one of the three IC components (Secundo et al., 2017).

In the European context, Italian political leaders attach enormous importance to the third mission of universities. Italy, in line with the Standards and Guidelines for Quality Assurance in the European Higher Education Area, has proposed a system of assessment and quality assurance to stimulate Universities, Departments, and Courses of the Study to the continuous improvement of the third mission activities.

With the introduction of the Self-Assessment, Periodic Evaluation and Accreditation (AVA) system, the third mission has been recognized as an institutional mission of universities, alongside the well-known teaching and research missions. Specific indicators and evaluation parameters of the TM are identified (DM 47/2013), and the TM quality is considered among the quality requirements of the Study Programs (DM 987/2016). This process of institutionalization of the TM has encouraged to implementation of an ad hoc information system represented by the SUA-TM/SI (Single Annual Form of Third Mission and Social Impact) within the SUA-RD (Single Annual Form of Departmental Research).

The present study aims to analyze the evaluation system used in Italian universities to appreciate how the AVA system is in line with the IC report models identified by the theory and practice.

Also, based on the EU recommendations, the research aims to understand if the set of ANVUR indicators, even if limited to the third mission, could represent a primary reference of a structured reporting of the IC, based on the prevailing models developed by the theory and practice on the subject. Accordingly, the research uses a qualitative methodology, which consists of examining the Italian evaluation system for the third mission in the light of the IC conceptual framework to compare the AVA model and evaluation model process-oriented affirmed in the IC theory and practice.

By adopting the fourth-stage IC perspective, the paper will assess whether IC is useful for managing third mission variables and activities. For the purposes of this paper, the definition of IC to be employed is the one by Stewart (1997), adapted by Secundo et al. (2016), and based on considerations regarding the specific nature of universities and their activities.

The research focuses specifically on Italian universities because Italy represents an example of a country where the New Public Management (NPM) wave brings several changes related to governance, management, and performance evaluation systems, searching for greater transparency and efficiency (Aversano et al., 2020). Moreover, the Italian context represents an important point of attention since there are no mandatory requirements for IC reporting, although it is known that the information of the IC components can find a place in a specific section of the Social Report (GBS, 2008).

The chapter is structured as follows: the next section provides a theoretical framework of the Intellectual Capital for measuring university's third mission; the third section presents the third mission evaluation system in the Italian context;

section four carries out a critical examination of the Italian evaluation system in the light of the IC framework for TM. The final section provides conclusions, implications, and limitations of the study.

2 An Intellectual Capital Perspective for Measuring University’s Third Mission

Scholars have provided heterogeneous interpretations of the third mission, evidencing the ambiguity and the hugeness of this concept in the literature (Frondizi et al., 2019).

Over the years, the university’s third mission has involved several activities, mainly consisting of exploiting knowledge internally generated to contribute to the social and economic development (Etzkowitz, 2014) of the environment in which universities operate. However, the ambiguity about the content of the third mission generates problems concerning the evaluation of the quality of the university’s third mission performance (Secundo et al., 2017).

Accordingly, specific indicators are necessary to make the universities able to ensure their effective management (Secundo et al., 2017). Therefore, several scholars have tried to develop methods and indicators, which could better measure the third mission performance (Molas-Gallart et al., 2002; Schoen, 2006; Laredo, 2007; Rothaermel et al., 2007; Montesinos et al., 2008; Etzkowitz, 2017; Secundo et al., 2017; Di Berardino & Corsi, 2018; Della Volpe & Esposito, 2020).

Montesinos et al. (2008) propose to evaluate the third mission focusing the attention on three dimensions: a social approach, an entrepreneur focus, and an innovative approximation.

Molas-Gallart et al. (2002) identified 65 potential indicators organized under 12 different classes of Third Mission activity. The different classes of Third Mission activity were based on a fundamental distinction between what universities have (capabilities) and what they do (activities). However, the authors were more interested in the commercialization of research results about the social role of the third mission.

Also, Etzkowitz (2017) and Rothaermel et al. (2007) gave more attention to the entrepreneurial aspect, identifying the following evaluation parameters: organization of research groups, third parties’ contracts, intellectual property, spin-offs, university–industry research centers, university licensing, science parks, incubators, and university spin-offs.

In addition, Schoen (2006) and Laredo (2007) classified the third-mission activities into eight groups: human resources, intellectual property, spin-offs, contracts with industry, contracts with public bodies, participation in policymaking, involvement in social and cultural life, public understanding of science. The first four dimensions concern economic activities, whereas the others concern the community aspect.

Thus, notwithstanding increasing efforts from the academic community, the mainstream research on third-mission quality assessment is reduced to technology transfer, spin-offs, patents, and licenses; this is probably because of the difficulty in recognizing and estimating the numerous activities falling within the third mission.

This scenario has inspired several scholars to highlight the role of IC in measuring the third mission performance (Etzkowitz, 2017; Secundo et al., 2017; Di Berardino & Corsi, 2018; Della Volpe & Esposito, 2020; Giacosa et al., 2020).

Di Berardino and Corsi (2018) used the quality evaluation approach to analyze the contribution of IC to the development of the third mission in Italian universities and to define the impact of these activities on the regional context.

The study of Della Volpe and Esposito (2020) also focused the attention on Italian universities. The study analyzed the Italian universities' official websites discursive practices to assess their involvement in the university's third mission. It shows that the current evaluation system is mostly associated with an economic valorization of research rather than a social commitment.

More attention on the quantitative evaluation of the third mission is placed by Secundo et al. (2017) and Giacosa et al. (2020).

Giacosa et al. (2020) proposed a framework to classify university performance indicators systematically, suggesting a specific set of indicators for the third mission.

The study of Secundo et al. (2017), following the E3M (European Indicators and Ranking Methodology for University Third Mission) project, proposed an intellectual capital perspective to measure the third mission based on the three interrelated areas: research (technology transfer and innovation), teaching (continuing education for entrepreneurial competencies), and social engagement following regional and national development.

The framework proposed by Secundo et al. (2017) connects each of the third mission goals to specific IC elements and take into consideration the impact of the third mission activities on the different levels of university structure, moving from the internal dimension (Department and University level) toward the external level (the whole community where the university is located) (Fig. 1).

The battery of IC indicators proposed by previous studies (Etzkowitz, 2017; Secundo et al., 2017: Giacosa et al., 2020) for measuring and reporting the university's third missions are represented in Table 2.

3 The Italian Evaluation System for the Third Mission

In Italy, the agency's tasks include assessing "the quality of processes, results, and products of management, training, research activities, including technology transfer," as specified by the founding regulations of ANVUR Presidential Decree 76/2010, Article 3 c. 1.

The reference to the quality of the third mission is included in the quality evaluation of scientific research, and the first occasion of assessment was represented by the 2004–2010 Research Quality Assessment (VQR 2004–2010). In this first

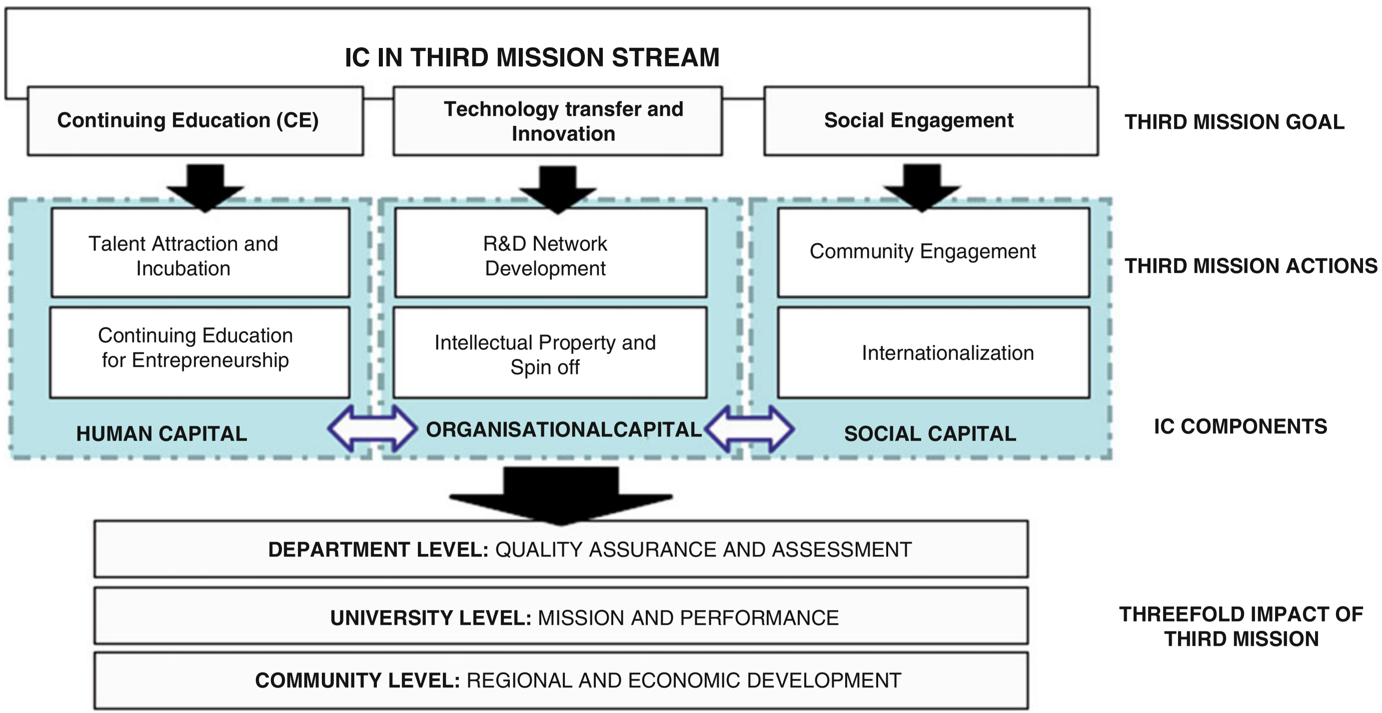


Fig. 1 The third mission of university: A performance framework IC-based. Source: Secundo et al. (2017, p. 235)

Table 1 Evaluation areas Third Mission/Social Impact

Strategic objectives of Third Mission/Social Impact	
Enhancement of research	Production of public goods
1. *Industrial property management* (patents, plant rights)	5. *Management of heritage and cultural activities* (archaeological excavations, museum poles, musical activities, buildings and archives historical buildings, historical libraries and newspaper libraries, theatres, and facilities sports)
2. *Spin-off companies*	6. *Public health activities* (clinical trial, non-interventional studies and empowerment, support structures)
3. *Third-party activities* (research/consultancy contracts with external clients, which were not considered among the revenues deriving from competitive projects)	7. *Continuing education, lifelong learning, and open teaching* (continuing education activities, Continuing Medical Education activities, Certification of skills activities, School-Work Alternation, Massive Open Online Course)
4. *Intermediary structures* (technology transfer offices, placement offices, incubators, science parks, consortia, and associations for the third Mission)	8. *Public engagement* (organization of concerts, theatrical performances, sporting events, exhibitions, organization of research sharing initiatives, policy making)

Source: ANVUR (2018)

experimentation, ANVUR introduced the concept of the Third Mission as “opening towards the socio-economic context through the enhancement and transfer of knowledge” that includes both the concept of economic enhancement of research and initiatives with sociocultural and educational values. Therefore, indicators related to technology transfer and the activities of the human sciences that impact society were defined, such as science museums and archaeological excavations.

With the introduction of the AVA system, the SUA-TM/IS information system within the SUA-RD has been created.

Subsequently, with the start of the 2015–2019 Research Quality Assessment (VQR 2015–2019), in 2018, new guidelines were developed for “the third mission and social impact” (ANVUR, 2018). With the new guidelines, some sections of the SUA-TM/IS have been revised. Above all, the part of the third mission activities defined as the production of public goods has been expanded, strengthening the detection of their social, cultural, and economic impact (Table 1).

Therefore, ANVUR recognizes economic and social propositions to assess the university’s third mission (ANVUR, 2018). On the one hand, it promotes economic growth by transforming the knowledge produced by research into knowledge useful for production purposes. On the other hand, it transforms public goods into well-being for society (Della Volpe & Esposito, 2020).

Unlike the research and teaching activities that are the institutional duties of every teacher and researcher, the TM is an institutional responsibility to which each university responds differently. In fact, the information content of the third mission can be understood very differently in the different disciplinary areas. For example, in the more technical departments, the third mission is measured above all in terms of patents and spin-offs. On the contrary, in the departments of the humanities area, the third mission is measured above all in terms of dissemination. Furthermore, in the medical departments, the third mission is understood in terms of translational medicine, such as the translation of research results into protocols and treatment solutions to be applied concretely to patient care, while in the social sciences, the third mission is understood as public engagement and collaboration with the reference community to face the great challenges of our time.

The guidelines require Italian universities to indicate in the *SUA-TM/IS* the strategic lines and the main objectives of their third mission activities and the indicators organized in eight information panels (Table 2).

At this point of the work, timely analysis of the AVA evaluation system about the IC report models becomes relevant to identify any opportunities for improvement.

4 The Indicators of the AVA System as a Partial Report of the Intellectual Capital

To understand if the Italian evaluation system could help to identify a possible primordial systematized report of the IC in the universities, we proceeded with a qualitative methodology based on an inductive approach, which consists in the comparison of the indicators suggested by ANVUR for the evaluation of the third mission activity, with the indicators provided by the IC framework regarding the third mission (Table 2). The comparison takes into consideration the TM processes identified by both the Italian guidelines and the IC literature.

Table 2 shows the third mission process in the first column, the indicators provided by the IC framework in the second column, and the indicators provided by the Italian evaluation system in the third column.

If there are no sets of indicators of a national matrix for the specific TM processes or deriving from the framework IC, the generic term N/A will be reported to indicate that it is not provided.

It should be noted that if the indicators of the AVA model were not identical to those recognized in the literature, it was decided, through a subjective approach, to attribute them to the conceptual categories of the IC based on the similarity of the information requested.

From the analysis of Table 2, it can be evidenced that the third mission activities identified both by the AVA system and IC framework are: (1) *Intellectual property and spin-offs*, (2) *Continuing education (CE) for entrepreneurial competence, and* (3) *Social engagement.*

Table 2 The theoretical reporting model of the IC vs. AVA system indicators set

Third mission processes	IC framework indicators	AVA system indicators
Intellectual property and spin-offs	*Human capital* – Number of staff involved in creative commons and social innovation project – Number of start-ups/spin-offs founded by graduates/HEI employees – Number of staff funded by competitively funded *Organizational capital* – Number of incubators co-owned by the university – Number of patents, licenses, trademarks co-owned by university *Social capital* – Number of international awards received – Number of consortiums	– Number of patent – Number of patents for new plant varieties present in the portfolio and licensed – Number of spin-off companies – Total annual revenues
R&D network development	*Human capital* – Number of joint publications with nonacademic authors – Number of postgraduate students and postdoctoral researchers directly funded by private business *Organizational capital* – Success rate in R&D project applications – Number of shared (open access) laboratories or buildings *Social capital* – Number of joint international R&D projects – Number of (new) partnerships in R&D projects – Number of companies co-funding research or education activities carried out by the university	N/A
Third-party activities	N/A	– Number of contracts/agreements with other PA – Number of contracts/agreements with local bodies – Number of contracts/conventions with research bodies
Intermediary structures	N/A	– Number of science parks – Number of consortia – Number and type of activities carried out by technology transfer offices – Number and type of activities carried out by placement offices

(continued)

Table 2 (continued)

Third mission processes	IC framework indicators	AVA system indicators
		– Budget committed for the management of the activity during the year – Number of employees – Number of training courses held by placement offices for its staff – Number of companies, public institutions, third sector organizations that have an active agreement with the university for internship and placement purposes – Number of internship and job offers published – Number of company presentation meetings (career, recruitment, and testimonial day, etc.) – Number of employees dedicated to the incubator – Number of companies incubated – Number of employees of the incubated companies
Management of heritage and cultural activities	N/A	– Number of historical buildings, historical archives, archaeological excavations, historical library; of theatres; of sports facilities, of museums and collections managed by the museum center – Structures dedicated to musical activities – Number of visitors in the year – Revenue from visitors – Awards and prizes – Number of staff dedicated to the management of HA – Number of agreements and/or conventions with other museums – Total number of participants in the musical activity – Number of staff engaged in the activities – Number of events in the year – National and international awards and prizes – Number and type of communication and social channels used

(continued)

Table 2 (continued)

Third mission processes	IC framework indicators	AVA system indicators
Continuing education (CE) for entrepreneurial competence	*Human capital* – Number of staff delivering CE with experience in launching start-ups/spin-offs – Percentage of staff teaching in CE programs *Organizational capital* – Number of active CE programs. – Number of ECT credits of the delivered CE programs – Number of corporate clients co-funding education of their staff *Social capital* – Number of international students in CE programs – Percentage of staff with entrepreneurship experience	*Lifelong learning, continuing medical education activities (ECM)* – Number of courses provided – Number of CFU/ECT recognized – Number of participants – Number of teachers involved – Number of professors outside the university – Number and type of third parties involved in the organization of the courses – Number of certifications derived by the skills certification activities – Number of teachers involved in skills certification activities – Number of school-work alternation projects carried out – Number of students involved in the projects – Number of teachers involved in the projects – Number of MOOC courses delivered – Number of participants to the MOOC – Number of teachers involved in MOOC
Talent attraction and incubation	*Human capital* – Number of HEI staff who attended continuing training courses – Number of research fellows *Organizational capital* – Number of staff employed for talent attraction and incubation *Social capital* – Percentage of staff/students with qualifications obtained abroad	N/A
Social engagement with the community	*Human capital* – Number of academic staff involved in volunteering advisory – Number of media appearances on public issues – Number of academic staff involved in the regional planning – Number of citizens attending workshops and scientific events	– Number and type of PE initiatives – Number of departments involved – Third parties involved in the organization – Geographic dimension (local, regional, national, international) – Public involved

(continued)

Table 2 (continued)

Third mission processes	IC framework indicators	AVA system indicators
	– Number of external stakeholders (managers, policymakers, etc.) involved in curriculum design and delivery *Organizational capital* – Number of events open to community/public – Number of research initiatives with direct impact on the community – Number of museum centers managed or co-managed by the structure *Social capital* – Number of partners in projects that do not generate income – Number of institutions involved in a formal agreement with the university	– Number of internal staff involved (Number of professors, number of administrators, number of other research staff, number of students and PhD students) – Number and type of communication and social channels used
Internationalization	*Human capital* – Number of scientific staff who stayed abroad for at least 5 days – Number of faculty presentations at scientific conferences *Organizational capital* – Number of scientific journals with university staff serving on editorial boards *Social capital* – Number of partner institutions delivering joint degree programs – Percentage of students engaged in inward and outward international mobility	N/A

Source: Etzkowitz (2017), Secundo et al. (2017), Giacosa et al. (2020)

In particular, the set of ministerial indicators, squared in the context of the classic IC report models, finds correspondence mainly in the Structural and Relational dimensions of the IC, seeing only minimally involved the Human one of the IC.

The reason could be that the measurement and management of IC focus more on the stock of capital rather than profits; therefore, in terms of indicators, the focus is on inputs and processes rather than outcomes (Secundo et al., 2017).

Social engagement and community involvement assume an important role both in the Italian evaluation system and in the IC framework. The measurement of the social engagement is pivotal to evaluate how university human capital is involved in the local and regional community, reinforcing the university's approach to the development of the ecosystem (Secundo et al., 2018).

Unlike the IC framework, the ministerial indicators give greater attention to the social sphere of the TM, focusing the attention on (1) *Management of heritage and cultural activities,* (2) *Intermediary structures*, *and* (3) *third-party activities*. They propose a considerable proportion of indicators to capture various interactions between the university and the local community to build a competitive advantage founded on the history and local heritage (Secundo et al., 2017).

The management of heritage assets is a visible and real pillar of the social role assumed by universities in the local communities; therefore, accurate reporting and evaluation systems are required to assure social commitment (Aversano et al., 2020).

Also, the measurement of the partnerships and collaboration with the third party is fundamental because it shows how the university actively engages with the external environment to create socioeconomic value and develop strong connections with enterprises and other public institutions (e.g., national and regional governments and other universities) (Ndou et al., 2018).

However, the Italian evaluation system for the TM does not pay enough attention to (1) *R&D network development,* (2) *Talent attraction and incubation, and* (3) *Internationalization.*

Internationalization has been considered a relevant activity within the IC framework because it represents how a university is navigating "the knowledge created by countries, cities and communities" (Dumay & Garanina, 2013, p. 21). On the contrary, the Italian evaluation system measures this activity more deeply in evaluating the didactic university mission.

Lastly, the R&D network development, limited to the social capital indicators, could be classified as Third-party activities.

5 Conclusions

In recent years, in many developed countries, public universities have faced an increasing reduction of public funds with the consequent need to reorganize their internal structures and match their activities with the needs and expectations of external actors (Della Volpe & Esposito, 2020).

A stronger focus on the outcome and the need to attract private resources have provoked a change in the decision-making process and imposed strengthened accountability and control to react to the mechanisms of "marketization" and "performance measurement" of academic activities (Neumann & Guthrie, 2002). Rigorous management of intangible resources—namely IC—becomes pivotal for an in-depth understanding of the value creation process. In the university system, the performance measurement process must consider that the value generation process is multidimensional and characterized by multiple values. In fact, the creation and transfer of knowledge generate value both in social terms (training and research activities contribute to the growth of society in scientific and cultural terms), and in economic terms (the transfer of knowledge on the territory becomes concrete in the creation and development of business and innovation).

In this scenario, it has been recognized the strategic relevance of measuring the third mission performance to activate the dialogue between universities and their environment and society. However, despite the relevance of this mission, in theory, and practice, are missing specific tools to monitor and evaluate the overall third mission performance. The evaluation system should go beyond the specific economic aspects (i.e., financial returns to a given intellectual property portfolio). It should also consider wider social and economic benefits such as the diffusion of knowledge and the contribution to employment for social, cultural, cultural, and economic development.

The present study analyses the AVA system used in Italian universities to appreciate how it is in line with the IC report models identified by the theory. Results show an alignment between the IC framework and the approach adopted in the AVA model. The comparison allows expressing a judgment on the ability of the AVA model to focus the attention on the key resources of a university that consumes, employs, and generates knowledge in its production processes. This aspect is particularly important because the lack of attention on the relevant parameters implies serious weaknesses in the evaluation system, both in terms of strategic and operational management and communication with the stakeholders.

Consequently, it is possible to state that the ministerial evaluation system, like those underlying the logic of drafting the IC reports, is designed to take on both external and internal informational relevance.

The analysis also evidences that the measures developed by the AVA system are not conventional accounting measures of IC reflecting third mission; rather, they are the measures of the relationships of IC used in the creation of value. These indicators are not understood as "performance measures" but represent the importance of the organizational value creation process in all the universities moving toward a third mission orientation.

Finally, it should be noted that the main limitation of this work is represented by the possibility of being able to view the IC from the perspective of the Italian context alone, neglecting to observe, in the same perspective, contexts that are comparatively relevant on an international level, the analysis of which could induce valuable observations on critical issues, points of strength and prospects for improvement of our national reality.

References

ANVUR. (2018). *Linee guida SUA-Terza Missione e Impatto Sociale delle Università italiane*. Available at: www.anvur.it/wp-content/uploads/2018/11/SUA-TM_Lineeguida.pdf

Aversano, N., Di Carlo, F., Sannino, G., Tartaglia Polcini, P., & Lombardi, R. (2020). Corporate social responsibility, stakeholder engagement and universities: New evidence from the Italian scenario. *Corporate Social Responsibility and Environmental Management, 27*(4), 1892–1899.

Della Volpe, M., & Esposito, F. (2020). Discursive practices about third mission. A survey from Italian universities official websites. *Quality in Higher Education, 26*(2), 224–239.

Di Berardino, D., & Corsi, C. (2018). A quality evaluation approach to disclosing third mission activities and intellectual capital in Italian universities. *Journal of Intellectual Capital, 19*(1), 178–201.

Dumay, J., & Garanina, T. (2013). Intellectual capital research: A critical examination of the third stage. *Journal of Intellectual Capital, 14*(1), 10–25.

Etzkowitz, H. (2014). The entrepreneurial university wave: From ivory tower to global economic engine. *Industry and Higher Education, 28*(4), 223–232.

Etzkowitz, H. (2017). Innovation lodestar: The entrepreneurial university in a stellar knowledge firmament. *Technological Forecasting and Social Change, 123*, 122–129.

Frondizi, R., Fantauzzi, C., Colasanti, N., & Fiorani, G. (2019). The evaluation of universities' third mission and intellectual capital: Theoretical analysis and application to Italy. *Sustainability, 11*(12), 3455.

GBS. (2008). *Il bilancio sociale. La rendicontazione sociale nelle università*. Documento di ricerca n. 7, Giuffrè, Milano.

Giacosa, E., Sorano, E., & Culasso, F. (2020). *Il monitoraggio e la valutazione delle missioni di un ateneo in una logica istituzionale*. Azienda Pubblica, N,2.

Laredo, P. (2007). Revisiting the third mission of universities: Toward a renewed categorisation of university activities? *Higher Education Policy, 20*(4), 441–456.

Molas-Gallart, J., Salter, A., Patel, P., Scott, A., & Duran, X. (2002). *Measuring third stream activities*. Final report to the Russell Group of Universities. SPRU, University of Sussex.

Montesinos, P., Carot, J. M., Martinez, J. M., & Mora, F. (2008). Third mission ranking for world class universities: Beyond teaching and research. *Higher Education in Europe, 33*(2–3), 259–271.

Ndou, V., Secundo, G., Dumay, J., & Gjevori, E. (2018). Understanding intellectual capital disclosure in online media big data: An exploratory case study in a university. *Meditari Accountancy Research, 26*(3), 499–530.

Neumann, R., & Guthrie, J. (2002). The corporatisation of research in Australian higher education. *Critical Perspectives on Accounting, 13*(5–6), 721–741.

Rothaermel, F. T., Agung, S. D., & Jiang, L. (2007). University entrepreneurship: A taxonomy of the literature. *Industrial and Corporate Change, 16*(4), 691–791.

Schoen, A. (2006). *Strategic management of university research activities, methodological guide*. PRIME Project 'Observatory of the European University'. Retrieved from http://www.enid-europe.org/PRIME/documents/OEU_guide.pdf

Secundo, G., Lombardi, R., & Dumay, J. (2018). Intellectual capital in education. *Journal of Intellectual Capital, 19*(1), 2–9.

Secundo, G., Elena Perez, S., Martinaitis, Ž., & Leitner, K. H. (2017). An intellectual capital framework to measure universities' third mission activities. *Technological Forecasting and Social Change, 123*(1), 229–239.

Secundo, G., Dumay, J., Schiuma, G., & Passiante, G. (2016). Managing intellectual capital through a collective intelligence approach: An integrated framework for universities. *Journal of Intellectual Capital, 17*(2), 298–319.

Stewart, T. A. (1997). *Intellectual capital: The new wealth of organizations*. Currency Doubleday.

Intellectual Capital Disclosure and Information Systems, Smart Technologies and Digitalization

Monica Bartolini, Rita Lamboglia, and Alessandra Lardo

1 Introduction

The purpose of this chapter is to analyze the relationship between Intellectual Capital (IC), Smart Technologies and Digitalization. In particular, if we consider the information system process, composed of data collection and storage, data modelling and analysis, and communication, we decided to analyze the last phase of this process, focusing on Intellectual Capital Disclosure (ICD).

Since the late 1990s, a number of influential articles and reports have considered the impact of developments in Information and Communications Technologies (ICTs) on corporate disclosure, highlighting how these developments have changed the ways that companies relate to their shareholders (Beattie & Pratt, 2003). Furthermore, many authors (e.g. Striukova et al., 2008; Dumay & Tull, 2007) encourage the use of specific corporate reporting channels different from annual reports, which companies could exploit to disclose better IC information. The new view of the emerging innovations in ICTs is called the "digital reporting era" and it is changing the ways in which companies relate to their stakeholders (Ghani et al., 2009; Hoffman & Mora Rodríguez, 2013).

Digitalization and smart technologies have affected internal communication as well as the external ones, and can blur the borders between organizations and ecosystems, acting as facilitator/catalyst of the IC research fourth stage. Corporate communication can be considered part of governance systems and deals with all

M. Bartolini
Department of Management, University of Bologna – Forlì Campus, Forlì, Italy
e-mail: monica.bartolini4@unibo.it

R. Lamboglia · A. Lardo (✉)
Department of Business and Economics, Parthenope University of Naples, Naples, Italy
e-mail: rita.lamboglia@uniparthenope.it; alessandra.lardo@uniparthenope.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_4

communication activities of internal and external coordination as well as interest pronouncement for stakeholders (Hauer et al., 2018).

To understand the importance of improving ICD through digitalization and smart technologies, it is necessary to realize that the twenty-first century society is a mass data community for which information is the most valuable asset and fundamental determinant for action (Kuś & Pypłacz, 2019). Having information extends access to other resources and allows companies and their stakeholders to take action to improve the current state.

However, organizations appear reluctant to voluntarily disclose their valuable IC because they are not aware of how to gather data and report them (Schaper et al., 2017) and they do it only if required by their regulatory context (Dumay & Tull, 2007). As stated by many authors, "*using technology can facilitate such a shift*" (La Torre et al., 2018). According to Bonsón and Escobar (2006), the variables affecting the spread of companies' voluntary disclosure by the Internet are: having been audited by one of the Big Four accountancy firms; the company's activity being in the financial sector; company size.

Recent studies reveal how it seems to be relevant to continue to investigate the digital era effects on ICD, as well as its contribution to reveal new approaches and opportunities for disclosing IC strategies and outcomes (Cuozzo et al., 2017). The lack of an established academic background on this specific subject represents our main research motivation and highlights opportunities for theoretical and practical contributions. Therefore, starting from these considerations, we perceived a need for an analysis of the potential role of digitalization in driving ICD. This theoretical gap inspired us the following research questions: *How could digitalization become an avenue for ICD and enhance it? What enablers and obstacles arise from digitalization and are the most prominent in driving ICD?*

Our study has an exploratory purpose, with the twofold objective of: (1) clarifying the relationship between Smart Technologies, Digitalization and ICD and (2) exploring the potential of technology to improve ICD through a preliminary systematization based on literature.

Previous research questions led our research process towards the development of a preliminary framework on enablers and obstacles of digitalization on ICD, which considers internal and external stakeholders. In doing so, we aim to provide a better understanding of the use of digital channels and tools in ICD processes and their effects on information flows from and to the organizations.

The research is based on a qualitative approach. We conducted a preliminary literature analysis in order to achieve our objectives. In accordance with our research proposition, we outline a framework to systematize and describe enablers and obstacles arising from digitalization in ICD.

The chapter is structured as follows. The following section is devoted to the review of the literature on the enablers and obstacles arising from digitalization and smart technologies for external and internal stakeholders. Section 3 presents our framework. Finally, the last section discusses our theoretical and practical contributions, together with the limitations and future opportunities of research.

2 Enablers and Obstacles Arising from Digitalization for External and Internal Stakeholders

In this section, we present the literature about the enablers and obstacles regarding ICD and digitalization from the two perspectives under investigation: external and internal stakeholders.

2.1 The External Stakeholders' Perspective

ICD is almost always considered an information mechanism mainly for the outside and beyond the annual report (Pisano et al., 2017). ICD literature is mainly concerned with value creation from a financial perspective, and focuses on an external financial value creation and on the discussion of the external benefits for organizations (Cuozzo et al., 2017), because market value is considered as an expression of a firm's IC (Chen et al., 2005).

Recent studies (Lardo et al., 2017) argue that firms try to achieve results by ICD to increase their popularity and, consequently, to create new value. This research is based on evidence that ICD, and its components, can improve the financial performance of companies and the value of its employees. The identification of intangible assets and the communication of their value seem to be viewed as a key competitive driver (Eustace, 2000). These studies are usually based on "Grand Theory" (Dumay, 2012; Llewelyn, 2003). This theory states that ICD is important for investors because it improves their decision making and it disciplines management and boards with positive economic rewards (Andriessen, 2004; Zarowin & Lev, 1999).

Also, the Dumay's theoretical study (2016) reveals how authors need to abandon reporting and instead concentrate on "disclosure", which represents how an organization makes public what "was previously secret or unknown," so that all stakeholders understand how an organization takes into consideration ethical, social and environmental aspects. ICD is important to investors and other stakeholders because they expect these types of disclosures from a company (Dumay, 2016). Despite the importance taken by ICD for external users, the impact of smart technologies and digitalization on ICD with regards to the effects on external users has not yet been well investigated (Dumay & Guthrie, 2017).

In general, experts perceive digitalization to play a significant role in the development of disclosure to the outside (Hauer et al., 2018). Currently, most researchers tend to highlight the enabling factors of technologies, highlighting how these produce a positive effect on the ICD as a mechanism mainly for the outside.

These studies mainly focus on social media and social networks as new crucial technologies for the IC growth (Falkowski, 2014). In recent years, it seems that firms have embraced the social networks to optimize interpersonal collaborations and transversal knowledge flows with their stakeholders. ICD can benefit from using social media in a variety of ways ranging from fruitful communications, helpful suggestions within online communities to posting videos or documents. Social networks allow capturing knowledge from employees and disseminating it to the other members of the social network communities who can reuse it to add value, improving firms' product and process innovation. Social networks are considered "collaborative tools" to foster knowledge sharing, boost interactions between organizational and stakeholders and promote innovation (Turban et al., 2011). Also, other studies (Dalmasso et al., 2018; Berraies & Chaher, 2014) found that the use of social networks develops a radical innovation in the companies, by promoting the flow of knowledge and the creation of new relationships. Berraies and Chaher (2014) also stressed that interactions between internal and external actors promote strategic knowledge, particularly: the development of new information and communication technologies, new methods, new suppliers of raw materials and the response to the market or competitive needs.

Starting from all these considerations, recent studies (Lardo et al., 2017) highlight also how companies are needed to hire social media experts who are able to develop, coordinate and manage digital communication strategies.

Literature has also focused on the economic and financial effects that these technologies produce. Over two decades ago, companies began to consider the relationship between intangible assets, such as human and relational capital and market values. Several researchers (Gerpott et al., 2008; Sullivan, 2000; Williams, 2001) have considered the disclosure of intangible assets and IC as an integral part of a company's value creation process from a market perspective.

This link now appears to be strengthened by the use of social media. In general, literature reveals that social media networks can create strong relationships among external stakeholders, and this establishes connections that can be transformed into economic returns for the company. In this way, the social media revolution seems to be contributed to developing the value of the company, and it has led to a full range of new distribution channels on various digital platforms, increasing the value of the relationships between companies and their stakeholders (Hamil & Chadwick, 2010).

2.2 *The Internal Stakeholders' Perspective*

If we focus on the perspectives of the internal stakeholders, we can see some different enablers and obstacles arising from digitalization and smart technologies.

The interactivity characterizing ICD through digital tools highlights the potential active role of ICD users in the communication process. They are able to select the information according to their specific purposes, but they also act as providers of precious additional data for firms. In so doing, internal stakeholders contribute to the strategy (re)formulation process. This becomes possible because of the bidirectional nature of digital channels (Holland, 2005) and their ability to generate Big Data. According to recent literature, Big Data, digital revolution and social media are drastically changing decision-making processes. In fact, processing large volumes or wide varieties of data allows firms to derive business value from them, when strong internal capabilities to bridge up ICT and data with decision-making is available (Ransbotham et al., 2015). This ability transforms Big Data into Business Analytics (BA) (Davenport & Harris, 2007), which enables better forecasting and smarter decisions in areas that were previously dominated by intuition rather than data and rigour. Growing evidence suggests that leading BA users achieve higher returns compared to their competitors (Brynjolfsson et al., 2011). Other authors (Raffoni et al., 2018) focus on BA based on Big Data and underline how this could enrich management control systems, particularly in terms of performance evaluation, goal communication and strategy formulation. Malmi and Brown (2008) emphasize the need to adapt management control systems to the digital revolution of the business environment. Using controlled experiments, companies can test hypotheses and analyze results to make more data-driven investment and operation decisions. In sum, recent studies highlight that the new digital context is changing communication for internal purposes too, and especially management accounting (Arnaboldi et al., 2017).

3 A Systematization of Enablers and Obstacles Arising from Digitalization in ICD

The analysis of the literature provided in the previous sections has highlighted that only a few articles explore corporate ICD in the light of changes in technology and, more in detail, how these innovative communication channels become drivers for IC value (Dumay & Guthrie, 2017). Generally speaking, experts perceive digitalization to play a significant role in making digitalized disclosure more flexible and faster, easier to be found and cheaper. Furthermore, most researchers tend to highlight the enabling power of technologies for external users, while we mentioned the importance for internal purposes too.

On the basis of these considerations, in the following sections we propose a systematization and a description of *enablers and obstacles arising from digitalization in ICD*.

3.1 Enablers Arising from Digitalization in ICD

Digital channels and tools differentiate from traditional ones by a number of characteristics, which overlap the critical success factors for an effective ICD process. We refer to the following features, which constitute enabling factors in our conceptual framework:

- *Interactivity*, i.e. the possibility for users to play an active role in the communication process, as well as the opportunity for firms to capture from the interaction precious additional information for management purposes. This becomes possible because of the bidirectional nature of digital channels. This also meets Holland (2005) emphasis on the dynamic elements of interaction and learning as fundamental characteristics of disclosure.

- *Dynamicity*, in fact while traditional annual reports provide backward-looking information and static reports, digital platforms and solutions can disclose updated information and also receive instant feedback from stakeholders, making the communication more dynamic. La Torre et al. (2018) highlight the importance to go beyond static and periodic reporting towards a more dynamic and relevant disclosure for stakeholders.
- *Personalization*, because the same set of information can be created to meet a plurality of information needs. Thanks to digital tools' features, users can navigate and retrieve customized disclosure, indeed. Therefore, this turn out to be calibrated for different audiences.
- *Effectiveness* and *flexibility*, because digitalization enables innovative communication tools and firms can then set up the most proper frame to open wide windows into their IC and can follow flexible and customized communications strategies. Electronic forms of reporting allow reporting users to select information they are more interested in (de Villiers et al., 2014, p. 1046). Furthermore, visualization, which includes various techniques for creating images, diagrams, and animations favoured by digital tools, can deeply add to the intelligibility of information. These factors impact the perceived usefulness and ease of use of digital tools, which are suggested to be important drivers of technology acceptance models (King & He, 2006).
- *Timeliness* of digital channels and *easy access* to an open arena, since digital channels offer instant, one-to-many communication that bypasses traditional media and allows firms to broadcast their intended messages to a large network of stakeholders. To sum up, data is available in real time and can be used faster, easier and more efficiently.
- *Efficiency*, because processes are expected to become standardized within IC disclosure and this generates time saving. Furthermore, if data are available in real time and can be used faster, easier and more efficiently, this reduces the uncertainty that stems from information asymmetry between managers and external investors and stakeholders. Finally, digitalization can reduce overlapping and double activities, for instance data enter activities avoided thanks to synchronization.
- *Measurability*, i.e. the ability to promptly measure users' responsiveness and interactivity to IC communication.
- *Mobility/availability*, which makes information highly accessible from a multitude of users and from a large number of devices. Information becomes available when, where and how everyone prefers.
- *Networked communication*, which enables improvements of the relationships with the plethora of stakeholders in the ecosystem.
- *Visibility*, that companies can leverage to create and strengthen the corporate image and reputation. Digital channels and tools are particularly suitable for creating an agile, flexible and modern picture of the business and, in doing so,

to advance the corporate image. This leads to integration between accounting and marketing activities.

3.2 Obstacles Arising from Digitalization in ICD

Organizations embracing digitalization face also important challenges and risks which turn out in potential obstacles to ICD digitalization. We aim to contribute to the literature by identifying the following:

- *Lack of digital human talent and skills* to organize, analyze and exploit data (Ransbotham et al., 2015). From this perspective, training is essential in getting people to accept innovation and to implement it. They need competences about technology devices and applications and on integration between different devices in work settings. Training can be formal and controlled by the organization or informal, e.g. based on personal experience exchange. This can be facilitated by social networks like LinkedIn and Twitter.
- *Resistance to change* and adaptation in human resources (Chen et al., 2009), because all organizational changes' may cause uncertainty, due to necessary restructuring and the way such changes are communicated and internalized by employees. Not all of them are aware of the benefits of technology and some may distrust technological tools.
- *Cultural barriers*, which influence the adaptation to digitalization. If there is a culture of use, this would encourage others to use innovative digital channels and tools. Hence, a cultural change is needed before such tools catch on with IC information users. Low individual computer experience and innovativeness can represent obstacles to the use of digital tools (King & He, 2006), since they restrict people perceptions of technology and their flexibility towards technological changes.
- *Low level of standardization* of information and communication flows, which makes digitalization more complex. Standardization is particularly hard when information refers to IC elements, given their undefined nature by definition; as a consequence, digitalization becomes even more challenging. To be converted into a digital format, information has to be objective, simple and clear.
- *Lack of digital assets*, i.e. technological resources constraints, when infrastructures (optic fibre, devices, hardware, software, etc.) are not adequate.
- *Legal aspects*, which refer to the fair and secure use of data in digitalization, from the law and regulation point of view. Protection, privacy and security of sensitive data during their collection, storage and transfer can be relevant issues and require specific protocols, measures and investments, to avoid security failure, information leakage, hackers attacks etc. Furthermore, gaps in the regulatory framework still exist and sometimes laws are not sufficiently clear and adequate.

- *Difficult balance between disclosable and undisclosable information*, in order to preserve strategic information secrecy and avoid to jeopardize key sources of competitive advantage, like distinctive knowledge, competences and resources.
- *Involuntary disclosure*, as a dark side of digital channels and tools, when negative aspects are made public and dangerously impact on stakeholders and investors' perceptions about the firm integrity and values.

3.3 A Framework for Enablers and Obstacles from the Internal and External Stakeholders' Perspectives

An awareness of enablers and obstacles to ICD digitalization can help to improve this process, avoiding pitfalls. The enablers included in our framework reinforce the theory that digitalization and smart technologies can blur the borders between organizations and ecosystems and, then, act as catalysts of the fourth stage of IC management. On the other hand, some important obstacles also arise.

Figure 1 summarizes how enablers and obstacles identified in our framework (i.e. our first dimension of analysis) overlap alternatively with external or internal users of digital tools for ICD (i.e. our second dimension of analysis). In Fig. 1, the overlaps are highlighted by the grey areas, relative to both dimensions.

If we focus on the impact on external stakeholders, more overlaps with enablers emerge. As a consequence, we believe that digitalization mainly facilitates IC disclosure and, hence, it also allows a wider spread/dissemination of valuable knowledge outside company boundaries, in favour of the entire community of stakeholders who coexist in the ecosystem. In doing so, digitalization and smart technologies contribute to IC exploitation. This phenomenon emerges as an additional magnificent consequence of the usage of digitalization and smart technologies for IC disclosure purposes. While less overlaps concerns external stakeholders and obstacles. However, cultural barriers on the use of digital technologies still exist, as well as a common scepticism about privacy protection issues.

If we focus, instead, on internal users, more obstacles appear to be relevant. Some of them mainly refer to organizational aspects, like the lack of digital talent reported by numerous studies, as well as the existence of cultural barriers against digitalization and staff resistance to change. Other obstacles concern insufficient digital assets, like investments in digital infrastructures and standardization along the information system process. Finally, the balance between voluntary and involuntary disclosure can be very challenging. However, thanks to the instant feedback from stakeholders and the Big Data that they provide just by making use of digital channels and tools, companies have access to precious inputs to renew their IC generation process. Digital and smart solutions enable organizations to gather information through the interconnection between IC disclosure providers and users. This information can be used by companies to create and strengthen their IC elements. Furthermore, it can be used for strategic decisions and corporate marketing activities. Therefore, a virtuous

1st dimension: Enables vs Obstacles to ICD digitalization		2nd dimension: External vs Internal stakeholders	
	Enablers	**External users**	**Internal users**
	interactivity		
	dynamicity		
	personalization		
	effectiveness and flexibility		
	timeliness and easy access		
	efficiency		
	measurability		
	mobility/availability		
	networked communication		
	visibility		
	Obstacles	**External users**	**Internal users**
	lack of digital human talent		
	resistance to change		
	cultural barriers		
	low level of standardization		
	lack of digital assets		
	legal aspects		
	disclosable and undisclosable		
	involuntary disclosure		

Fig. 1 Enablers and obstacles to ICD digitalization for external and internal users

circle originates: digital media can even become strategic external sources for IC identification and, in turn, positively contribute to new IC creation.

4 Concluding Remarks

The first aim of this research was to clarify the relationship between Smart Technologies, Digitalization and ICD. The second aim was to explore the potential of technology to improve ICD through a preliminary systematization based on literature.

To achieve our objectives, the chapter proposes a preliminary framework providing a systematization of enablers and obstacles to ICD digitalization for external and internal stakeholders.

Our framework highlights enablers generated by digitalization of IC disclosure, which lead to wider dissemination of valuable knowledge inside and outside a company's boundaries, in favour of the entire community of stakeholders, internal and external. This meets their expectations and needs for flexible, interactive, multidirectional and timely approaches, technologies and infrastructures to acquire, process and disclose data and information.

Our analysis confirms different information needs of external stakeholders compared to internal ones. While external stakeholders require reliable and timely information about companies' IC to guide their behaviour, internal stakeholders need to share and process large volumes and a wide variety of data to contribute to the strategy (re)formulation process.

This study makes theoretical and practical contributions. For researchers, it contributes to the extant literature that seeks to better understand the relationship between ICD and digitalization, by adding further theoretical insights to the existing studies regarding ICD.

Practical implications of the study are essentially related to the clarification of which are the main obstacles faced by firms, underlining the key and critical aspects to overcome. In particular, our results suggest that additional investments are necessary to enhance the digital talent of human capital and to break down cultural barriers against digitalization that still exist. Therefore, education and training could represent critical success factors to be embedded in the firm's strategy.

Additional efforts should also reinforce digital assets in the form of digital infrastructures. On the basis of the obstacles to ICD digitalization still existing, we recommend using a mixed structure of communication tools and channels.

Furthermore, the integration of the technologies used for the internal and external disclosures could reduce the obstacles for the two categories of stakeholders (external and internal) and also enrich the factors enabling ICD.

The implementation of these practical contributions could determine several benefits for companies, e.g. each stakeholder can access on demand a large volume of information in their particular area of interest, and companies could improve corporate image, competitive advantage and their market value. Therefore, we can state that digitalization and smart technologies can blur the borders between organizations and ecosystems and, then, act as catalysts of the fourth stage of IC exploitation and management.

Our study is only a preliminary analysis. Future research could improve the model and test it empirically.

References

Andriessen, D. (2004). IC valuation and measurement: Classifying the state of the art. *Journal of Intellectual Capital, 5*(2), 230–242.

Arnaboldi, M., Busco, C., & Cuganesan, S. (2017). Accounting, accountability, social media and big data: Revolution or bype? *Accounting, Auditing and Accountability Journal, 30*(4), 762–776.

Berraies, S., & Chaher, M. (2014). Knowledge creation process and firms' innovation performance: Mediating effect of organizational learning. *International Journal of Human Resource Studies, 4*(1), 204–222.

Beattie, V., & Pratt, K. (2003). Issues concerning web-based business reporting: An analysis of the views of interested parties. *The British Accounting Review, 35*(2), 155–187.

Bonsón, E., & Escobar, T. (2006). Digital reporting in Eastern Europe: An empirical study. *International Journal of Accounting Information Systems, 7*(4), 299–318.

Brynjolfsson, E., Hitt, L., & Kim, H. (2011). Strength in numbers: How does data-driven decision making affect firm performance. In *9th Annual Industrial Organization Conference*, April 22.

Chen, M. C., Cheng, S. J., & Hwang, Y. (2005). An empirical investigation of the relationship between intellectual capital and firms' market value and financial performance. *Journal of Intellectual Capital, 6*(2), 159–176.

Chen, H. H., Chen, S. C., & Tsai, L. H. (2009). A study of successful ERP – from the organization fit perspective. *Journal of Systemics, Cybernetics and Informatics, 7*(4), 8–16.

Cuozzo, B., Dumay, J., Palmaccio, M., & Lombardi, R. (2017). Intellectual capital disclosure: A structured literature review. *Journal of Intellectual Capital, 18*(1), 9–28.

Dalmasso, C., Gand, S., & Garcias, F. (2018). Stimuler l'innovation radicale par l'usage d'un réseau social d'entreprise: une expérimentation dans l'industrie pétrolière. *Revue Française de Gestion, 272*(3), 103–120.

Davenport, T., & Harris, J. G. (2007). *Competing on analytics*. Harvard Business Press.

de Villiers, C., Rinaldi, L., & Unerman, J. (2014). Integrated reporting: Insights, gaps and an agenda for future research. *Accounting, Auditing & Accountability Journal, 27*(7), 1042–1067.

Dumay, J. C. (2012). Grand theories as barriers to using IC concepts. *Journal of Intellectual Capital, 13*(1), 4–15.

Dumay, J. (2016). A critical reflection on the future of intellectual capital: From reporting to disclosure. *Journal of Intellectual Capital, 17*(1), 168–184.

Dumay, J., & Tull, J. A. (2007). Intellectual capital disclosure and price-sensitive Australian stock exchange announcements. *Journal of Intellectual Capital, 8*(2), 236–255.

Dumay, J., & Guthrie, J. (2017). Involuntary disclosure of intellectual capital: Is it relevant? *Journal of Intellectual Capital, 18*(1), 30–45.

Eustace, C. (2000). *The intangible economy: Impact and policy issues. Report of the European high level expert group on the intangible economy*. European Commission.

Falkowski, M. (2014). Social media's role in intellectual capital's growth. *Review of Business and Economics Studies, 2*(2), 66–74.

Gerpott, T. J., Thomas, S. E., & Hoffmann, A. P. (2008). Intangible asset disclosure in the telecommunications industry. *Journal of Intellectual Capital, 9*(1), 37–69.

Ghani, E. K., Laswad, F., & Tooley, S. (2009). Digital reporting formats: Users' perceptions, preferences and performances. *The International Journal of Digital Accounting Research, 9*(1), 45–98.

Hamil, S., & Chadwick, S. (2010). *Managing football: An international perspective*. Butterworth-Heinemann.

Hauer, G., Harte, P., & Kacemi, J. (2018). An exploration of the impact of industry 4.0 approach on corporate communication in the German manufacturing industry. *International Journal of Supply Chain Management, 7*(4), 125–131.

Hoffman, C., & Mora Rodríguez, M. (2013). Digitizing financial reports – Issues and insights: A viewpoint. *The International Journal of Digital Accounting Research, 13*(1), 73–98.

Holland, J. (2005). A grounded theory of corporate disclosure. *Accounting and Business Research, 35*(3), 249–267.

King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & Management, 43*, 740–755.

La Torre, M., Valentinetti, D., Dumay, J., & Rea, M. A. (2018). Improving corporate disclosure through XBRL. *Journal of Intellectual Capital, 19*(2), 338–366.

Lardo, A., Dumay, J., Trequattrini, R., & Russo, G. (2017). Social media networks as drivers for intellectual capital disclosure: Evidence from professional football clubs. *Journal of Intellectual Capital, 18*(1), 63–80.

Llewelyn, S. (2003). What counts as theory in qualitative management and accounting research? Introducing five levels of theorizing. *Accounting, Auditing & Accountability Journal, 16*(4), 662–708.

Kuś, A., & Pypłacz, P. (2019). The importance of information management in the context of industry 4.0: Evidence from the Kuyavian-Pomeranian Forbes diamonds. *Social Sciences, 8*(6), 169.

Malmi, T., & Brown, T. A. (2008). Management control systems as a package – Opportunities, challenges and research directions. *Management Accounting Research, 19*(4), 287–300.

Pisano, S., Lepore, L., & Lamboglia, R. (2017). Corporate disclosure of human capital via LinkedIn and ownership structure. *Journal of Intellectual Capital, 18*(1), 102–127.

Raffoni, A., Bartolini, M., Visani, F., & Silvi, R. (2018). Business performance analytics: Exploring the potential of performance management systems. *Production Planning and Control, 29*(1), 51–67.

Ransbotham, S., Kiron, D., & Kirk Prentice, P. (2015). The talent dividend, the 2015 data & analytics report. *MIT Sloan Management Review & SAS*. Accessed November 13, 2020, from http://sloanreview.mit.edu/projects/analytics-talent-dividend/.

Schaper, S., Nielsen, C., & Roslender, R. (2017). Moving from irrelevant intellectual capital (IC)reporting to value-relevant IC disclosures: Key learning points from the Danish experience. *Journal of Intellectual Capital, 18*(1), 82–101.

Striukova, L., Unerman, J., & Guthrie, J. (2008). Corporate reporting of intellectual capital: Evidence from UK companies. *The British Accounting Review, 40*(4), 297–313.

Sullivan, P. J. (2000). *Value-driven intellectual capital: How to convert intangible corporate assets into market value*. John Wiley & Sons.

Turban, E., Bolloju, N., & Liang, T. P. (2011). Enterprise social networking: Opportunities, adoption, and risk mitigation. *Journal of Organizational Computing and Electronic Commerce, 21*(3), 202–220.

Williams, S. M. (2001). Is intellectual capital performance and disclosure practices related? *Journal of Intellectual Capital, 2*(3), 192–203.

Zarowin, P., & Lev, B. (1999). The boundaries of financial reporting and how to extend them. *Journal of Accounting Research, 37*(2), 353–385.

The Impact of Smart Technologies and Digitalization on Intellectual Capital

Federica De Santis and Paolo Esposito

1 Introduction[1]

Long before the more recent wake of international studies, the classic Italian accounting school had identified companies as cybernetic systems (Bertini, 1975), a system of ideas (Bertini, 1995, p. 17) and a knowledge-based organization (Zanda, 2009, p. 209) that combines the means and the production factors made available by the advancements of science (Amaduzzi, 1953, p. 16; Masini, 1978, p. 42; Airoldi et al., 1994) to create lasting value over time (Giannessi, 1960, p.46). According to the Italian doctrine, a company can create lasting value by exploiting and governing the changing dynamics (Amodeo, 1965, p. 12) of innovative technology to support the people working within the organization (Besta, 1922, p. 3) who provide their humanity, and skills as applied in human work (Ferrero, 1968, p. 4).

During the last two decades, national and international academic literature has focused on the need for businesses to create value by leveraging the potential of intangible assets and of Intellectual Capital (IC), and by managing knowledge within the organization both in the private (Stewart, 1997; O'Donnell et al., 2000; Lev, 2003; De Santis & Giuliani, 2013; Moustaghfir & Schiuma, 2013; Giuliani, 2015;

[1]The chapter results from the joint effort of the authors, but the individual contributions are as follows: Paolo Esposito wrote Sects. 1 and 2, Federica De Santis wrote Sects. 3, 4 and 5.

F. De Santis (✉)
Department of Economics and Management, University of Pisa, Pisa, Italy
e-mail: federica.desantis@unipi.it

P. Esposito
Department of Law, Economics, Management and Quantitative Methods, University of Sannio, Benevento, Italy
e-mail: pesposito@unisannio.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_5

Roos, 2017) and in the public sector (Anselmi, 1995; Farneti, 1999; Bueno Campos et al., 2006; Esposito et al., 2020a, b).

The value creation potential of IC and intangible assets for communities (Bonani, 2002; Esposito et al., 2020a, b; Secundo et al., 2020) is acquiring a crucial role within the modern economies, especially in crisis situations and in increasingly competitive business environments (Flamholtz & Hua, 2003). In such a scenario information and knowledge represent one of the key drivers for the creation of value (Esposito & Ricci, 2014) and the acquisition of a sustainable competitive advantage (Del Giudice et al., 2013; Murray et al., 2016). IC is defined as the set of knowledge, information, intellectual property available to a company that can be used to create wealth and value (Stewart, 1997). IC can also be described as the interaction between three distinct but interrelated components: human capital (Edvinsson & Malone, 1997), organizational capital (Bontis, 1998) and relational capital (Cuganesan, 2005).

Currently, we are on the verge of a fourth industrial revolution (Industry 4.0), which is transforming the way in which businesses interact with their customers, employees and suppliers. In such a scenario, businesses are required to upgrade their technological and innovative capabilities according to the Industry 4.0 needs for competing in the dynamic environment (Mahmood & Mubarik, 2020).

The rise of the knowledge economy, the increasing social connectivity and the fast advancements of technology can exert a marked impact on IC (Edvinsson, 2013; Borin & Donato, 2015) as they force companies to face new challenges. Big Data and Data Analytics (BDA), Artificial Intelligence (AI) and Machine Learning (ML), as well as the Internet of Things (IoT), i.e. the purported Smart Technologies (STs) (Murray et al., 2016; Schwab, 2016; De Santis & Presti, 2018) constitute the most representative paradigms of Industry 4.0. Therefore, it becomes of interest to investigate how STs can impact on IC management as a whole, and how digitalization can exert an influence on the individual components of IC. In so doing, this study proposes a structured literature review that allows to summarize the topic under investigation and to propose an insightful and critical analysis on the opportunities and challenges that STs bring to the creation and development of IC.

2 Intellectual Capital and Value Creation in the Digital Age

It is amply recognized that IC brings value to organizations and that IC and its components constitute a key source of competitive advantage (Drucker, 1994). We consider IC as the "intellectual material, knowledge, experience, intellectual property and information that can be put to use to create value" (Dumay, 2016, p. 169) and derives from the interrelation between three distinct components: human capital, organizational capital and relational capital.

Human Capital (HC) is the tacit or implicit knowledge, acquired by individuals working in the organization during their life and aimed at achieving company's objectives. It includes individuals' skills, experiences, education, as well as the motivation of each employee within the organization (Edvinsson & Malone, 1997).

Organizational capital (OC) is the set of all coded and non-coded knowledge embedded within the routines of the organization owned by the company (Bontis, 1998). It represents the complex sum of all the non-human constituents of organizational knowledge that arises from processes and organizational learning. It includes the company's IT networks, databases, organizational charts, process manuals, routines, but also a company's patents, R&D systems, its contracts, rights and obligations (Esposito et al., 2020a, b).

Relational capital (RC) is the most external dimension of IC, as it can be defined as the knowledge embedded in all the relationships that companies create with employees, customers, suppliers, competitors and government but also with brand names, trademarks and corporate reputation (Cuganesan, 2005).

In recent decades, scholars and practitioners have analysed IC with different approaches, developing several concepts, methods and tools aimed at measuring, managing and reporting on IC (Giuliani, 2015). Currently, we are in the fourth stage of IC research, in which scholars seek to understand "how IC works in organizations, how it manifests itself and how people, processes and relationships are mobilized in relation to it" (Chiucchi & Dumay, 2015, p. 306) by adopting a wider concept of value creation that expands its boundaries beyond monetary value and organizational wealth into wider societal value (Dumay & Garanina, 2013; Esposito & Ricci, 2015). A twofold reason has stimulated the adoption of this approach. First, the rise of knowledge economy and the fast advancement of digitalization and STs have made apparent that a company's ability to create value is more and more a matter of its capability to manage knowledge (Secundo et al., 2017). Second, the so-called datafication of the world, in which "almost anything can be recorded, measured and captured digitally, and thereby turned into data" (Cao et al., 2015, p. 423) have blurred the boundaries between internal and external knowledge assets that companies can leverage to gain a lasting competitive advantage (De Santis & Presti, 2018).

Researchers claim that Industry 4.0 is profoundly changing the basis of competitive advantage, from tangible resources to intangible resources (Secundo et al., 2020). Digitalization can foster the creation of knowledge on a broad perspective and generate new opportunities for IC management (Secundo et al., 2017), thus becoming a new form of corporate asset. In the digital age, to create "a bridge between brains inside the organization, i.e. HC, and brains outside the organization, i.e. RC" (Borin & Donato, 2015, p. 286; De Santis & Presti, 2018, p. 364) increasingly represents a strategic assignment (Cavicchi & Vagnoni, 2018).

3 Research Method

This study aims to give a clear understanding of the impact STs have on various IC dimensions, both in terms of opportunities and challenges, by providing different lenses through which the existing literature can be analysed. The authors started with the assumption that STs can potentially create new value and new opportunities for IC management. However, the process of turning them into tangible or intangible assets that become IC is still largely under-investigated (Secundo et al., 2017; De Santis & Presti, 2018). Moreover, an investment in STs cannot be considered risk free. Firms must both harness the power of such technologies (Ricci, 2010), and clearly understand the challenges that such an investment poses to the organization (Erevelles et al., 2016).

To reach the aim of the study, the authors conducted a structured literature review (SLR) which is considered the best type of academic review for summarizing a particular issue and developing an insightful and critical analysis, as it gives the advantage of "standing on the shoulders of giants" (Massaro et al., 2016; Presti & Mancini, 2020). The approach followed to conduct the SLR can be summarized as follows:

1. definition of the research question;
2. definition of the research protocol;
3. selection of papers to analyse;
4. codification and interpretation of the selected contributions;
5. identification of future research paths.

The research question addressed with this study is: What is the impact of adopting STs in the traditional IC dimensions taking a value creation perspective?

Regarding the research protocol, the authors identify the information sources, methods, means and tools to be used to select, analyse and summarize the selected papers (Petticrew & Roberts, 2006; Lombardi & Secundo, 2020). We collected literature from Web of Science, Scopus and Business Source Complete databases as leading sources to access the relevant contributions on the investigated topic. As the debate on STs and digitalization of companies is still in its early stages and covers a wide variety of research fields, the authors had to limit search to "business" and "management" categories (Massaro et al., 2016; De Villiers & Dumay, 2013). Once the search categories have been defined, the researchers extracted not only academic publications, but also conference proceedings, book chapters and professional contributions. To guarantee their relevance, only peer-reviewed contributions were selected. Moreover, for language reasons, the analysis included only contributions written in English.

To ensure consistency with the research purpose and with the keywords traditionally associated with the IC topic, the authors identified the following search terms: "intellectual capital", "intangibles", "intangible assets". Only papers that mentioned the terms "smart technolog*" or "digitalization" in their title, abstract or in the keywords along with one of the abovementioned search terms, each as a fixed phrase, were extracted. This avoided the risk of selecting too many irrelevant articles (Massaro et al., 2016). The number of contributions retrieved using the systematic search, after eliminating duplicates, came to 49.

Since the first literature search was based on contributions' title, abstract or keywords, we proceeded with a complete and deeper analysis of the extracted contributions. None of the utilized sources can be labelled as predominant as most of the results were duplicated. During the cleaning phase, which consisted in selecting only those contributions that were pertinent to the investigated topic, we ensured the relevance of the contributions. From the 49 contributions initially retrieved, only 19 were considered for developing the study. Then, the authors manually analysed these contributions in parallel. Manual coding, indeed, is suitable to ensure the true sense of an expression, as often different words or sentences can be used to explain the same concept (Guthrie et al., 2012).

4 Smart Technologies: Opportunities and Challenges for the IC Dimensions

The term digitalization used to describe the process through which STs are explored and exploited to reshape existing business processes and seize new opportunities (Ricci et al., 2020). In fact, STs allow companies to more efficiently coordinate business processes and/or to enhance customer experience, thus improving the company's value creation potential (Verhoef et al., 2019).

The use of information technology can facilitate the process of generating, structuring, managing and sharing knowledge within and outside the organization, that represent strategic tasks in the digital age (Secundo et al., 2017). Nevertheless, the exploitation of faster and smarter technology is not enough to survive and succeed in the current dynamic competitive environment, as it only provides "the basic ingredients to leverage existing firm knowledge and other resources to create more value for customers" (Ricci et al., 2020, p. 2). It is likewise imperative to combine digitalization with innovations in human, organizational and relational capital and in the way in which such components interact (Schneider, 2018). Only this way companies can create innovative new products and services, thus maintaining a sustainable competitive advantage (Cormican & O'Sullivan, 2003). That is to say that, to be successful, investments in digitalization should lead to the acquisition and development of new intellectual capital in all its forms, i.e. human, organizational and relational capital (Ricci et al., 2020).

4.1 The Impact of Digitalization on Human Capital

Much of the analysed contributions (7 out of 19) focus on the relationship between digitalization and HC, thus confirming the strategic relevance that this component has for the success of any organizations. At the same time, the attention shown by recent academic research points out that the disruption brought by the advent of the digital age imposes strong changes to HC and its management (Cano-Kollmann et al., 2018).

Schneider (2018) highlights that employees are now much better informed about business processes, machines functioning and products along the entire supply chain, due to the availability of smarter and faster communication means like intra- and Internet, enterprise social networks and technologies such as the IoT. The use of technology allows employees to better coordinate their activities with each other, and with customers and suppliers. This social and machine networking potential provides employees with the opportunity to locate expertise and to acquire new knowledge to expand their knowledge base. The interaction among employees by means of intranet and enterprise social networks stimulates their learning processes. Indeed, the publications posted by other workers become knowledge on best practices and ideas that workers can access and internalize in their own knowledge base, with a positive impact also in workers' autonomy, efficiency and task involvement (Berraies, 2019).

However, such improvements are not for free. First, the exploitation of the mentioned STs also determines a higher need to properly use and communicate the available information. Second, the Industry 4.0 revolution often leads to profound changes in production processes, which are increasingly oriented towards differentiated, customized products to satisfy customers' needs and firms may accordingly decentralize production in networks of workplaces. Moreover, the increasing product connectivity can drive companies to change their business models to enrich their offer with accessory services connected to the products, such as maintenance or delivery (Roy et al., 2009). Employees are thus challenged with more demanding jobs, which require flexibility to adapt to changing products and processes, better coordination along the supply chain and multitasking learning to enhance their ability to respond to customers. In sum, firms need more highly skilled employees who continuously update their expertise (Schneider, 2018).

Digital collaboration through enterprise social networks and intranets and its potential in terms of knowledge sharing among employees also nurtures the collective knowledge of the firm by creating repertories of searchable knowledge to capture and codify individual expertise (Archer-Brown & Kietzmann, 2018). By stimulating workers' interactions and tearing down "information silos", enterprise social networks allow the externalization and structuration of tacit knowledge within formal and informal discussion spaces, thus contributing also to the improvement of the company's Organizational Capital (Berraies, 2019).

The impact of digital technologies on HC can be considered pervasive and omnidirectional (Fenech et al., 2019; Larkin, 2017), since they affect every aspect of the human resources management, from resource planning, recruiting and selection, to performance measurement and rewarding. In this respect, Black and van Esch (2020) extensively debate on the use of smart technologies (from social networks to artificial intelligence algorithms) to enhance recruiting systems.

AI algorithms provide companies with the opportunity to draw from the widest possible talent pool and, at the same time, to stay as targeted as possible when searching for a suitable workforce. In fact, digitalization does not just expand the size or breadth of the purported talent pool, but rather the depth of information about candidates in the pool. At the same time, digitalization creates bi-directional transparency, so that interested candidates can exploit the huge amount of easy-to-access information to make more informed decisions about who they want to work for. This also has the potential to assure higher commitment of employees to the selected company (De Santis & Presti, 2018).

Using AI in recruitment processes also allows to dramatically reduce the time-to-hire, which is often a strategic lever to beat the competition for hiring the most talented candidates (Black & van Esch, 2020). The use of advanced technologies in personnel recruitment (e.g. gamification of tests to gain insights on skills and personality) can also contribute to create a positive experience for candidates. Indeed, recruitment experience has been proved as a highly influential variable on candidates' word-of-mouth and, accordingly, on firms' reputation (Talent Board, 2017).

However, it would be misleading to assume that smart or digital recruiting is without challenges or potential concerns, which are mainly related to the cost and the time needed for the investment, to the complexity it introduces in the recruitment process, as well as to ethical and privacy issues and to the potential resistance from traditional recruiters.

4.2 The Impact of Digitalization on Organizational Capital

Regarding OC, i.e. all the non-human constituents of organizational knowledge that arises from processes and organizational learning, Edvinsson and Malone (1997) proposed a distinction between process capital and innovation capital. The former refers to the processes, techniques and programmes that enhance efficiency of manufacturing or the delivery of services. The innovation capital refers to the company's ability to innovate its products, processes, brands or patents by developing new intellectual properties.

In order for STs to unfold their full potential in terms of their contribution to value creation, companies must combine investments in IT with training activities, new ways of organizing work and appropriate management techniques (Brynjolfsson & McAfee, 2014; Ricci et al., 2020). Therefore, to effectively pursue a digital transformation, firms must adjust their OC and adopt a holistic work organization that emphasizes teamwork, few hierarchical controls and decentralized decision-making (Schneider, 2018, p. 43).

According to Mahmood and Mubarik (2020), to properly adjust OC to the requirements of digital revolution can positively impact on the company's organizational ambidexterity, i.e. the organization's ability to carry out and combine two distinct but intertwined learning activities: exploitation and exploration. Exploration nurtures the innovation capital, as it refers to experimentation, search and discovery of innovations. Exploitation, in turn, supports the development of process capital (Edvinsson & Malone, 1997), since this learning activity relates to efficiency, selection, refinement and implementation activities.

The use of STs in supporting business activities can enhance the development of OC. Berraies (2019) analyses the contribution of enterprise social networks on organizational ambidexterity. The author concludes that the ability of social networks in capturing and storing knowledge from the different participants (employees, customers, suppliers) favours the structuration of individuals' knowledge, thus making social networks a complementary knowledge management tool. Indeed, social networks contribute to OC improvement by preventing knowledge loss and by offering guidance about how processes are optimally realized, as the knowledge generated by individuals' interaction on social networks, shared documents and best practices are stored in company's databases (Berraies, 2019; Archer-Brown & Kietzmann, 2018; Riemer & Scifleet, 2012).

Moreover, the emergence of BDA tools makes it available for the organization vast amounts of data coming not only from specific groups of people such as the employees, customer and suppliers, but from everyone who interacts in the increasingly expanding corporate ecosystem. These technologies have thus the potential to exponentially increase the actors that, both from the inside and from the outside the organization, contribute to the firm's knowledge development process (De Santis & Presti, 2018).

However, Schneider (2018, p.40) underlines that OC "has considerable inertia" as it "changes slowly, through individual and organizational learning". Such characteristics may slow down, at least at the beginning, the process of introducing STs within the organization to join the digital revolution. Finally, the contribution of STs to the improvement of OC might be impaired by some significant issues related to the adoption of advanced technological tools. First, the huge volumes of data retrieved from a multiplicity of internal and external sources may contain poor quality data that consequently have a limited or even negative impact on organizational learning processes. Moreover, the complex algorithms applied to extract knowledge from raw data (e.g. through data mining and AI) can have a "black boxing" effect on the information processing, thus limiting the opportunity to effectively increase corporate's knowledge (Kaisler et al., 2013).

4.3 The Impact of Digitalization on Relational Capital

In a broad sense, RC encompasses the knowledge embedded in all the relationships that organizations develop with the different agents in its environment such as customers, suppliers, competitors, government and stakeholders in general (Cuganesan, 2005). Since one of the key features of digitalization is its ability to support the knowledge assets management and to bring people together in dispersed organizations, it becomes apparent that the availability of STs can exert a significant impact on the development of RC.

As a consequence of the growing competition and environmental dynamism, as well as of the diffusion of real-time communication media, suppliers, customers and stakeholders are becoming increasingly involved in business processes. In such a scenario, the use of information technology is moving from an individual level to a group one (Cormican & O'Sullivan, 2003). Accordingly, organizations are required to provide the right information, to the right people, at the right time, in the right format, anywhere within its expanding ecosystem (Secundo et al., 2017).

Digitalization determines transparency, reciprocity and trust among the agents within the corporate ecosystem that have the potential to increase the value of RC (Villalobos & Moreva, 2019). The ever increasing computational power of devices, the availability of cloud repositories and of advanced analytics make it possible to integrate different data sets and to link the company's information system with external ones, providing firms with an extended and comprehensive view of their objects of interest (De Santis & Presti, 2018). Firms currently have the opportunity to seamlessly integrate the data sets of different entities along the supply chain, to capture and share accurate information timeously in order to coordinate their respective activities, enhance efficiency and improve supply chain performance (Devaraj et al., 2007).

Lambourdiere and Corbin (2020) investigated the application of blockchain technology to supply chain performance, demonstrating that this technology increases transparency by providing to all members a complete view of the entire supply chain in real time. Such visibility and timeliness have a positive impact on operational and strategic performance, since flows can be tracked and traced in real time and potential problems can be identified faster and more accurately. However, blockchain technology does not determine an enhancement of the supply chain performance by itself. In fact, any improvement heavily depends on the ability of each organization to identify, use and assimilate both internal and external information.

Finally, Lombardi and Secundo (2020) point out that digitalization of corporate reporting determines an improvement in company's transparency and accountability to both stakeholders and shareholders. By means of digitalization, stakeholder engagement and sustainable reporting practices are enhanced as the use of the most recent information and communication technologies makes it possible to turn reporting into valuable communication.

5 Conclusions

The advent of the digital age and the development of STs create new relationships between humans and machines, changes work characteristics and organizational structures and broadens exponentially the relationships between the firm and its ecosystem (Esposito, 2020). That is why IC can be considered at the very heart of the fourth industrial revolution. Stemming from these considerations, this section investigates the relationship between STs and IC, to understand the impact that technology has on the creation, management and development of the three dimensions of IC.

By means of a SLR, we proposed some interesting insights. First, the relationship between STs and IC should be interpreted as bi-directional and mutual. Indeed, whilst, on the one hand, the adoption of the most advanced technological tools offers several opportunities to develop each component of a company's intellectual capital, on the other a strong IC is considered a prerequisite for stimulating companies in stepping into the digital revolution (Mahmood & Mubarik, 2020; Schneider, 2018).

Second, the analysed literature suggests that investing in digital technologies is not sufficient per se to gain their value creation potential. Scholars underline that digitalization must be complemented with other investments in intangible assets (Brynjolfsson & McAfee, 2014). In other words, an investment in digital technologies "only provides the basic ingredients to leverage existing firm's knowledge and other resources" to create value (Ricci et al., 2020, pp. 2–3). To succeed in exploiting such value creation potential, a new and holistic work organization is required, where greater attention is given to direct, network-like cooperation and information exchanges among employees, but also with all the actors interacting in the increasingly wide corporate ecosystem (Schneider, 2018).

To be successful in this task, firms must harness the power of IT and understand the potential of new technologies, as well as the risks that STs can bring to the organization. However, there are only a very few publications investigating how firms could exploit the opportunities and handle the challenges of digitalization under an IC management perspective. Further research is needed to confirm or revise the findings derived from the theoretical analysis. Researchers might conduct longitudinal case studies to analyse how companies' IC adjusts and evolves by means of STs. Moreover, future research might use the insights gained from this study to build a model on the factors influencing the adoption of STs to be tested in a quantitative manner.

Finally, this study has some limitations, mostly related to the adopted methodology. Though the SLR methodology allowed us to collect enough publications and seminal works on STs and IC to offer a synthetic picture of the phenomenon under investigation, time and language constraints and imperfect information made it difficult to cover all the literature that directly or indirectly deals with the contribution of STs and digitalization to IC components.

References

Airoldi, G., Brunetti, G., & Coda, V. (1994). *Economia aziendale, il Mulino*. Bologna.

Amaduzzi, A. (1953). *L'azienda nel suo sistema e nell'ordine delle sue rileva-zioni*. Utet.

Amodeo, D. (1965). *Ragioneria generale delle imprese*. Giannini.

Anselmi, L. (1995). *Il processo di trasformazione della pubblica amministrazione*. Giappichelli.

Archer-Brown, C., & Kietzmann, J. (2018). Strategic knowledge management and enterprise social media. *Journal of Knowledge Management, 22*(6), 1288–1309.

Berraies, S. (2019). The effect of enterprise social networks use on exploitative and exploratory innovations: Mediating effect of sub-dimensions of intellectual capital. *Journal of Intellectual Capital, 20*(3), 426–452.

Bertini, U. (1975). *L'azienda come sistema cibernetico*. In Aa. Vv., Scritti in onore del Professor Alberto Riparbelli, Cursi.

Bertini, U. (1995). *Il sistema aziendale delle idee*. Giuffrè.

Besta, F. (1922). *La ragioneria*. Vallardi.

Black, J. S., & van Esch, P. (2020). AI-enabled recruiting: What is it and how should a manager use it? *Business Horizons, 63*(2), 215–226.

Bonani, G. P. (2002). *La sfida del capitale intellettuale. Principi e strumenti di knowledge management per organizzazioni intelligenti* (Vol. 238). FrancoAngeli.

Bontis, N. (1998). Intellectual capital: An exploratory study that develops measures and models. *Management Decision, 36*(2), 63–76.

Borin, E., & Donato, F. (2015). Unlocking the potential of IC in Italian cultural ecosystems. *Journal of Intellectual Capital, 16*(2), 285–304.

Brynjolfsson, E., & McAfee, A. (2014). *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. WW Norton & Company.

Bueno Campos, E., Salmador, M. P., & Merino, C. (2006). Towards a model of intellectual capital in public administrations. *International Journal of Learning and Intellectual Capital, 3*(3), 214–232.

Cano-Kollmann, M., Hannigan, T. J., & Mudambi, R. (2018). Global innovation networks–organizations and people. *Journal of International Management, 24*(2), 87–92.

Cao, M., Chychyla, R., & Stewart, T. (2015). Big data analytics in financial statement audits. *Accounting Horizons, 29*(2), 423–429.

Cavicchi, C., & Vagnoni, E. (2018). Intellectual capital in support of farm businesses' strategic management: A case study. *Journal of Intellectual Capital, 19*(4), 692–711.

Chiucchi, M. S., & Dumay, J. (2015). Unlocking intellectual capital. *Journal of Intellectual Capital, 16*(2), 305–330.

Cormican, K., & O'Sullivan, D. (2003). A collaborative knowledge management tool for product innovation management. *International Journal of Technology Management, 26*(1), 53–67.

Cuganesan, S. (2005). Intellectual capital-in-action and value creation: A case study of knowledge transformations in an innovation project. *Journal of Intellectual Capital, 6*(3), 357–373.

De Santis, F., & Giuliani, M. (2013). A look on the other side: Investigating intellectual liabilities. *Journal of Intellectual Capital, 14*(2), 212–226.

De Santis, F., & Presti, C. (2018). The relationship between intellectual capital and big data: A review. *Meditari Accountancy Research, 26*(3), 361–380.

De Villiers, C., & Dumay, J. (2013). Construction of research articles in the leading interdisciplinary accounting journals. *Accounting, Auditing & Accountability Journal, 26*(6), 876–910.

Del Giudice, M., Della Peruta, M. R., & Maggioni, V. (2013). Collective knowledge and organizational routines within academic communities of practice: An empirical research on science–entrepreneurs. *Journal of the Knowledge Economy, 4*(3), 260–278.

Devaraj, S., Krajewski, L., & Wei, J. C. (2007). Impact of eBusiness technologies on operational performance: The role of production information integration in the supply chain. *Journal of Operations Management, 25*(6), 1199–1216.

Drucker, P. F. (1994). *Post-capitalist society*. Routledge.

Dumay, J. (2016). A critical reflection on the future of intellectual capital: From reporting to disclosure. *Journal of Intellectual Capital, 17*(1), 168–184.

Dumay, J., & Garanina, T. (2013). Intellectual capital research: A critical examination of the third stage. *Journal of Intellectual Capital, 14*(1), 10–25.

Edvinsson, L. (2013). IC 21: Reflections from 21 years of IC practice and theory. *Journal of Intellectual Capital, 14*(1), 163–172.

Edvinsson, L., & Malone, M. S. (1997). *Intellectual capital: The proven way to establish your company's real value by finding its hidden brainpower*. Piatkus.

Erevelles, S., Fukawa, N., & Swayne, L. (2016). Big data consumer analytics and the transformation of marketing. *Journal of Business Research, 69*(2), 897–904.

Esposito, P. (2020). Capitale intellettuale, smart technologies e digital transformation: quali prospettive? In D. Mancini et al. (Eds.), *Capitale intellettuale, smart tecnologies e digitalizazzione: sinergie e opportunità*. FrancoAngeli.
Esposito, P., & Ricci, P. (2015). *How to turn public (dis)value into new public value? Evidence from Italy, public money & management*. Routledge – Taylor & Francis Group.
Esposito, P., & Ricci, P. (2014). *Public (dis)value: A case study, in public value management, measurement and reporting* (Guthrie, J., et al., 2014). Emerald.
Esposito, P., Ricci, P., & Sancino, A. (2020a). *Leading for social change: Waste management in the place of social (ir)responsibility, corporate social responsibility and environmental management*. Wiley.
Esposito, P., Spano, A., & Vermiglio, C. (2020b). La Blockchain nel Settore Pubblico. In D. Mancini et al. (Eds.), *Capitale intellettuale, smart technologies e digitalizzazione: sinergie e opportunità*. Franco Angeli.
Farneti, G. (1999). Verso una nuova definizione di "azienda", con quali conseguenze sull'economia aziendale: prime riflessioni. *Rivista italiana di Ragioneria e di Economia aziendale, 7–8*, 351–352.
Fenech, R., Baguant, P., & Ivanov, D. (2019). The changing role of human resource management in an era of digital transformation. *Journal of Management Information and Decision Sciences, 22* (2), 1–10.
Ferrero, G. (1968). *Istituzioni di economia d'azienda*. Giuffrè.
Flamholtz, E., & Hua, W. (2003). Searching for competitive advantage in the black box. *European Management Journal, 21*(2), 222–236.
Giannessi, E. (1960). *Le aziende di produzione originaria*. Cursi.
Giuliani, M. (2015). Intellectual capital dynamics: Seeing them in practice through a temporal lens. *Vine, 45*(1), 46–66.
Guthrie, J., Ricceri, F., & Dumay, J. (2012). Reflections and projections: A decade of intellectual capital accounting research. *The British Accounting Review, 44*(2), 68–82.
Kaisler, S., Armour, F., Espinosa, J. A., & Money, W. (2013). Big data: Issues and challenges moving forward. In *46th Hawaii International Conference System Sciences (HICSS)* (pp. 995–1004).
Lambourdiere, E., & Corbin, E. (2020). Blockchain and maritime supply-chain performance: Dynamic capabilities perspective. *Worldwide Hospitality and Tourism Themes, 12*(1), 24–34.
Larkin, J. (2017). HR digital disruption: The biggest wave of transformation in decades. *Strategic HR Review, 16*(2), 55–59.
Lev, B. (2003). *Intangibles. Gestione, valutazione e reporting delle risorse intangibili delle aziende*. ETAS.
Lombardi, R., & Secundo, G. (2020). *The digital transformation of corporate reporting – A systematic literature review and avenues for future research*. Meditari Accountancy Research.
Mahmood, T., & Mubarik, M. S. (2020). Balancing innovation and exploitation in the fourth industrial revolution: Role of intellectual capital and technology absorptive capacity. *Technological Forecasting and Social Change, 160*, 120248.
Masini, C. (1978). *Il sistema dei valori d'azienda: un problema di calcolo economico nelle imprese: razionalità e metodo*. Giuffrè.
Massaro, M., Dumay, J., & Guthrie, J. (2016). On the shoulders of giants: Undertaking a structured literature review in accounting. *Accounting, Auditing & Accountability Journal, 29*(5), 767–801.
Moustaghfir, K., & Schiuma, G. (2013). Knowledge, learning, and innovation: Research and perspectives. *Journal of Knowledge Management, 17*(4), 495–510.
Murray, A., Papa, A., Cuozzo, B., & Russo, G. (2016). Evaluating the innovation of the internet of things: Empirical evidence from the intellectual capital assessment. *Business Process Management Journal, 22*(2).
O'Donnell, D., O'Regan, P., & Coates, B. (2000). Intellectual capital: A Habermasian introduction. *Journal of Intellectual Capital, 1*(2), 187–200.

Petticrew, M., & Roberts, H. (2006). *Systematic reviews in the social sciences: A practical guide*. Blackwell.

Presti, C., & Mancini, D. (2020). Il risk management ei social media: un'analisi della loro relazione in letteratura. *Management Control, 2*, 155–178.

Ricci, P. (2010). *Il soggetto economico nell'azienda pubblica*. Chi comanda davvero nell'azienda pubblica e perché, Rirea.

Ricci, F., Scafarto, V., Ferri, S., & Tron, A. (2020). Value relevance of digitalization: The moderating role of corporate sustainability. An empirical study of Italian listed companies. *Journal of Cleaner Production, 276*, 123282.

Riemer, K., & Scifleet, P. (2012). Enterprise social networking in knowledge-intensive work practices: A case study in a professional service firm. In *Proceedings of the 23rd Australasian Conference on Information Systems*, Geelong, Victoria, December 3–5.

Roos, G. (2017). Knowledge management, intellectual capital, structural holes, economic complexity and national prosperity. *Journal of Intellectual Capital, 18*(4), 745–770.

Roy, R., Shehab, E., Tiwari, A., Baines, T. S., Lightfoot, H. W., Benedettini, O., & Kay, J. M. (2009). The servitization of manufacturing: A review of literature and reflection on future challenges. *Journal of Manufacturing Technology Management, 20*(5), 547–567.

Schneider, M. (2018). Digitalization of production, human capital, and organizational capital. In *The impact of digitalization in the workplace* (pp. 39–52). Springer.

Schwab, K. (2016). *La quarta rivoluzione industriale*. FrancoAngeli.

Secundo, G., Del Vecchio, P., Dumay, J., & Passiante, G. (2017). Intellectual capital in the age of big data: Establishing a research agenda. *Journal of Intellectual Capital, 18*(2), 242–261.

Secundo, G., Ndou, V., Del Vecchio, P., & De Pascale, G. (2020). Sustainable development, intellectual capital and technology policies: A structured literature review and future research agenda. *Technological Forecasting and Social Change, 153*, 119917.

Stewart, T. A. (1997). *Intellectual capital: The new wealth of organizations*. Nicholas Brealey Publishing.

Talent Board. (2017). *Talent board North American candidate experience research report*. Accessed November 9, 2020, from https://www.thetalentboard.org/press-releases/talent-board-2017-north-american-candidate-experience-research-reportnow-available/

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2019). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research, 122*, 889–901.

Villalobos, G. S. S., & Moreva, E. L. (2019). The enterprise' IC management under the digitalization. *Management Science, 9*(3), 78–85.

Zanda, G. (2009). *Il governo della grande impresa nella società della conoscenza*. Torino: Giappichelli.

Intellectual Capital and the Role of Technologies in Public Universities: A Case Study Analysis

Maria Nardo, Roberto Maglio, Fabiana Roberto, Francesco Agliata, and Andrea Rey

1 Introduction

Intellectual Capital (IC) remains an emerging topic in academic literature, especially when referring to the public sector. Early studies attributed an accounting-related meaning to IC (Edvinsson & Malone, 1997), focusing on its representation of intangible resources, or resources that are based on information or include it, and their ability to create market value (Guatri, 1997).

The reason for the scarce diffusion of IC within organisations has even been attributed to this accounting phenomenon (Guthrie et al., 2012), indicating that the term IC highlights the importance of knowledge as essential to the growth and development of society (Drucker, 1993).

Author contributions: All authors wrote the chapter but their primary individual contributions are reflected as follows: Section 1—*Introduction*—is to be ascribed to R. Maglio; Sect. 2—*Background of the study*—is to be ascribed to A. Rey; Sect. 3—*IC and technology in universities. Literature review and research questions*—is to be ascribed to F. Agliata; Sect. 4—*Methodology* —and Sect. 5—*Case study analysis*—are to be ascribed to F. Roberto; Sect. 6—*Conclusion, limitations and future research agenda* —is to be ascribed to M. Nardo. All the authors have read and agreed to the published version of the manuscript.

M. Nardo (✉)
Department of Political and Social Sciences, University of Calabria, Rende, Italy
e-mail: maria.nardo@unical.it

R. Maglio · F. Roberto · A. Rey
Department of Economics, Management, Institutions, University of Naples 'Federico II', Naples, Italy
e-mail: roberto.maglio@unina.it; fabiana.roberto@unina.it; andrea.rey@unina.it

F. Agliata
Department of Economics, University of Campania 'L. Vanvitelli', Caserta, Italy
e-mail: francesco.agliata2@unicampania.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_6

Thus, scholars began to associate IC analysis with knowledge-management methods and, therefore, with a set of business activities and processes that create value in a broad sense, instead of a set of intangible resources (Choo & Bontis, 2002).

There is broad agreement that IC should be analysed with reference to its link with corporate strategies for generating economic, social and environmental value (Roos et al., 2011). In this sense, IC is currently the most important driver for achieving smart, sustainable and inclusive economic and social development (Matos et al., 2020; Nardo & Veltri, 2013). Under this framework, the subject of IC began to spread and gain scholarly interest in the context of public organisations as well.

Since the 1990s, several studies have addressed the taxonomy of IC (Andriessen, 2004). IC can be differentiated into three categories: human capital, organisational (or structural) capital and relational (or social) capital (Bontis, 1998). Accordingly, human capital represents the intangible value of human competencies (knowledge, expertise and experiences); structural capital embodies the knowledge that remains inside the organisation (procedures, databases, etc.) and relational capital refers to resources associated with the external relationships that the organisation entertains with customers, suppliers and partners (Guthrie et al., 2017).

In other words, structural capital, including its technological components, is the backbone that supports IC within organisations (Lombardi et al., 2020).

Several studies have investigated the relationship between IC and organisational performance, both in public sector entities (Siboni et al., 2013a) and in private companies (Carlucci et al., 2004). To date, however, research has mostly involved for-profit organisations, with a particular focus on IC information disclosure in their annual reports. In recent years, the trend has shifted slightly with studies that have also highlighted the central role of IC in public organisations (Dumay et al., 2015).

Research involving public universities is less widespread, although scholarly attention is growing. Some empirical studies have investigated IC reporting practices within universities (Bezhani, 2010; Guthrie & Petty, 2000) or IC plans (Nardo et al., 2017; Siboni et al., 2013b).

Universities, especially public ones, assume a specific responsibility in the production and dissemination of knowledge (Lapsley & Miller, 2004), and they have been recognised as critical institutional actors for the creation of a 'Europe of knowledge' (EC, 2006). Consequently, IC development and disclosure represent primary goals for universities and should play a central role in universities' management (Secundo et al., 2015).

2 Background of the Study

In recent years, the Italian government has given particular attention to providing instruments and tools for planning, measuring and evaluating performance, defined by the Legislative Decree n. 150/2009 as the performance cycle, to improve the quality of public services and, therefore, also of state universities. This regulation required state entities, including state universities, to issue a performance plan including information on IC (CIVIT, 2010; DPF guidelines n. 1/2017, p. 22). To the best of the author's knowledge, this represents the only mandatory requirement in place for IC performance planning in universities.

A similar trend is reflected in the most recent programmatic guidelines for the reform of the Public Administration of the Draghi government, presented by the Minister for Public Administration (Parliamentary Auditions, 09/03/2021). These reforms envisage that the enhancement of human capital and knowledge will increase productivity, efficiency, trust and legality and will ensure that the resources allocated through the Next Generation EU plan and the National Recovery and Resilience Plan to deal with the Covid-19 emergency will contribute to sustainable innovations of public processes and services.

One of the European Commission's first recommendations on reforms and projects that affect the renewal of the Public Administration is the need for a strong push towards investments in technology and its digitisation (EC, 2006). Strategies for knowledge development and investments in technologies represent key elements of IC, particularly for the development of structural or organisational capital.

In the context of these reforms, the current study employs a single case study to investigate how Italian universities deal with IC, particularly with its technological dimension. To this end, planning documents, including performance plans, personnel enhancement plans and strategic plans and reports, including social reports and quality benefit reports, were examined. The document analysis was strengthened by an action research approach, as the researchers are affiliated with the organisation under study.

The paper is structured as follows. Section 3 analyses relevant literature about IC in universities and derives research questions. Section 4 presents the methodology adopted for the study. Section 5 is dedicated to the single case study analysis. Section 6 outlines study conclusions, limitations and a future research agenda.

3 IC and Technology in Universities: Literature Review and Research Questions

IC in universities is an emerging area of growing importance in empirical and theoretical studies, especially related to the technology dimension of IC. Although no explicit specialisation in the topic currently exists, previous discussions suggest that IC studies in universities only recently began to investigate the technology dimension (Hsu et al., 2015).

To date, there is no generally accepted IC framework. Nevertheless, one of the most commonly used is the Bontis IC framework (1998), described above, which classifies IC into human capital, relational capital and structural (or organisational) capital. Traditionally, structural capital is considered as comprising of the routines, procedures, strategies and policies that guide an organisation's daily operations, whereas organisational capital is the collective and institutionalised knowledge and experience residing within and utilised through the databases, patents, manuals, structures, systems and processes of an organisation (Tsui et al., 2014). As a result, the technological dimension tends to revert to structural capital.

Several scholars have argued that universities should satisfy the information needs of stakeholders by providing them with transparent information about intangible resources (Ramírez-Córcoles et al., 2011). Generally, studies investigating how universities disseminate information to stakeholders highlight a low-quality level of disclosure due to low awareness of IC (Bezhani, 2010).

The following research question is thus derived:

RQ1. How does the University disclose its knowledge among internal and external stakeholders? Which documents and tools are used?

Previous studies indicate that IC information tends to be represented in both reporting documents (Bezhani, 2010; Guthrie & Petty, 2000) and planning documents (Nardo et al., 2017; Siboni et al., 2013b). IC is often investigated within the framework of the internal organisational mechanisms for employee evaluation (Veltri & Puntillo, 2020). More strategically, IC has been studied in connection with sustainability and sustainability reports (Brusca et al., 2018). The technological dimension has recently gained scholars' attention (Secundo et al., 2020) for raising the effectiveness and innovation of internal processes, decision-making (Fernández-López et al., 2018) and facing emergencies, as in the case of Covid-19, which has pushed universities to strengthen the use of technology in all activities (Arias Velàsquez & Mejía Lara, 2021).

The following research question is thus derived:

RQ2. How is IC mapped, measured and then managed by the University? Are these models consistent with internal strategic management processes and accounting information systems?

It has been argued that the pervasiveness of technology is relevant for addressing societal and sustainability challenges in areas such as health, instruction, energy and transportation (Secundo et al., 2020). However, access to technology in isolation does not result in value creation (Söderholm et al., 2019). Public universities adopt technologies to pursue mission-related objectives and institutional functions: teaching, research and the third mission. Traditionally, knowledge in universities is managed if it can be traced back to research and new technologies for innovative teaching. It is less frequently found in third mission activities (Di Berardino & Corsi, 2018; Secundo et al., 2017).

The following research question is thus derived:

RQ3. How does knowledge management promote the University's missions and strategies? What is top management's awareness of the strategic role and significance of intangible assets associated with IC?

4 Methodology

We addressed our research questions by adopting a qualitative methodology with a descriptive-exploratory approach (Chiucchi, 2012) through a case study analysis (Yin, 2014).

In the IC field, the case study approach has been widely applied (Serenko et al., 2010), notably in research on IC disclosure and management in public sector organisations (Dumay et al., 2015), including universities (Lombardi et al., 2019; Veltri & Puntillo, 2020). The case study methodology is particularly predominant in studies on the third stage of IC research (Guthrie et al., 2012), which addresses the praxes of IC as they are implemented in organisations (Bisogno et al., 2018; Dumay et al., 2017). Thus, such a methodology fits well with the aim of the paper, which relates to addressing 'how' questions.

The case under investigation is the University of Naples Federico II, a historical university known as the oldest public university in the world, founded by Emperor Frederick II of Swabia in 1224. In the national context, it is one of the largest public universities with 69,460 students enrolled in the 2020–21 academic year and 4912 employees between academic and administrative staff. In addition, the University performs in recent rankings and evaluations of the National Evaluation Agency of the University System and Research (ANVUR, 2021).

Thus, the university selected fits well with the aim of this study and the methodology adopted because it is a critical and representative case in the national context (Yin, 2014).

The study was conducted through a text analysis approach (Yin, 2014) using the main planning and reporting documents of the University, including the Performance Measurement and Evaluation System, Strategic Plans, University Budget, Integrated Plan; Three-Year Plan for the Prevention of Corruption and Promotion of Transparency, Positive Action Plan, Social Report and Performance Report. These documents were retrieved from the Transparent Administration section that is present on the University website as required by law. Additional internal documents from the University offices, including the Simplification and Digitisation Plan and board minutes, were collected and analysed by the researchers. To ensure compliance with precepts of research validity and reliability, we adopted a triangulation strategy (Creswell, 2010) by using different sources of information and triangulating between different researchers during data collection and analysis.

5 Case Study Analysis

The analysis aims to show how structural capital, particularly the technological dimension, is managed in public universities, and how IC is a useful lens for exploiting their potential domains of application as well as for capitalising their value as human, relational and structural assets.

This section is organised in subsections that address the three research questions derived from the literature review.

5.1 IC Disclosure Practices Among University Stakeholders (RQ1)

The University transfers knowledge to internal and external stakeholders through various planning and reporting documents. The institutional website (in the dedicated space entitled 'Transparent Administration' as required by law) contains the main documents as well as summaries, facilitating stakeholders' reading and understanding. The University, going beyond the mandated obligations, recently decided to draw up and publish the Social Report (SR, 2015), a voluntary report that is not a widespread practice in Italian universities. Prior research has indicated that the Social Report was not created specifically for IC reporting; however, it represents a privileged tool and container of organisations' IC (Nardo, 2007; Nardo & Veltri, 2013).

The stakeholders the University refers to are depicted in Fig. 1.

An in-depth analysis of internal stakeholders, especially students and employees, is presented in Table 1. In effect, the biggest budget expenditure of universities is the

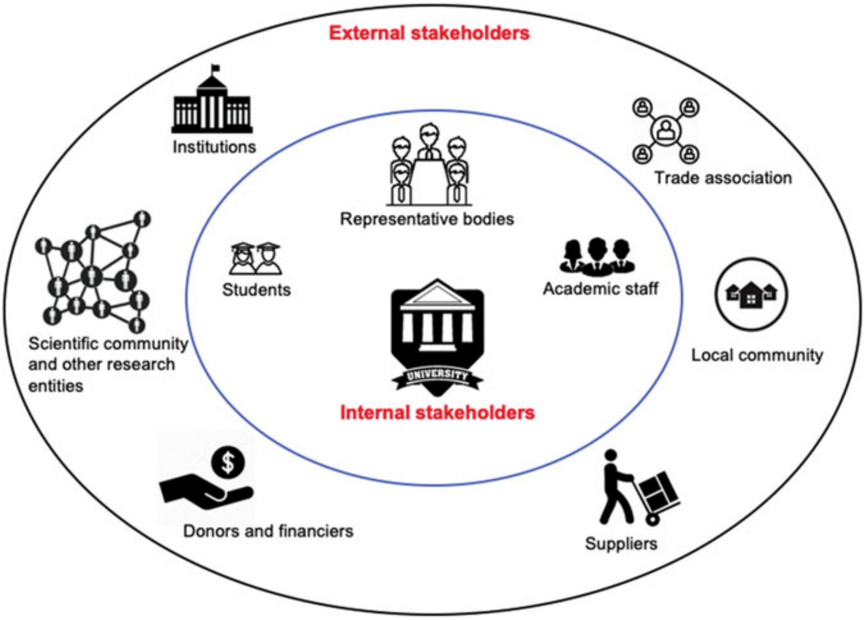


Fig. 1 University's internal and external stakeholders. Source: Author's elaboration from SR (2015)

Table 1 Human capital

	Students	Academic and administrative staff
Indicators	– N. of students by department	– N. of full professors
	– N. of students by degree course	– N. of associate professors
	– N. of students by gender	– N. of permanent researchers
	– Students' average exams score	– N. of temporary researchers
	– Students' average graduation score	– N. of research fellows
	– Geographical origin of graduates	– N. of collaborators
	– N. of outgoing and incoming Erasmus students by department	– N. of administrative staff
	– N. of outgoing Erasmus students by country	
	– N. of Ph.D students	

Source: Author's elaboration from SR (2015) and IP (2021)

cost of employees, and the highest income is obtained from the enrolment fees paid by the students. Compared to other European countries, Italian universities have a lower level of donations from businesses and private individuals (European University Association, 2020).

Based on the results of the analysis for *RQ1*, IC disclosure in the planning and reporting documents is mainly descriptive in nature, despite the systematic implementation of indicators, especially for the human capital dimension.

5.2 IC Mapping, Measurement and Management by the University (RQ2)

The University does not draw up a specific IC Report; instead, the mapping, measurement and management of IC occur at different levels of government (e.g. management, board of directors) and through multiple documents.

Human capital is quantified and communicated through the Social Report and the University Integrated Plan as follows (Table 2):

The staff analysis focuses on the type of contract and category as well as gender. The gender analysis is included in the most recent Performance Report and Integrated Plan and the Gender Budget published by the University in 2016 (PR, 2020; IP, 2021; GB, 2016). The structural capital is represented through the description of the research and teaching laboratories, platforms and equipment as well as the number of courses of study offered at different levels, as represented below (Table 3):

Research knowledge is represented through the following indicators that measure researchers' productivity (Table 4):

Table 2 Human capital measurement

	Indicators	01/01/2021
Human capital	– N. of full professors	680
	– N. of associate professors	972
	– N. of researchers	364
	– N. of temporary researchers	614
	– N. of administrative staff	2282
	– N. of grant holders	310
	– N. of PhD students	1158
	– N. of medical specialists	1879
	– N. of contract teachers	774
	– N. of students enrolled	69,460

Source: Author's elaboration from IP (2021)

Table 3 Teaching offer measurement

	Indicators	01/01/2021
Teaching offer	– N. of degree courses (3-years)	77
	– N. of master's degree courses (not single cycle)	75
	– N. of single cycle master's degree courses	9
	– N. of PhD courses in the 33rd cycle	40
	– N. of Masters of I and II level	37
	– N. of specialization schools of non-medical area	9
	– N. of specialization schools of medical area	53
	– N. of online courses provided due to Covid-19 emergency	400
	– N. of degree during one month of the first lockdown in March 2020	1428
	– N. of exams taken during one month of the first lockdown in March 2020	12,952

Source: Author's elaboration from IP (2021)

Table 4 Research productivity

	Indicators	01/01/2021
Research	– N. of projects funded by the European Research Council (ERC) programme	7
	– N. of projects funded by the European Research and Innovation Programme Horizon 2020	61
	– N. of papers in journal	5764
	– N. of patents	8
	– N. of papers in Conference Proceedings	1019
	– N. of Chapters or Essays	1107
	– N. of Monographs or scientific treatises	128

Source: Author's elaboration from IP (2021)

Research knowledge is also represented in research agreements involving high-quality partners. At the end of 2019, the University established a scientific collaboration with the Italian Space Agency to promote, develop and disseminate scientific and technological research applied to the aerospace field through joint and coordinated implementation of initiatives, activities and programmes.

The management of the structural capital also occurs through the university annual report; currently, there is no accounting system for intangibles.

5.3 IC Management and the University's Missions (RQ3)

The University's strategy is focused on three main functions: teaching, research and third mission (SR, 2015, p. 28), within which objectives and action plans are defined. In addition to the first and second missions, the University embraces the spirit of a third mission to contribute to the development of culture, social and economic well-being, and the country's productivity. The University implemented the 'triple helix' model, adding an entrepreneurial role to research and teaching activities (Lombardi et al., 2019). The mission, focused on the three main functions, is defined in objectives, indicators and activities presented in Tables 5, 6 and 7.

In recent years, the University adopted a strategy aimed at responding to the needs of the modern digital society and focusing effectively on the third mission. The strategy involved such measures as increasing tools in the fields of advanced training and research, the creation of new start-ups, the internationalisation of its activities and the attraction of students and talents from abroad. Despite the challenges caused by the Covid-19 emergency, the University continues its technological transfer actions both through research and consultancy activities, laboratory services, technology licensing, exchange of research staff, continuous training courses carried out by third parties and other forms of information transfer with the external environment and through initiatives aimed at increasing the capacity to transform research results into new products, the creation of new businesses and the attraction of international funds.

Whilst the three functions are pursued in parallel, the push for the use of technology is mainly observed in teaching and training. One example is the Federica-Virtual Campus Project. This advanced model of web-learning is the largest European platform headed by a public university, and the project enhances the competitive advantage of the University Federico II. Recently the project has been recognised by the European Commission as an excellence initiative due to its high specialisation, and it was included in the portal of the best academic resources of the European universities.

In 2020, when the Covid-19 outbreak started along with government lockdown measures, the University immediately adopted the necessary actions to strengthen online learning systems to allow the use of distance or blended courses for all students. The Covid-19 emergency changed some planned actions, but the

Table 5 First mission indicators

	Objective	Indicators
First mission—teaching	Develop and improve the quality of teaching through the use of innovative technologies (e.g. web-learning methods)	– N. of web-courses activated
		– N. of web-lessons done
		– N. of users of the web-learning platform
		– N. of links on the web-learning platform
		– N. of images on the web-learning platform
	Enhance the prospects for the internationalisation of student's career	– N. of course study in English
		– N. of dual degree with foreign universities
		– N. of scholarship
	Students' internationalisation	– N. of Erasmus students outgoing
		– N. of Erasmus students incoming
		– N. of students who have taken exams abroad
		– N. of foreign students receiving scholarships
	Create paths of excellence in postgraduate training	– N. of Master's degrees in first and second level
		– N. of Further training courses
		– N. of Graduate schools
		– N. of PhD courses

Source: Author's elaboration from SR (2015) and IP (2021)

University has demonstrated a good capacity for emergency management in part due to the investments already made in technology.

Collaborations between the University and internationally renowned companies also continue and contribute to consolidating an innovative teaching path, which represents a main goal of the University. Therefore, the third mission is also carried out through high-level professional training courses and through agreements with companies and consulting firms (relational capital). Examples include the agreements with Apple and Deloitte Consulting as well as courses focused on digital transformation and its connections with the Industry 4.0 paradigm.

Relational capital is also represented by the various mobility agreements, which support the University's attractiveness and the international mobility of students, pursued with the strategic goal of internationalisation. The internationalisation strategy's main goal is offering several courses of study in English language as well as joint courses or dual degrees with foreign universities. Moreover, the

Table 6 Second mission indicators and actions

	Objective	Indicators actions
Second mission—research	Enhance the university competitiveness strengthening the areas with the higher VQR score	– N. of autonomous research groups
	Increase quality and scientific productivity	– N. of programmes for infrastructure modernisation
		– Recruitment of highly qualified young researchers and activation of incentive reward mechanisms
		– Implementing systems for monitoring opportunities for the collection of sources of funding
		– Strengthening human capital exchanges between departments
		– Encouraging scientific collaborations with prestigious and internationally renowned research centres
		– N. of articles in journals
		– N. of Articles in Conference Proceedings
		– N. of Chapters or Essays
		– N. of Monographs or scientific treatises
		– N. of patents
	Access to competitive sources of finance for scientific research	– N. of projects funded through European financing
		– N. of projects funded through national funding, mainly provided by the Ministry of Universities and Research (MIUR), and by public research bodies
		– N. of projects funded through regional financing
		– N. of projects funded through private financing (e.g. banking foundations and other companies)
		– N. of agreements with public or private entities and companies aimed at financing doctoral scholarships and contracts for researchers
	Internationalisation of research	– N. of teachers incoming
		– N. of teachers outgoing
		– N. of partnerships with European universities
		– N. of foreign researchers
		– N. of foreign grant holders
		– % of PhDs graduated abroad
		– N. of foreign PhD students

Source: Author's elaboration from SR (2015) and IP (2021)

Table 7 Third mission indicators and actions

	Objective	Indicators/Actions
Third mission—Technology Transfer	Support the development of networks between universities, research centres and companies	– N. of patents
		– N. of spin-offs
		– N. of business incubators
	Increase the number of collaborations with companies operating in the technological field	
	Support the orientation of young people towards scientific activity	
	Develop partnership and membership of technological consortia and district	
	Promote the implementation and growth of initiatives on an interregional and transnational basis	
	Consolidate national and international networks between research centres and technology transfer	
Third mission—students' orientation and inclusion	Support young people approaching the university world	A system illustrating and offering information, through mini-guides, on study and employment opportunities
	Enhance the inclusion and equal opportunities of students who, within their university life, may experience a state of discomfort due to physical, psychological and/or social difficulties	– The Centre for Active and Participatory Inclusion of Students
		– N. of hours of reception
		– N. of hours of counselling
		– N. of hours of pedagogical support
		– N. of hours of technological support
		– N. of enrolled students
		– N. of inclusion projects
		– N. of inclusion projects*100/n. Students = % of enrolled students who have benefited from an inclusion project
	Promoting quality and innovation of the training offer in relation to the needs of the students and society	– Increase of spaces intended for classrooms, laboratories, study rooms and libraries (n. places and sqm)
Third mission—University services	Improve the University library system	– N. of centre libraries
		– N. of department libraries
		– N. of potential institutional users
		– N. of book loans
		– N. of databases and subscription ebooks

(continued)

Table 7 (continued)

	Objective	Indicators/Actions
		– N. of bibliographic records in opaque
		– N. of periodicals and subscriptions to periodicals
	The University Language Centre	– N. of locations
		– N. of international certifications
		– N. of multimedia classrooms
	The University Sport Centre	
Third mission—ICT & Digitalization	Achieve a "digital administration" The University Centre for Information Services aim to reorganize administrative processes according to a flow logic, thus enhancing inter and intra-structure cooperation	– N. of activities of software development
		– N. of users
		– N. of servers
		– N. of websites
		– N. of computerised classrooms
		– N. of digital signs
		– N. of certified e-mails
		– Dissemination of the use of the UNINAPEC system
		– Expansions of the digital signature service
		– Improvement of the documentation management of the Collegial Bodies
		– Management of SIOPE + collection payment orders
	Design and Implementation of the University Territorial Information System (SIT). Creation of an archive containing all the information relating to the real estate parts of the University in geo-referenced form, to arrive at a real digital model of the University (DEM—Digital Enterprise Model) aimed at facilitating communication and optimizing the detection times of the real estate information	– % properties whose information is uploaded to SIT
	Organization and management	– Design and implementation of a telematic procedure for participation in the comparative assessment procedures for professors and researchers
	Optimization of procedures for the improvement of support services	– Analysis, redefinition and dematerialization of the refund procedure for mission expenses.

(continued)

Table 7 (continued)

	Objective	Indicators/Actions
		– Computerized management of the application for participation in exams for professional qualifications
		– Introduction a platform for Electronic Voting
	Adaptation of the University to regulatory changes	– Digital file of the employee and dematerialization of the documents relating to the newly hired University staff
		– Digital file of documents relating to contract professors
	IT Order	– System consolidation establishment of good management practices through the production of documents and training of staff
	Migration of the survey section to a new technological infrastructure integrated with the system for consulting statistical data	

Source: Author's elaboration from SR (2015) and IP (2021)

University aims to enhance the possibility of international careers for its students, promoting scholarships and developing activities to attract scholars from all over the world (see Table 8).

The summary presented here, drawn from analysis of the main university documents (SR, 2015; IP, 2021) and direct observation of the institution, shows how technology is widespread in all activities and strategies of the University.

6 Conclusion, Limitations and Future Research Agenda

This paper aimed to increase understanding of the intersection of IC and performance in universities, with a specific focus on technology, through the analysis of a case study. The topic of IC in universities is still under theoretical development and consolidated theoretical frameworks are lacking to aid in interpreting the results.

From the single case study analysis, it could be derived that, as for all public Italian universities, the University Federico II does not draw up and disclose a specific IC report (Venditti, 2010). In Italy, there have been no efforts to support this practice; however, examples do exist in other countries, as in the case of the intellectual capital report in Austrian universities (Altenburger & Schaffhauser-Linzatti, 2006).

Table 8 University's Internationalisation measures

	Objective	Indicators	01/01/2021
Internationalisation	Increase in international courses of study	– N. of MSc degrees in English	11
		– N of Second Level International Masters	2
	Increase courses of study with double or joint degrees in partnership with foreign universities	– N. of double/joint degrees	8
	Increase the internationalisation of study courses through the provision of mobility scholarships inbound and outbound	– N. of Visiting Professor	
		– N. of outgoing students with scholarship	
		– N. of incoming students with scholarship	

Source: Author's elaboration from IP (2021)

Although the University has chosen not to develop a specific IC Report, it has drawn up the Social Report, which several studies identify as a privileged document to represent IC (Nardo, 2007; Nardo & Veltri, 2013).

The IC mapping is, however, spread out through various documents, both planning and reporting as well as strategic (Strategic Plans) and operational (Integrated Plan and University budget).

The IC dimension related to human capital is widely represented; however, it is measured mostly by quantitative indicators rather than in qualitative terms. Indicators on the number of employees, teachers, contract and full-time researchers and category level are tracked, but few indicators are reported in terms of the skills and quality of the academic staff. Some evaluation elements can be found regarding the scientific productivity of teachers and researchers.

The three dimensions of IC are present in the various objectives of the University and, therefore, are transversally present in the research, training and third mission activities. For instance, relational capital indicators can be found in the objectives of the third mission in the form of agreements with companies and other bodies and in research and teaching agreements for international mobility purposes.

Structural capital is not presented as autonomous and independent of human and relational capital; rather structural capital is presented as the infrastructure that allows human capital and relational capital to express their potential. In terms of structural capital, the technological component assumes a crucial role, including codified forms of knowledge within the University, such as information systems, software, manuals, databases and intranets.

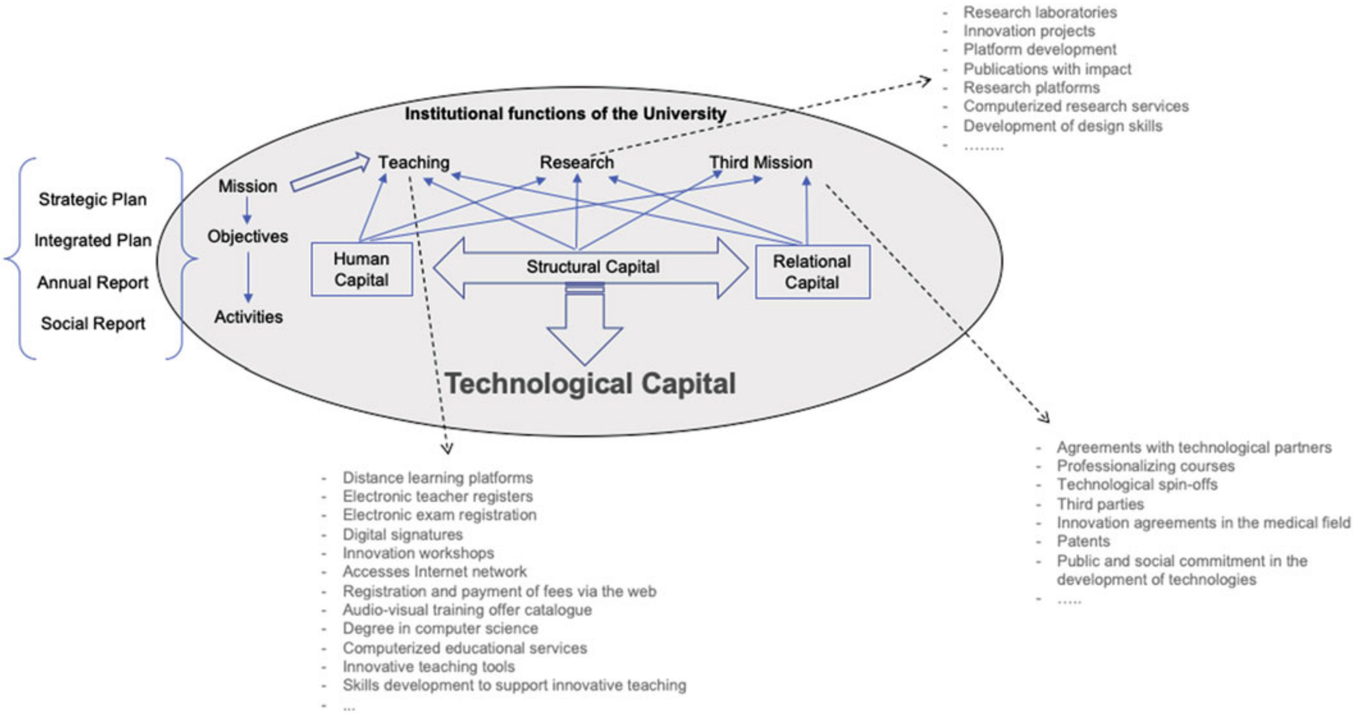


Fig. 2 IC flows in Universities and its link with technologies. Source: Author's elaboration

The organisational dimension of structural capital, which refers to the culture, values, type of leadership and the climate of collaboration that characterise an organisation, is the most difficult to manage and communicate due to its intangible nature (Kianto et al., 2017).

In any case, the structural capital investments in technology are being used to pursue various strategies of the University in the areas of teaching, third mission and research.

The case study analysis indicates that technology cannot be considered in isolation but rather in its role supporting the other dimensions of IC; for example, relational capital is supported by technology; the networks are virtual; even human capital uses technology in mapping of skills or online courses for staff.

The organisational, or structural, capital in which technology is prevalent is transversal to the other dimensions of IC, as shown in Fig. 2.

Therefore, IC not only represents a set of knowledge-based resources it also involves the activities undertaken by an organisation to manage them.

This study is not without limitations. The results of this study cannot be generalised, as it is a single case study (Eisenhardt, 1989). However, the study has the advantage that the researchers have closely analysed the University whilst belonging to the same organisation. An additional strength of the study is its focus on the specific IC component of organisational or structural capital by investigating the technological resources of the University.

Further research is needed to better understand the role of technology as a component of structural capital in enabling performance. Accordingly, the paper offers an outline for future research. Despite the positive relationship between IC and performance, more in-depth comprehension of their linkage and intrinsic meaning is needed for the development of technology policies. Therefore, this paper calls for future research focused on the specific theme of technology policy.

References

Altenburger, O., & Schaffhauser-Linzatti, M. (2006). The order on the intellectual capital statements of Austrian universities. In *International Federation of Scholarly Associations of Management VIIIth World Congress*, Berlin, September 28–30.

Andriessen, D. (2004). IC valuation and measurement: Classifying the state of the art. *Journal of Intellectual Capital, 5*(2), 230–242.

ANVUR. (2021). *Rapporti ANVUR di Accreditamento Periodico*. Available at: https://www.anvur.it/attivita/ava/accreditamento-periodico/rapporti-anvur-di-accreditamento-periodico/

Arias Velàsquez, R. M., & Mejía Lara, J. V. (2021). Knowledge management in two universities before and during the COVID-19 effect in Peru. *Technology in Society, 64*, 101479.

Bezhani, I. (2010). Intellectual capital reporting at UK universities. *Journal of Intellectual Capital, 11*(2), 179–207.

Bisogno, M., Dumay, J., Manes Rossi, F., & Tartaglia Polcini, P. (2018). Identifying future directions for IC research in education: A literature review. *Journal of Intellectual Capital, 19*(1), 10–33.

Bontis, N. (1998). Intellectual capital: An exploratory study that develops measures and models. *Management Decision, 36*(2), 63–76.
Brusca, I., Labrador, M., & Larran, M. (2018). The challenge of sustainability and integrated reporting at universities: A case study. *Journal of Cleaner Production, 188*, 347–354.
Carlucci, D., Marr, B., & Schiuma, G. (2004). The knowledge value chain – How intellectual capital impacts business performance. *International Journal of Technology Management, 27* (6–7), 575–590.
Chiucchi, M. S. (2012). *Il metodo dello studio di caso nel Management Accounting*. Giappichelli.
Choo, C. W., & Bontis, N. (2002). *The strategic management of intellectual capital and organizational knowledge*. Oxford University Press.
CIVIT. (2010). *Struttura e modalità di redazione del Piano della performance*. Available at: https://performance.gov.it/system/files/Delibera-n-112_2010.pdf
Creswell, J. W. (2010). Mapping the developing landscape of mixed methods research. *SAGE, 2*, 45–68.
Department of Public Functions (DPF) guidelines. (2017). *Linee guida per il Piano della performance*. Available at: http://www.funzionepubblica.gov.it/sites/funzionepubblica.gov.it/files/LG_Piano_performance_giugno_17.pdf
Di Berardino, D., & Corsi, C. (2018). A quality evaluation approach to disclosing third mission activities and intellectual capital in Italian universities. *Journal of Intellectual Capital, 19*(1), 178–201.
Drucker, P. F. (1993). *Post capitalist society*. HarperCollins.
Dumay, J., Guthrie, J., & Puntillo, P. (2015). IC and public sector: A structured literature review. *Journal of Intellectual Capital, 16*(2), 267–284.
Dumay, J., Guthrie, J., Ricceri, F., & Nielsen, C. (2017). Intellectual capital management in public universities. In J. Guthrie, J. Dumay, F. Ricceri, & C. Nielsen (Eds.), *The Routledge companion to intellectual capital*. Routledge.
Edvinsson, L., & Malone, M. S. (1997). *Intellectual capital: Realizing your company's true value by finding its hidden brainpower*. HarperBusiness.
Eisenhardt, K. M. (1989). Building theories from case study research. *The Academy of Management Review, 14*(4), 532–550.
European Commission. (2006). *Reporting intellectual capital to augment research development and innovation in SMEs*. Brussels. Available at: https://ec.europa.eu/invest-in-research/pdf/download_en/2006-2977_web1.pdf
European University Association. (2020). *Public funding observatory*. Available at: https://www.eua.eu/downloads/content/eua%20pfo%202019%20report.pdf
Fernández-López, S., Rodeiro-Pazos, D., Calvo, N., & Rodríguez-Gulías, M. (2018). The effect of strategic knowledge management on the universities' performance: An empirical approach. *Journal of Knowledge Management, 22*(3), 567–586.
Gender Budget (GB). 2016). Available at: http://www.fedoa.unina.it/11427/1/Primo%20bilancio%20di%20genere.pdf
Guatri, L. (1997). *Valore e Intangibles nella misura della performance aziendale. Un percorso storico*. EGEA.
Guthrie, J., Dumay, J., Ricceri, F., & Nielsen, C. (2017). *The Routledge companion to intellectual capital*. Routledge.
Guthrie, J., & Petty, R. (2000). Intellectual capital: Australian annual reporting practices. *Journal of Intellectual Capital, 1*(3), 241–251.
Guthrie, J., Ricceri, F., & Dumay, J. (2012). Reflections and projections: A decade of intellectual capital accounting research. *The British Accounting Review, 44*(2), 68–82.
Hsu, D. W., Shen, Y. C., Yuan, B. J., & Chou, C. J. (2015). Toward successful commercialization of university technology: Performance drivers of university technology transfer in Taiwan. *Technological Forecasting and Social Change, 92*, 25–39.
Integrated Plan (IP). (2021). Available at https://www.unina.it/documents/11958/24971449/Piano.Integrato_2021.2023_per_CdA.pdf

Kianto, A., Sáenz, J., & Aramburu, N. (2017). Knowledge-based human resource management practices, intellectual capital and innovation. *Journal of Business Research, 81*, 11–20.

Lapsley, I., & Miller, P. (2004). Transforming universities: The uncertain, erratic path. *Financial Accountability and Management, 20*(2), 103–106.

Lombardi, R., Chiucchi, M. S., & Mancini, D. (Eds.). (2020). *Smart technologies, digitalizzazione e capitale intellettuale. Sinergie e opportunità*. Franco Angeli.

Lombardi, R., Massaro, M., Dumay, J., & Nappo, F. (2019). Entrepreneurial universities and strategy: The case of the University of Bari. *Management Decision, 57*(12), 3387–3405.

Matos, F., Vairinhos, V., Salavisa, I., Edvinsson, L., & Massaro, M. (2020). *Knowledge, people, and digital transformation: Approaches for a sustainable future*. Springer.

Nardo M. T. (2007) Verso un sistema integrato di report per il capitale intangibile. In G Fabbrini & A Ricciardi (Eds.), *Intangible assets. Principi contabili, modalità di reporting e tecniche di valutazione*. FrancoAngeli.

Nardo, M. T., Sangiorgi, D., & Siboni, B. (2017). Indagine sulla qualità dei piani della performance nelle università italiane. Quali prospettive per il futuro? *Economia Aziendale Online, 8*(1), 57–68.

Nardo, M. T., & Veltri, S. (2013). Integrating corporate social responsibility and intellectual capital report: A small sample research. *International Journal of Knowledge-Based Development, 4*(1), 5–18.

Parliamentary Auditions. (2021, 09/03). *Communications from the Minister for Public Administration on programmatic guidelines*. Available at: http://documenti.camera.it/leg18/resoconti/commissioni/bollettini/pdf/2021/03/09/leg.18.bol0544.data20210309.com0111c0111.pdf and http://www.funzionepubblica.gov.it/articolo/ministro/09-03-2021/un-nuovo-alfabeto-la-pubblica-amministrazione

Performance Report (PR). (2020). Available at: https://www.unina.it/documents/11958/22177341/Relazione.performance.2019.pdf

Ramírez-Córcoles, Y. R., Penalver, J. F. S., & Ponce, Á. T. (2011). Intellectual capital in Spanish public universities: Stakeholders' information needs. *Journal of Intellectual Capital, 12*(3), 356–376.

Roos, G., Bainbridge, A., & Jacobsen, K. (2011). Intellectual capital analysis as a strategic tool. *Strategy and Leadership, 29*(4), 21–26.

Secundo, G., Ndou, V., Del Vecchio, P., & De Pascale, G. (2020). Sustainable development, intellectual capital and technology policies: A structured literature review and future research agenda. *Technological Forecasting and Social Change, 153*, 2–21.

Secundo, G., Perez, S. E., Martinaitis, Ž., & Leitner, K. H. (2015). An intellectual capital maturity model (ICMM) to improve strategic management in European universities. *Journal of Intellectual Capital, 16*(2), 419–442.

Secundo, G., Perez, S. E., Martinaitis, Ž., & Leitner, K. H. (2017). An intellectual capital framework to measure universities' third mission activities. *Technological Forecasting and Social Change, 123*, 229–239.

Serenko, A., Bontis, N., Booker, L., Sadeddin, K., & Hardie, T. (2010). A scientometric analysis of knowledge management and intellectual capital academic literature (1994-2008). *Journal of Knowledge Management, 14*(1), 3–23.

Siboni, B., del Sordo, C., & Pazzi, S. (2013a). Sustainability reporting in state universities: An investigation of Italian pioneering practices. *International Journal of Social Ecology and Sustainable Development, 4*(2), 1–15.

Siboni, B., Nardo, M. T., & Sangiorgi, D. (2013b). Italian state university contemporary performance plans: An intellectual capital focus? *Journal of Intellectual Capital, 14*(3), 414–430.

Social Report (SR). (2015). Available at: http://www.unina.it/documents/11958/7853944/PrimoBilancioSocialeFedericoII.pdf

Söderholm, P., Hellsmark, H., Frishammar, J., Hansson, J., Mossberg, J., & Sandström, A. (2019). Technological development for sustainability: The role of network management in the innovation policy mix. *Technological Forecasting and Social Change, 138*, 309–323.

Tsui, E., Wang, W. M., Cai, L., Cheung, C. F., & Lee, W. B. (2014). Knowledge-based extraction of intellectual capital-related information from unstructured data. *Expert Systems with Applications, 41*(4), 1315–1325.
Veltri, S., & Puntillo, P. (2020). On intellectual capital management as an evaluation criterion for university managers: A case study. *Journal of Management and Governance, 24*(1), 135–167.
Venditti, M. (2010), *Missione, sistemica e reportistica del capitale intellettuale dell'azienda Università: prime riflessioni*. In A. Pitasi (a cura di), *Il valore tangibile degli intangibili. Comunicazione, conoscenza e complessità nelle nuove strategie di impresa*. McGraw-Hill.
Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). Sage.

The Emerging of Enhanced Intellectual Capital: The Impact of Enabling Technologies on the Professional Football Clubs

Raffaele Trequattrini, Fabio Nappo, Benedetta Cuozzo, and Alberto Manzari

1 Introduction

In the current context, the innovation represents a significant and fundamental strategic factor: technological innovation is considered a driver of competitive behavior, and the organizations must implement evolutionary processes that take into account technological progress, managerial, innovation, and knowledge best practices (Chesbrough, 2013).

This transformation has led to a change in the strategy and leadership adopted by companies, which have developed a different way of thinking, new business models, and a greater use of technology to improve the experience of employees, customers, partners, and all corporate stakeholders (Berman, 2012).

With the advent of Industry 4.0, the implementation of enabling technologies generates an enhancement of strategic knowledge related to intellectual capital, which allows companies to acquire a stable and lasting competitive advantage.

The chapter aims at analyzing the impact of these technologies on the companies' intellectual capital management. Using the framework of intellectual capital as an interpretative key to illustrate the evolution of the managerial function, we will define the concept of enhanced intellectual capital. This framework is demonstrated in the context of professional football to demonstrate how the use of technologies is able to enhance intellectual capital by improving sports and economic performance.

R. Trequattrini · F. Nappo · B. Cuozzo (✉)
Department of Economics and Law, University of Cassino and Southern Lazio, Cassino, Italy
e-mail: raffaele.trequattrini@unicas.it; fabio.nappo@unicas.it; benedetta.cuozzo@unicas.it

A. Manzari
Department of Economics, Management and Business Law, University of Bari Aldo Moro, Bari, Italy
e-mail: alberto.manzari@uniba.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_7

Section 2 describes the main literature about the transition from the knowledge economy to the digital economy; Section 3 introduces the theoretical research framework; Section 4 provides the main cases of application of technologies in the professional football sector; Section 5 provides the conclusions of the research.

2 From the Knowledge Economy to the Digital Economy

In the age of the knowledge economy (Foray, 2004; Zanda, 2012), the strategic resource is represented by intangible assets; they are considered the determinants of the organizations' success and represent strategic resources that improve the competitiveness of companies and could generate an increase in the company value in a long time (Chen et al., 2004). Intangible assets have grown in importance so much as several authors have focused on the strategic role of intellectual capital (IC) (Petty & Guthrie, 2000; Kaufmann & Schneider, 2004).

The IC has increased its relevance in the economic-managerial field since it is considered a tool to increase company's profitability (Mouritsen et al., 2001).

Stewart (1997) defines IC as "...intellectual material, knowledge, experience, intellectual property, information...that can be put to use to create wealth" and it is composed of three components: human capital, relational capital, and structural capital.

Human capital represents a set of knowledge, skills, capabilities, capacities own by individuals in the organization (Becker, 1964; Lev & Schwartz, 1971; Nonaka, 1994). Relational capital is the knowledge relative to a set of relationships between the company and stakeholders (Dorrego et al., 2013; Prahalad & Ramaswamy, 2000). The structural capital is owned by the organization; it can be reproduced and made available to each individual. It is represented by the strategy, culture, structures, systems, practices, and organizational procedures (Bontis, 1998).

With the advent of Industry 4.0 (Berger, 2014), characterized by the emergence of smart factories in which cyber-physical systems monitor physical processes and communicate with each other and human beings in real time, (Ciffolilli & Muscio, 2018), the fundamental role is done by the new Key Enabling Technologies, which can be summarized as follows:

- Advanced manufacturing solution (collaborative robots interconnected and quickly programmable);
- Additive manufacturing (3D printers connected to digital development software);
- Augmented Reality (augmented reality to support production processes);
- Blockchain;
- Simulation (simulation between interconnected machines to optimize processes);
- Horizontal/Vertical Integration (information integration along the value chain from supplier to consumer);
- Industrial Internet (communication between elements of production, not only within the company, but also externally thanks to the Internet's use);

– Cloud (implementation of all cloud technologies such as the online information's storage, the use of cloud computing, and external data analysis services, etc.);
– Cyber Security (security during network operations and on open systems);
– Big Data Analytics.

The innovations in the fields of information technology, microelectronics, and robotics have thus recently produced a new phenomenon: the so-called Digital economy.

Nowadays, the digital era and the Industry 4.0 paradigm, combining different technologies, open unforeseen possibilities to create radically new products, services, to share knowledge between different actors of the technology ecosystem and to generate innovative business models (Spieth et al., 2016).

In the digital economy, therefore, the knowledge used for the management of enabling technologies is strategic, given that these technologies can represent factors able to strengthen the intellectual capital of companies (Dumay, 2009; Guthrie et al., 2012; La Torre et al., 2018; Secundo et al., 2017, 2020).

The implementation of enabling technologies could generate an enhancement of strategic knowledge related to intellectual capital, which allows companies to acquire a stable and lasting competitive advantage.

The literature on the impact of digital transformation on the management of intellectual capital has not been extensively investigated; therefore, this research aims to fill this gap. In this perspective, the aim is to analyze the impact of these technologies on the companies' intellectual capital management. Therefore, the question guiding our research is:

RQ1) How the digital technology revolution could influence the management of Intellectual Capital?

3 Methodology

This study presents a qualitative research (Hair et al., 2019) with a deductive approach, based on the application of our theoretical framework of the enhanced intellectual capital. For our research purposes, a qualitative study design was chosen since a comprehensive analysis of how new technological solutions that allow to enhance the intellectual capital of the companies.

3.1 Theoretical Research Framework

This paragraph presents a framework for IC management in new companies facing the digital transformation and to answer the research questions of this research. The digital transformation has formed the basis for the emergence of the digital economy that represents the pervasive use of IT (hardware, software, application, and

Fig. 1 Theoretical framework

telecommunications) in all aspects of the economy (Atkinson & McKay, 2007). As asserted, in the digital economy, the knowledge used for the management of enabling technologies is strategic, given that these technologies can represent factors able to strengthen the intellectual capital of companies. In particular, many characteristics of the enabling technologies could affect the intellectual capital components. First of all, Artificial Intelligence means the ability of a computer to perform functions and reasoning typical of the human mind (Mitchell et al., 2013); in some activities, machines have greater capabilities than humans; in others, humans are superior to machines; therefore, proper management consists of combining the abilities of machines and humans (Brynjolfsson & McAfee, 2014). The blockchain is a digital ledger, decentralized and distributed over a network, structured as a chain of blocks responsible for data storage (Nofer et al., 2017); its structure allows to reduce the costs associated with controlling trust.

The Big Data represents a large amount of data that has the characteristics of Volume, Velocity, Variety, Veracity, and Value (Laney, 2001); it also be looked at from the perspective of the processes that make it possible to obtain knowledge from data (Harlow, 2018). Furthermore, Big Data has played a fundamental role in the enhancement of platforms, in this perspective, the trend is towards the commercial exploitation of the data acquired by customers (Srnicek, 2017).

The characteristics of the technologies described make possible to propose a primary theoretical framework based on the enhancement of intellectual capital (Fig. 1).

This framework is applied and demonstrated in the context of professional football; the research demonstrates how the use of technologies is able to enhance intellectual capital by improving sports and economic performance.

3.2 Research Context

The football industry has become a major economic sector all over the world. In this light, professional football is not to be considered economic, social, and political structures and having a significant financial and cultural impact (Beech & Chadwick, 2004; Sšderman & Dolles, 2013). Thus, professional football has become a relevant economic growth lever influencing economic trends. Professional football clubs are assimilated to Knowledge Intensive Organizations (Trequattrini et al., 2017) supported by intangible assets.

In the first step of our research, we have selected the cases of application of enabling technologies in the field of professional football sector. In the second step, the selected cases were classified according to the technologies used and the components of the intellectual capital involved.

4 Results and Discussion

This section classifies the enabling technologies used in the professional football sector and, for each of them, describes the cases of application and the main results of these applications.

4.1 Artificial Intelligence

The club performance is adversely affected by injuries, as affect the availability of the players and increase players rehabilitation costs. Sports teams have tried to take an approach to detect which variables and metrics determined the injuries origin, tools that could be used in order to predict the injury risk (Lippi et al., 2010). Nowadays artificial intelligence has the potential to change this scenario through the Electronic Performance and Tracking Systems (EPTS), monitoring technologies capable of providing extremely reliable data streams derived from every training and game session (Ehrmann et al., 2016). A practical example is the one developed by the National Research Council (CNR) and the University of Pisa, in collaboration with Futbol Club Barcelona. This technology, which is based on a GPS and a Machine Learning algorithm trained over the course of a season to recognize and associate training parameters, physical and metabolic indicators of the players, and the possibility of injury, is called “Injury Forecaster” (Rossi et al., 2018). From the movements made by the players, various information is extracted from the GPS such as the distance traveled, the metabolic power, the accelerations, the decelerations, and the artificial intelligence system, variables that are subsequently associated with the risk of injury. The technological tool, after that, warns the team coaches and coaching staff if imminent injuries are foreseen in training or during a match. The system has demonstrated an accuracy, over 50%, while existing techniques reach 5%. By following these suggestions, sports clubs can therefore halve injuries and save significant medical care costs for their athletes. Not all injuries can certainly be predicted through this model, it is not possible to predict whether an athlete will fall to the ground at any given moment and be injured. Instead, it is possible to try to measure the risk of a player’s muscle injuries, with the exception of particular cases such as hamstring strain or tendinopathy (PT), it has not yet found consistent identification of risk factors (Meeuwisse et al., 2007; Higgins, 2002; Kakavas et al., 2020).

Other technological systems expression the relationship between artificial intelligence and sport are the Goal-Line Technology (GLT) and the Virtual Coach (VC). Regarding GLT, it is used to determine when the ball has crossed the goal line through the assistance of electronic devices and human figures capable of programming them to assist the match referee. GLT aims to provide certain information to the match official to facilitate decision-making process. The two approved systems are: GoalRef and Hawk-Eye (Ahmadi & Sobhani, 2014).

As of 2013, the United States was the first country, after the 2012 Club World Cup in Japan, to use technology for national leagues, specifically Major League Soccer. Following it in 2013, the competition for the national football teams of the Confederations Cup in 2013, the FIFA World Cup 2014, and the Premier League in England in the 2013–14 championship. In Italy it was introduced instead starting from the 2015–16 Serie A championship.

On the other hand, an increasing number of clubs decide to adopt a data science tools to make increasingly informed decisions during matches and on the transfer market.

For this reason, the Serie A has supported the adoption of Virtual Coach (VC) tool, developed by an Italian startup Math & Sport, to provide the 20 Serie A clubs a tool that helps analyze match tracking data in real time. This is a support to technical staff decisions, based on the real-time analysis of position data both of game actions and of the ball with the aim of providing analysis and indications through an application on a tablet. The analyses are developed between deterministic mathematical models and artificial intelligence models, to investigate the players' behavior and their interaction. The VC identifies attacking action factors or a defensive scheme particularly dangerous, classifying variables with an highest impact on the team's performance in a specific moment game such as modules, covers, transitions, speed, distances, synchronous movements, choices in passing, technical-tactical, and even cognitive aspects of the players.

4.2 Blockchain

The Blockchain represents an innovative tool capable of positively influencing the sports world. Established on a large scale following the launch of electronic coins, first of all bitcoin, it is finding application in various sectors, including sports and football. Its characteristics allow to its content remains immutable, once written it is no longer modifiable or eliminable, unless the entire writing is invalidated. Application examples in the world of professional football are those of Paris Saint-Germain (PSG), the main football team in France, and Juventus, in Italy, which decided in 2018, specifically, to launch their own cryptocurrency for the purpose to encourage the supporter's participation around the world. The implementation of this project has made it possible to use blockchain technology, aimed, in this case, at satisfying a dual purpose: to use this currency both as a loyalty tool and as a mechanism to provide its fans with a set of benefits in terms of participation. To achieve these objectives, the companies have entered into a partnership with Socios.com for the creation of official tokens dedicated to fans from all over the world, who are given the possibilities indicated above. In general, through this project, the football teams aim to achieve the same goal that can be pursued through social networks, that is to increase the participation of fans in the "life" of the sports club, but with the addition of the element financial Fan Tokens that can be purchased with traditional money with which football teams certainly expect to trigger a virtuous circle of loyalty. To ensure that this project is successful, it is inevitable to be able to find the right balance between profit, an objective that the club intends to pursue, and the guarantee for the fan that their opinion has a real weight, albeit minimal, within the club's decision-making processes. For this reason, it was decided to use blockchain technology for this project, to guarantee fans the certainty that the opinions expressed are correctly recorded, viewable at any time, and protected by high-level cryptographic systems. Another possible use of the blockchain is for the payment of sponsorships of football clubs, a practice that is constantly growing through cryptocurrencies (Demartino, 2018). Both parties can derive significant benefits from these agreements: sponsors will be able to expand their reach through the business networks established by the clubs, clubs will sell advertising space and earn through the use of a previously unexploited category (Murphy & Ahmed, 2018; Birch, 2018). The most important case in relation to this combination is represented by the partnership between the trading platform eToro and a series of English Premier League clubs (football and finance, 21-08-21). The innovation lies in the fact that part of the sponsorship agreements are paid in Bitcoin through eToro, partner that provides moreover the necessary means for clubs to experiment with methods of paying the players' salaries through the aforementioned platform. In this sense, in consideration of the recurring sponsorship phenomena characterized by money laundering, a correct and constant monitoring of the movement of money through blockchain technology would certainly be effective in avoiding illegal purposes (Candita, 2019).

One of the top European leagues, the Belgian Jupiler Pro League, announced on 23 October 2018 a partnership with the cryptocurrencies platform Sorare, to give the possibility to buy and exchange cryptographic cards of the players and giving the opportunity to users not to carry out mere transactions of buying and selling the cards of their favorite players, but also to verify the variation of their value based on the performances offered in the championship matches. The cards can be exchanged through an auction system and can be used exclusively within the Sorare platform to earn rewards, and, in the future, they will also be able to acquire an economic value on third-party platforms (Gergiou, 2018).

Other possible uses of the blockchain are with regard to the ticketing system, the purchase of clubs, and the payment of player's salaries. Consequently, the practical implications of Blockchain in the professional football sector can be summarized in this way (Fig. 2).

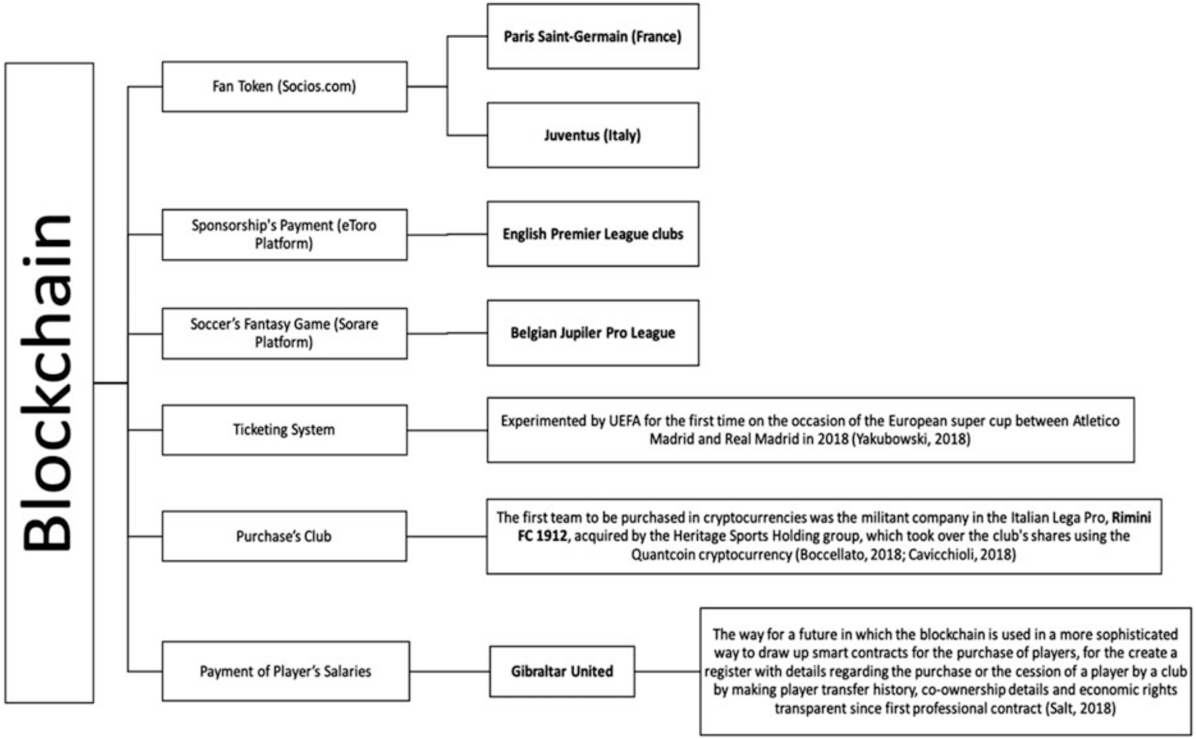


Fig. 2 Practical applications of blockchain in the professional soccer sector

4.3 Big Data and Platform

Further tools capable of increasing the value of the football product are the platforms. Some of these are:

Tzoone: a network capable of connecting players, coaches, and agents in the field of football, a digital platform launched by the Antalia. The services offered are aimed at anyone working in the world of football. The main areas of activity are divided between the network, tzoone TV and the management services offered to clubs, from Serie C to the Third category. By accessing the site, athletes have the opportunity to create a real network, coming into contact with intermediaries and companies in the professional or amateur world, coaches and health professionals, but also journalists and marketing staff. By integrating different services into a single platform, it contains another function called "transfermarket" that allows companies to create announcements and players to submit their candidacy all in digital format. The platform launched in 2019 has been assimilated to the social network LinkedIn, specialized however in the soccer sector[1];

Wyscout: a tool used by hundreds of football coaches, professional clubs, and sports agencies to research and study footballers from almost every league in the world. It represents a platform capable of going to replace DVDs and VHSs, a way to examine a player without sending a scout to follow him. Thanks to this means, any sports director can see a player in a hundred countries and then decide whether to negotiate his purchase or send an observer to follow him in person. In addition to the scouting function, the platform also offers coaching. In fact, Mr. Claudio Ranieri was one of the first to use this tool for technical-tactical purposes in his adventure with Leicester, and more experts believe that the use of the contents of this medium was decisive for the victory of the Premier League with English training.[2]

Noisefeed: complementary platform with respect to Wyscout's functionalities, the startup based in Chiavari today represents the main vertical Social Context Monitoring software for the professional football industry and can boast respectable numbers with about three hundred thousand profiles included in the database, thanks to which it is possible not only to check, but also to study the players and the Industry in general as well as to share news, posts, and statistics on international football. Noisefeed has become an increasingly requested tool not only by companies, but also by professionals in the sector: sports directors, scouts, agents, and media. This platform, in fact, represents a tool in the evaluation process of a professional footballer able to monitor and protect the reputation of the players and, at the same time, help those who have to make decisions

[1] https://www.economyup.it/startup/tzoone-la-piatrestea-italiana-che-vuole-diventare-il-linkedin-del-calcio/

[2] https://www.economyup.it/startup/wyscout-come-funziona-la-piatumentia-che-ha-aiuti-ranieri-a-far-vincere-il-leicester/

based on reliable data, news, and statistics, and not only on hypotheses. For each athlete, the platform provides, on the one hand, the information of what a player posts on social networks or says, together with what people close to him say or post, on the other a series of news concerning him, selected through the Noisefeed algorithm capable of retrieving information from verified sources, both national and international. In this way, insiders will have a true and most faithful representation of what the athlete is saying in real time and what the external environment says about him. Recently, a new feature has been added that can chronologically explore the player's previous career also from the point of view of injuries suffered, thus implementing the amount of information that this tool is able to provide to professionals.[3]

These platforms tend to emphasize the relationship that is going to consolidate between football, digital, and Big Data. The matches are an inexhaustible source of data both for the fans, to know the performance of the players, and for the technical staff to analyze the health of their players and the performance of the opponents. Starting from the assumption that data management represents a possible value source for sports clubs and for the football world, sports federations have also tried to promote the training of management figures and ad hoc techniques for the management of Big Data. This is the figure of the Match Analyst, an expert figure called to develop specific skills on three key issues: tactics, Big Data, precisely, so that the technical staff are able to carry out analyses and evaluations using Big Data Analytics tools, information from a match, and finally video analysis, to be considered as a specific skill that allows you to have a reading of data and information on the behavior of athletes.

5 Primary Conclusions, Limitations, and Future Research

The theoretical framework used, consequently, in application to the professional football sector, can be summarized in this way (Fig. 3).

As demonstrated, enabling technologies have a significant impact on the professional football sector and on the management of intellectual capital, in particular these technologies allow its enhancement.

The importance of technology is also demonstrated in light of the emergency due to the Covid-19 pandemic, football clubs have seen a radical contraction in box office receipts. To encourage the reopening of the facilities, and a partial restart of the sports show structures, Udinese Calcio and Infront have recently experimented with a technological solution to facilitate the reopening of the stadiums in safety. The test of this new technology was staged thanks to an innovative technological device designed by the Be Shaping The Future Group to monitor compliance with

[3] https://sportup.startupitalia.eu/2020/02/05/noisefeed-finestra-quel-si-dice-nel-mondo-del-calcio/

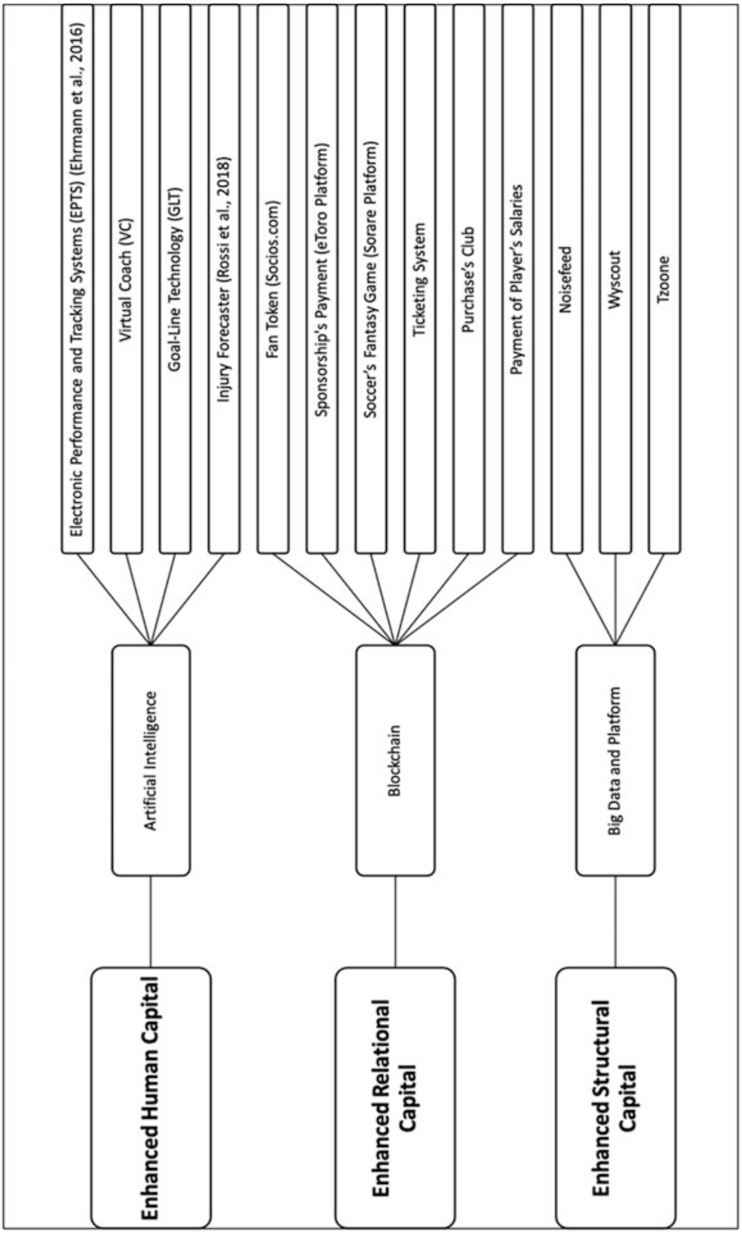


Fig. 3 Theoretical framework applied to the Professional Soccer Sector

anti-Covid regulations and protocols. Before entering the stadium, for the championship match between Udinese and Fiorentina, the approximately 350 professionals usually present in the matchday at the Dacia Arena were equipped with a device that signals with a vibration, to the wearer and to the stewards, failure to respect social distancing, also allowing the tracing of contacts within the stadium, in full respect of privacy. They wore a device capable of lighting up green or red, depending on whether or not the distance of one meter between one person and another was respected. In the event that the device signals the red light, it will vibrate and the stewards will intervene, who will ensure that the necessary distance is respected. A first initiative, an experimentation, another technology that expresses the ever-current and growing connection between innovation, technology, and soccer.[4]

The research has various limitations. First, only the context of professional football was examined; the cases analyzed are just some of the applications of the technologies to the context of professional football. In order to generalize the results, future research will be carried out on other areas of high cognitive intensity and in the analysis, will be introduced, new cases of application of enabling technologies.

References

Ahmadi, Z., & Sobhani, N. (2014). Arbitration management with using artificial intelligence technology (the sample: Goal-line Technology in Football). *Modeling of Artificial Intelligence, 2*, 48–58.

Atkinson, R. D., & McKay, A. (2007). *Digital prosperity*. ITIF. https://itif.org/publications/2007/03/13/digital-prosperity-understanding-economic-benefits-information-technology

Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special reference to education*. University of Chicago Press.

Beech, J., & Chadwick, S. (Eds.). (2004). *The business of sport management*. Pearson Education.

Berger, R. (2014). *Industry 4.0. The new industrial revolution. How Europe will succeed. Think Act*.

Berman, S. J. (2012). Digital transformation: Opportunities to create new business models. *Strategy & Leadership, 40*(2), 16–24.

Birch, J. (2018). *Back of the net: Cryptocurrency stands to win big in the football sector*. Coin Telegraph.

Bontis, N. (1998). Intellectual capital: An exploratory study that develops measures and models. *Management Decision, 36*(2), 63–76.

Brynjolfsson, E., & McAfee, A. (2014). *The second machine age: Work, progress and prosperity in a time of brilliant technologies*. W.W. Norton & Company. ISBN: 978-0-393-23935-5.

Candita, G. (2019). *Valute virtuali e antiriciclaggio: la guida per individuare le operazioni sospette*. IPSOA.

Chen, J., Zhu, Z., & Xie, H. (2004). Measuring intellectual capital: A new model and empirical study. *Journal of Intellectual Capital, 5*(1), 195–212.

Chesbrough, H. (2013). *Open business models: How to thrive in the new innovation landscape*. Harvard Business Press.

[4] https://firenze.repubblica.it/sport/2021/02/28/news/fiorentina_udinese_progetto_re-start-289612088/

Ciffolilli, A., & Muscio, A. (2018). Industry 4.0: National and regional comparative advantages in key enabling technologies. *European Planning Studies, 26*(12), 2323–2343.

Demartino, I. (2018). *A brief history of cryptocurrency and sports partnerships*. Coin Journal.

Dorrego, P. F., Costa, R. V., & Fernández, C. F. J. (2013). Product innovation and relational capital: Evidence from Portugal. *Electronic Journal of Knowledge Management, 11*(4), 295–308.

Dumay, J. (2009). Intellectual capital measurement: A critical approach. *Journal of Intellectual Capital, 10*(2), 190.

Ehrmann, F. E., Duncan, C. S., Sindhusake, D., Franzsen, W. N., & Greene, D. A. (2016). GPS and injury prevention in professional soccer. *The Journal of Strength & Conditioning Research, 30* (2), 360–367.

Foray, D. (2004). *Economics of knowledge*. MIT.

Harlow, H. (2018, September). Ethical concerns of artificial intelligence, big data and data analytics. In *European conference on knowledge management* (pp. 316–323). Academic Conferences International Limited.

Higgins, J. P. (2002). Nonlinear systems in medicine. *The Yale Journal of Biology and Medicine, 75* (5–6), 247.

Gergiou S. (2018) *Jupiler Pro League claims global first with crypto trading cards*. Sportspromedia. Available at https://www.sportspromedia.com/news/jupiler-pro-league-belgium-sorarecrypto-trading-deal

Guthrie, J., Ricceri, F., & Dumay, J. (2012). Reflections and projections: A decade of intellectual capital accounting research. *British Accounting Review, 44*(2), 68–92.

Hair, J. F., Jr., Page, M., & Brunsveld, N. (2019). *Essentials of business research methods*. Routledge.

Kakavas, G., Malliaropoulos, N., Pruna, R., & Maffulli, N. (2020). Artificial intelligence: A tool for sports trauma prediction. *Injury, 51*, S63–S65.

Kaufmann, L., & Schneider, Y. (2004). Intangibles: A synthesis of current research. *Journal of Intellectual Capital, 5*(3), 366–388.

La Torre, M., Dumay, J., & Rea, M. A. (2018). Breaching intellectual capital: Critical reflections on big data security. *Meditari Accountancy Research, 26*(3), 463–482.

Laney, D. (2001). *3-D data management: Controlling data volume, velocity and variety*. Application Delivery Strategies by META Group Inc. disponibile sul sito. https://blogs.gartner.com/doug-laney/files/2012/01/ad949-3D-Data-Management-Controlling-Data-Volume-Velocity-and-Variety.pdf

Lev, B., & Schwartz, A. (1971). On the use of the economic concept of human capital in financial statements. *The Accounting Review, 46*(1), 103–112.

Lippi, G., Longo, U. G., & Maffulli, N. (2010). Genetics and sports. *British Medical Bulletin, 93*(1), 27–47.

Meeuwisse, W. H., Tyreman, H., Hagel, B., & Emery, C. (2007). A dynamic model of etiology in sport injury: The recursive nature of risk and causation. *Clinical Journal of Sport Medicine, 17* (3), 215–219.

Mitchell, R., Michalski, J., & Carbonell, T. (2013). *An artificial intelligence approach*. Springer.

Mouritsen, J., Larsen, H. T., & Bukh, P. N. D. (2001). Intellectual capital and the 'capable firm': Narrating, visualising and numbering for managing knowledge. *Accounting Organizations and Society, 26*(7–8), 735–762.

Murphy, H., & Ahmed, M. (2018). *Football clubs dive into wild world of cryptocurrencies*. Financial Times.

Nofer, M., Gomber, P., Hinz, O., & Schiereck, D. (2017). Blockchain. *Business & Information Systems Engineering, 59*(3), 183–187.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14–37.

Petty, P., & Guthrie, J. (2000). Intellectual capital literature review: Measurement, reporting and management. *Journal of Intellectual Capital, 1*(2), 155–175.

Prahalad, C. K., & Ramaswamy, V. (2000). Co-opting customer competence. *Harvard Business Review, 78*(1), 79–90.

Rossi, A., Pappalardo, L., Cintia, P., Iaia, F. M., Fernàndez, J., & Medina, D. (2018). Effective injury forecasting in soccer with GPS training data and machine learning. *PLoS One, 13*(7), e0201264.

Secundo, G., Del Vecchio, P., Dumay, J., & Passiante, G. (2017). Intellectual capital in the age of big data: Establishing a research agenda. *Journal of Intellectual Capital, 18*(2), 242–261.

Secundo, G., Ndou, V., Del Vecchio, P., & De Pascale, G. (2020). Sustainable development, intellectual capital and technology policies: A structured literature review and future research agenda. *Technological Forecasting and Social Change, 153*, 1119917.

Spieth, P., Schneckenberg, D., & Matzler, K. (2016). Exploring the linkage between business model (&) innovation and the strategy of the firm. *R&D Management, 46*(3), 403–413.

Srnicek, N. (2017). *Platform capitalism*. Wiley.

Sšderman, S., & Dolles, H. (Eds.). (2013). *Handbook of research on sport and business*. Edward Elgar.

Stewart, T. A. (1997). *Intellectual capital: The new wealth of organisations*. Doubleday-Currency.

Trequattrini, R., Lardo, A., Cuozzo, B., & Cano, R. M. (2017). Intellectual capital as driver for controlling managers' performance: An innovative approach. *Management Control, 3*, 123–142.

Zanda, G. (Ed.). (2012). *Corporate management in a knowledge-based economy*. Springer.

Big Data and Business Analytics: Definitions and Implications in the Business Environment

Marisa Agostini and Alessandro Spano

1 Introduction

The growing complexity of the business environment forces companies to be able to make decisions rapidly and effectively. This requires knowing how to manage internal processes and making sure that data support decisions. The strategic use of data not only supports cost reduction and increased efficiency but also allows us to reveal new opportunities by facilitating the emergence of hidden or unknown paths. For example, the analysis of hundreds of demographic and health variables may help predict the risk associated with hospital admission (Valentini, 2017) or prevent injuries in professional footballers (Davenport, 2006). Broadly speaking, the fields of possible applications of big data (BD) and business analytics (BA) are practically immeasurable.

Today's available technologies allow us to analyse vast quantities of data coming from many different sources. For example, the emergence of the Internet of Things has opened the unexpected possibility of gathering data from every object connected to the Internet. The value of this amount of data lies in the possibility of analysing and learning from it by relating different data to produce new knowledge. Some scholars suggest that 'big data is possibly the most significant "tech" disruption in business and academic ecosystems since the meteoric rise of the internet and the digital economy' (Agarwal & Dhar, 2014, p. 443).

M. Agostini (✉)
Department of Management, Ca' Foscari University of Venice, Venice, Italy
e-mail: marisa.agostini@unive.it

A. Spano
Department of Economics and Business Sciences, University of Cagliari, Cagliari, Italy
e-mail: spano@unica.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_8

At the same time, companies in both the private and public sectors run the risk of being overwhelmed by data (Schniederjans et al., 2014), missing the above-mentioned opportunities.

For these reasons, BD and BA have started to attract the interest of business and management scholars with regard to their implications for the business environment. This chapter focuses on their role and provides an overview of how modern technologies may foster their use for a wider variety of organizations and how they will impact the possibility of being more competitive and profitable. Using a qualitative methodology, we consider the following research question:

RQ: What are the implications of big data and business analytics for businesses?

This qualitative study is based on thematic analysis, which 'seeks to identify and bring together the main, recurrent, or most important issues or these arising from a body of literature' (Mays et al., 2005, p. 12). Specifically, the authors analysed two main bodies of literature referring to BD and BA, respectively. In addition, within the BA domain, the study focused on a specific sub-area, process mining, because of its relevance for businesses.

2 Definitions and Main Features in the Academic Literature

2.1 Big Data

An incredible amount of data has been produced in the last few years (Fawcett & Waller, 2014; Surbakti et al., 2020), arising from the BD phenomenon, which needs to be considered and managed despite its complexity. This complexity is related to the coexistence of multidimensional interactions among different people from different contexts to make decisions and create data for different purposes. Indeed, widespread adoption and continuous improvement of technology are revolutionizing the way data are generated, collected, transmitted, and stored, contributing to such BD breakthroughs (Günther et al., 2017). Both academic and practitioner-oriented literature are still trying to frame this phenomenon, but there is no unique definition or precise evaluation of BD at the moment (Gandomi & Haider, 2015; Surbakti et al., 2020).

Regarding the first of these issues (a definition of BD), the extant literature defines BD through a growing list of features. High 'volume', 'velocity', and 'variety' were the three characteristics of BD first identified (Laney, 2001). Then, two further properties were added: 'value', meaning its potential and need to be properly extracted for both firms and stakeholders, and 'veracity', referring to both the context and the sources of BD (Yin & Kaynak, 2015). More recently, 'seven Vs' (Mishra et al., 2017) have been identified, including 'variability' and 'visualisation', referring to possible insights from data analysis. Moreover, BD has been categorized according to its variety into three main types: structured data, with precise length and format; semi-structured data; and unstructured data, which cannot be framed within a specific format or formula (Torrecilla & Romo, 2018). All these properties highlight both the complexity and the potential benefits of BD, which are still challenging for data management (Shams & Solima, 2019). Indeed, BD may imply many corporate advantages (e.g. volume and velocity in data availability for rapid corporate responses to new events or variables), but it can also bring a number of threats: most data are collected from Internet sources (e.g. social networking, research studies, medical data, crime reports, web server logs, broadcast audio streams, scans of government documents, banking transactions, financial market data, etc.) and physical devices (e.g. cameras, GPS on cars, traffic flow sensors, phone signals, audio recorders). They can be transaction, clickstream, video, or voice data (Kauffman et al., 2012) that come from sources generally external to the organization (Zuboff, 2015). Moreover, they differ from the data usually adopted and generated specifically for business uses (Arnaboldi et al., 2017). They are often collected without a pre-defined purpose, promoting a bottom-up, inductive approach to their exploration (Constantiou & Kallinikos, 2015). Therefore, regarding the second item (the evaluation of BD), the same BD features (such as intangibility, variability, and ambiguous profitability) make it difficult to determine exactly how much it is worth. It is also impossible to apply traditional accounting rules for BD budgeting. It represents an information asset whose real economic benefits are still in question.

The combination of at least three items seems to be required to make BD worthwhile and able to create value: suitable and updated information sources; appropriate technology and analytical support (De Mauro et al., 2016); and human capability to properly manage BD's huge size, deep complexity, and necessary technology (Mikalef et al., 2020).

2.2 Business Analytics

BA has emerged as a field of study due to its increasing importance (Holsapple et al., 2014). Among the many available definitions of BA, in this chapter, we propose three. The first is more general, considering BA to be 'delivering the right decision support to the right people at the right time' (Laursen Gert & Thorlund, 2017, p. xiv). A second, more complex definition by Schniederjans et al. (2014) describes BA as 'a process beginning with business-related data collection and consisting of sequential application of descriptive, predictive, and prescriptive major analytic components, the outcome of which supports and demonstrates business decision-making and organizational performance'. The third definition, proposed by Davenport and Harris (2007, p. 16), states, 'By analytics we mean the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions'.

What the three proposed definitions have in common is their focus on the possibility of using data to support businesses in improving their effectiveness and profitability, which is what distinguishes BA from mere analytics.

The core of BA is not new; in fact, the need to get support to make decisions dates back far into the past, and analysing data to make decisions is a common experience. BA can, in theory, be performed by hand, not necessarily with sophisticated technologies as the idea of collecting and analysing data to support decisions is not new. What is different today within BA is the availability of modern digital technologies that provide an unprecedented capacity to analyse data at a magnificent speed. Furthermore, these technologies allow for the analysis of massive amounts of data (BD) from multiple-year periods and multiple sources.

As Chahal et al. (2019, p. vii) suggest, 'Data in its raw form is usually useless, and the driving force behind any data-driven organisation is insights and conclusions drawn from the data, which can suggest a new course of action'. By intelligently using data, companies can become more competitive and profitable because they are able not only to analyse what happened in the past but also to use historical data to determine paths and make predictions for the future. They can better understand customers' needs and tastes and make better use of corporate resources.

3 Big Data and Business Analytics: Implications in the Business Environment

3.1 Big Data: Implications in the Business Environment

The business application of BD has become unavoidable in corporate management and decision making (Tseng et al., 2019). It has wide-reaching organizational effects not only on the way in which decisions are made but also in terms of processes and competences. As the previous paragraphs emphasize, data has no value in itself; rather, it gains value through its use and application in specific organizational and business contexts (Power, 2014). This is true of all types of BD, including both structured and unstructured data from both internal sources (financial, sales, mail, etc.) and external sources (social media, public databases, etc.). It may reveal trends and monitor economic, environmental, or social impacts. Such business applications of BD mainly consist of three consecutive steps: data collection, data structuring, and knowledge discovery. Unstructured BD is considered amorphous data (Bendle & Wang, 2016) and must be properly processed to be usable in the last steps (data structuring and knowledge discovery). Therefore, the first step is especially relevant and requires a clear purpose (often missed) for data collection: companies may collect a mass of data from different sources, as described above, with the general aim of improving business performance, but they should choose a specific range of corporate functions (e.g. marketing, innovation, employee searches, risk management) before starting data collection. For instance, they may benefit from BD availability and timeliness by predicting customers' needs and creating value through new products, services, or processes (Pigni et al., 2016). For this purpose, not only can BD be collected from external sources, but information about corporate activities can also be provided to external users. The BD approach includes both gathering and distributing firms' information about business activities, technology adoption strategies, innovation, and development (Blazquez & Domenech, 2018). It recognizes and uses the possibility of connecting with millions of users worldwide on a regular and continuous basis; this represents the key characteristic of (social media) technology that has sparked the explosion of BD (Arnaboldi et al., 2017).

The extant literature stresses the opportunities that BD provides in the business environment (Chen et al., 2012; Clarke, 2016). It can foster innovative products and services (Davenport et al., 2012); improve customer relationships (Jobs et al., 2015); identify employees for specific jobs and tasks according to their competences, creating more time and resources to develop soft skills and creativity (Wilson et al., 2017); help rethink corporate governance and business strategy to maintain sustainable competitive advantage (Tihanyi et al., 2015); and identify the right corporate partners and most efficient supply chain flows (Tseng et al., 2019).

We would be remiss to ignore the effects of BD breakthroughs in the business environment, but its opportunities also create challenges for organizations and decision makers. As we have argued above, the same features of BD reveal the complexity of using such data. Many questions about the application of BD remain unanswered in the business environment. Some of them are recalled here to emphasize the challenges of 'datafication' and the tensions that organizations face in the attempt to realise value from BD (Galliers et al., 2017).

What data should be collected, and what external sources can be trusted? There is a tendency to use structured data more often, even though most BD is unstructured and available on external platforms.

Which data do organizations and their components value most? Companies recognize the possibility of BD to generate value, but most are not sure how such data can be used across their business to bring worth to different parts of the organization.

Which key competencies should be fostered to properly collect and manage BD? The extant literature does not provide a univocal answer. It emphasizes new kinds of job roles in relation to BD (e.g. data scientists and domain experts) and focuses on the importance of educating key personnel. The disclosure of objectives, widespread communication, and specific BD training should provide employees with an overview of changing processes and enhance their understanding of personal contributions to business goals (Müller & Jensen, 2017). Specifically, managers and corporate leaders must control and disclose BD processes and consequences inside their organizations, especially forecasting them before data entry. Additional human capacity and expertise are required to ensure data quality for decision-making purposes.

To summarize, on the one hand, the main managerial concerns regard BD's reliability and security, proper methodologies, employee competencies, algorithm transparency, organizational fit, reputational risk, and value extraction. All such issues should be incrementally disclosed, addressed, and shared across organizations. On the other hand, possible solutions require organizations to identify 'right players in the right roles with the right relationships in a constantly shifting game'

(Fawcett & Waller, 2014, p. 162), scanning and promoting management skills, building a team capable of reflecting, thinking critically, and winning in a continuously changing and highly competitive environment.

3.2 Business Analytics: Implications in the Business Environment

A 2011 study claims that for every dollar spent on analytics applications, there is a $10 payoff (Nucleus Research, 2011). This is just one of the features that makes BA particularly attractive for businesses. Two main reasons are deemed to justify this assertion. First, the available technologies allow for smooth integration between data sources and BA applications. Second, BA tools support decision making, which eventually results in a significant increase in profitability. For example, thanks to BA, it is possible to conduct more detailed and objective cost analyses.

Additionally, BA fosters a deeper understanding of customers' buying paths, exploring what customers buy and why. This allows, on the one hand, greater customer satisfaction and, on the other hand, increased sales and, eventually, profitability. By using BA techniques, it is possible not only to consider the profitability of individual products but also to analyse how one product is related to other products, including the so-called cross-selling and upselling (Laursen Gert & Thorlund, 2017). Using statistical techniques, one can uncover existing or even potential relations between two or more products and services to see, for example, what different goods and services are bought together. Consequently, companies can see if customers buying one specific product are also likely to buy another product or service and then offer to individual customers buying one product another related product or service (cross-selling). Also, BA makes it easier to increase the profitability of an existing customer or to sell a potential customer a good or service that is more profitable than what they were initially willing to buy (upselling). A company might be interested in learning if a customer is likely to buy an upgraded good or service, thus generating additional income; for example, a software company might be interested in understanding what customers are likely to buy an upgrade. These techniques are commonly used in many industries, such as the hotel industry—in which, as part of the revenue management strategy, hotels attempt to sell customers superior rooms (Denizci Guillet, 2020)—as well as the sports and healthcare industries (Camm et al., 2019). BA has also been adopted to support several corporate functions, varying from finance to human resources, marketing, and supply chains, and several industries, including governmental organizations (Camm et al., 2019, p. 11).

It is not difficult to foresee that in the future, companies will not be able to ignore BA if they want to remain competitive in a turbulent and continuously changing environment (Davenport & Harris, 2007). Although some may believe that BA is a prerogative for large companies, today's available tools allow SMEs as well to enjoy its benefits and opportunities.

4 A New Development in the Business Analytics Sector: Process Mining

Process mining is emerging as a new development for both research and practice in the BA field. Indeed, it allows companies to monitor their processes on a stable basis using already existing process data. One of the seminal sources for understanding process mining is the *Process Mining Manifesto*, published by the Institute of Electrical and Electronics Engineers (IEEE). The Manifesto states that process mining:

> sits between computational intelligence and data mining on the one hand and process modelling and analysis on the other hand. The idea of process mining is to discover, monitor and improve real processes (i.e., not assumed processes) by extracting knowledge from event logs readily available in today's (information) systems (IEEE, 2012, p. 1).

Process mining connects data mining and business process modelling and analysis (van der Aalst, 2016) by using data already available in the corporate information system (the event log) to detect and monitor the real activities that compose a given process, linking the analysis to those event logs. The increased availability of event data and more advanced process mining techniques are the main reasons for the emergence of this new field.

A log refers to a specific activity and is related to a particular case (i.e. a process instance) (IEEE, 2012, p. 3). Every time a new transaction impacts one or more of the process's activities, the analysis of that specific process is automatically updated.

There is a significant initial effort first to map the processes and then to find where the event logs are so that they can be linked to the process mining software. Also, data come from the different available sources, so data extraction is an integral part of process mining (van der Aalst, 2016).

Today's available techniques allow for analysing significant amounts of data about a process over time, making it possible to know how the process develops and making it easier to detect inefficiencies.

The precondition for process mining to work is that process information must be digital so that event logs can be extracted and analysed. Events can come from many sources, such as the accounting system or others. Companies that have implemented an enterprise resource planning system are, to some extent, in a better position, as it is relatively more straightforward for them to find and connect the event logs. More recently, some software products have begun to allow tracking logs from many sources, even emails, provided they relate to a given process.

By effectively analysing event logs, process mining can 'provide insights, identify bottlenecks, anticipate problems, record policy violations, recommend countermeasures, and streamline processes' (IEEE, 2012, p. 3).

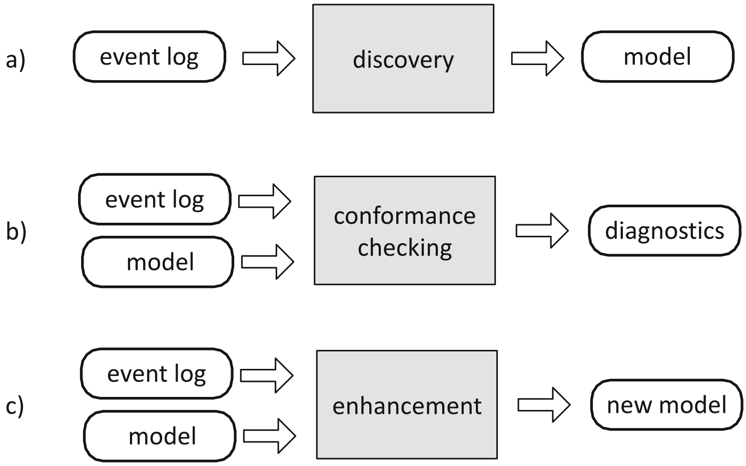


Fig. 1 The three types of process mining. Source: IEEE (2012)

There are three types of process mining: discovery, conformance, and enhancement. The discovery type uses event logs to produce a model and highlight the real process. Conformance process mining compares an existing model with a real process as it emerges from the logs and sees whether they are consistent with each other. That is, starting from an expected process, the analysis reveals if and how the actual process deviates from the model. The last type is enhancement, which aims to find how an existing process model can be improved, drawing on the observed process as recorded in the event logs. The main difference between conformance and enhancement process mining lies in the fact that the former is limited to verifying the existence of differences between the model and the actual process, while the latter takes a step forward and aims to change the initial model to improve it (Fig. 1).

Discovery process mining is probably the most commonly used type, but the two other types appear to be particularly useful as well.

Process mining is in its initial phase, and today it is mainly implemented in very large organizations. There are also critical requirements for the broader use of process mining techniques, such as the availability of high-quality event logs, the possibility of extracting them from the different sources, and the phenomenon of process drift, in which a process changes while being observed (van der Aalst, 2016, p. 16). All of these aspects make process mining an up-and-coming field for research and open important opportunities for practice.

Finally, the characteristics of process mining and its potential make it a fascinating tool for a wider variety of organizations, not just in the private sector but in the public and non-profit sectors as well.

5 Concluding Remarks

BD, characterized especially by high volume, velocity, and variety, and its application though BA, based on specific technology and analytical methods, may generate information assets (De Mauro et al., 2016) and represent relevant corporate resources if a practical paradox is promptly solved (Arnaboldi et al., 2017). On the one hand, BD-BA reduces the space left to human judgement and (following) actions in the construction of knowledge. On the other hand, BD-BA improves measurement, representation, and rational decision making. In the middle, there are many potential benefits and challenges due to BD characteristics and management. Indeed, managers are called to plan, decide, and act using BD-BA, adapting business processes, estimating business value due to BD-BA, taking into account its benefits and challenges, and appropriately communicating and involving the entire organization. Such clear disclosure should state how management plans to use BD-BA across the company and create value for different business processes and organizational units.

Therefore, several implications may arise from implementing BD-BA in the business sector. First, the systematic use of BD-BA may significantly impact the entire business (e.g. production planning, purchasing and logistics decisions, daily operations). Second, its implementation requires clear managerial objectives that should be stated in strict connection with business strategies and processes. Third, it could provide valuable insights into customer needs and behaviours, loyalty, retention, and resale (Müller & Jensen, 2017). It provides information flows and may enable organizational decision makers to produce better resource reconfigurations and develop valuable capabilities that may create competitive advantages in highly dynamic and uncertain environments. The chapter has highlighted both the opportunities and the challenges that BD-BA presents for businesses. The entire organizational process of using advanced BA technologies for BD analysis may help managers uncover useful information (e.g. unknown patterns) and make better decisions across corporate business processes. In this way, the decision-making process will be deeply supported by competitor analyses, business strategy, investment decisions, marketing, human resource management, and accounting. This synergy helps companies achieve their primary (sustainable) goals and gain long-term profitability in a challenging business environment characterized by high competition, rapid change, and massive flows of data.

The main limitation of this study is that more in-depth investigation should be conducted to better understand the actual implications derived from the use of BD-BA and to generalize the main findings of this chapter. Moreover, case study research may help in the further exploration of additional potential uses of the examined technologies.

References

Agarwal, R., & Dhar, V. (2014). Big data, data science, and analytics: The opportunity and challenge for IS research. *Information Systems Research, 25*(3), 443–448.

Arnaboldi, M., Busco, C., & Cuganesan, S. (2017). Accounting, accountability, social media and big data: Revolution or hype? *Accounting, Auditing & Accountability Journal, 30*(4), 762–776.

Bendle, N. T., & Wang, X. S. (2016). Uncovering the message from the mess of big data. *Business Horizons, 59*(1), 115–124.

Blazquez, D., & Domenech, J. (2018). Big data sources and methods for social and economic analyses. *Technological Forecasting and Social Change, 130*, 99–113.

Camm, J. D., Cochran, J. J., Fry, M., Ohlmann, J. W., Anderson, D. R., Sweeney, D. J., & Williams, T. A. (2019). *Business analytics*. Cengage Learning.

Chahal, H., Jeevan, J., & Wirtz, J. (Eds.). (2019). *Understanding the role of business analytics some applications*. Springer.

Chen, H., Chiang, R. H., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. *MIS Quarterly*, 1165–1188.

Clarke, R. (2016). Big data, big risks. *Information Systems Journal, 26*(1), 77–90.

Constantiou, I. D., & Kallinikos, J. (2015). New games, new rules: Big data and the changing context of strategy. *Journal of Information Technology, 30*(1), 44–57.

Davenport, T. H. (2006). *Competing on analytics*. Harvard Business Review.

Davenport, T. H., & Harris, J. G. (2007). *Competing on analytics. The new science of winning*. Harvard Business School Publishing Corporation.

Davenport, T. H., Barth, P., & Bean, R. (2012). How 'big data' is different. *MIT Sloan Management Review, 54*(1), 43–46.

De Mauro, A., Greco, M., & Grimaldi, M. (2016). A formal definition of big data based on its essential features. *Library Review, 65*(3), 122–135.

Denizci Guillet, B. (2020). Online upselling: Moving beyond offline upselling in the hotel industry. *International Journal of Hospitality Management, 84*, 1–13.

Fawcett, S. E., & Waller, M. A. (2014). Can we stay ahead of the obsolescence curve? On inflection points, proactive preemption, and the future of supply chain management. *Journal of Business Logistics, 35*(1), 17–22.

Galliers, R. D., Newell, S., Shanks, G., & Topi, H. (2017). Datification and its human, organizational and societal effects. *The Journal of Strategic Information Systems, 26*(3), 185–190.

Gandomi, A., & Haider, M. (2015). Beyond the hype: Big data concepts, methods, and analytics. *International Journal of Information Management, 35*(2), 137–144.

Günther, W. A., Mehrizi, M. H. R., Huysman, M., & Feldberg, F. (2017). Debating big data: A literature review on realizing value from big data. *The Journal of Strategic Information Systems, 26*(3), 191–209.

Holsapple, C., Lee-Post, A., & Pakath, R. (2014). A unified foundation for business analytics. *Decision Support Systems, 64*, 130–141. https://doi.org/10.1016/j.dss.2014.05.013.

IEEE. (2012). *Process mining manifesto*. The Institute of Electrical and Electronics Engineers (IEEE).

Jobs, C. G., Aukers, S. M., & Gilfoil, D. M. (2015). The impact of big data on your firms marketing communications: A framework for understanding the emerging marketing analytics industry. *Academy of Marketing Studies Journal, 19*(2), 81.

Kauffman, R. J., Srivastava, J., & Vayghan, J. (2012). Business and data analytics: New innovations for the management of e-commerce. *Electronic Commerce Research and Applications, 11* (2), 85–88.

Laney, D. (2001). 3D data management: Controlling data volume, velocity and variety. *META Group Research Note, 6*(70), 1. Retrieved from http://blogs.gartner.com/doug-laney/files/2012/01/ad949-3D-Data-Management-Controlling-Data-Volume-Velocity-and-Variety.pdf

Laursen Gert, H. N., & Thorlund, J. (2017). *Business analytics for managers: Taking business intelligence beyond reporting*. Wiley.

Mays, N., Pope, C., & Popay, J. (2005). Systematically reviewing qualitative and quantitative evidence to inform management and policy-making in the health field. *Journal of Health Services Research & Policy, 10*(Suppl 1), 6–20. https://doi.org/10.1258/1355819054308576

Mikalef, P., Krogstie, J., Pappas, I. O., & Pavlou, P. (2020). Exploring the relationship between big data analytics capability and competitive performance: The mediating roles of dynamic and operational capabilities. *Information & Management, 57*(2), 103169.

Mishra, N., Singh, A., Rana, N. P., & Dwivedi, Y. K. (2017). Interpretive structural modelling and fuzzy MICMAC approaches for customer centric beef supply chain: Application of a big data technique. *Production Planning & Control, 28*(11–12), 945–963.

Müller, S. D., & Jensen, P. (2017). Big data in the Danish industry: Application and value creation. *Business Process Management Journal, 23*(3), 645–670.

Nucleus Research. (2011). *How analytics makes midsize companies more profitable*. Retrieved from.

Pigni, F., Piccoli, G., & Watson, R. (2016). Digital data streams: Creating value from the real-time flow of big data. *California Management Review, 58*(3), 5–25.

Power, D. J. (2014). Using 'big data' for analytics and decision support. *Journal of Decision Systems, 23*(2), 222–228.

Schniederjans, M. J., Schniederjans, D. G., & Starkey, C. M. (2014). *Business analytics. Principles, concepts and application. What, whey and how*. Pearson.

Shams, S. R., & Solima, L. (2019). Big data management: Implications of dynamic capabilities and data incubator. *Management Decision, 57*(8), 2113–2123.

Surbakti, F. P. S., Wang, W., Indulska, M., & Sadiq, S. (2020). Factors influencing effective use of big data: A research framework. *Information & Management, 57*(1), 103146.

Tihanyi, L., Graffin, S., & George, G. (2015). Rethinking governance in management research. *Academy of Management Journal, 1015*(1), 1–9.

Torrecilla, J. L., & Romo, J. (2018). Data learning from big data. *Statistics & Probability Letters, 136*, 15–19.

Tseng, M. L., Wu, K. J., Lim, M. K., & Wong, W. P. (2019). Data-driven sustainable supply chain management performance: A hierarchical structure assessment under uncertainties. *Journal of Cleaner Production, 227*, 760–771.

Valentini, C. (2017). L'algoritmo per salvare la gente dall'ospedale. *Italia Oggi*.

van der Aalst, W. (2016). *Process mining: Data science in action*. Springer.

Wilson, A., Thompson, T. L., Watson, C., Drew, V., & Doyle, S. (2017). Big data and learning analytics: Singular or plural? *First Monday, 22*(4).

Yin, S., & Kaynak, O. (2015). Big data for modern industry: Challenges and trends. *Proceedings of the IEEE, 103*(2), 143–146.

Zuboff, S. (2015). Big other: Surveillance capitalism and the prospects of an information civilization. *Journal of Information Technology, 30*(1), 75–89.

Big Data and Artificial Intelligence to Support Risk Management: A Systematic Literature Review

Grazia Dicuonzo, Francesca Donofrio, and Graziana Galeone

1 Introduction

The corporate downfalls of the early 2000s, the global financial crisis of the last years, and the recent outbreak of the COVID-19 pandemic have pushed companies into making efforts to improve Risk Management (RM) practices (PwC, 2020). RM covers different applications and technological fields, involves both business and operational aspects, and affects all sectors at various levels and with different magnitudes. From an Information Technology (IT) perspective, RM can have dual value (Sanford & Moosa, 2015): (1) operational RM and (2) data availability to applications, digital services, and lines of business. This last aspect is perhaps the most critical, especially today in the era of big data (BD), where application tasks are increasingly data intensive (Martínez-Rojas et al., 2018). For this reason, it is becoming increasingly important to invest in data to model cross-cutting RM solutions and strategies that find the right support in infrastructure (Dicuonzo et al., 2019; Sundhararajan et al., 2018).

The increase in the quantity and quality of data stored or accessible by companies, the growing value of data, and the spread of national and international regulations require companies to manage data and information (Fenz & Neubauer, 2018). On the one hand, from the perspective of RM, the concept of "data availability" translates into data accessibility and usability by IT systems or "data-intensive" tasks, such as

This chapter represents the results of a joint research project carried out by the three authors. However, the various paragraphs of the chapter are in particular divided as follows: paragraphs 1 and 4 G. Dicuonzo; paragraphs 2 and 3.2 F. Donofrio; paragraphs 3.1 and 3.3 G. Galeone.

G. Dicuonzo (✉) · F. Donofrio · G. Galeone
Department of Economics, Management and Business Law, University of Bari Aldo Moro, Bari, Italy
e-mail: grazia.dicuonzo@uniba.it; francesca.donofrio@uniba.it; graziana.galeone@uniba.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_9

those of BD analytics or artificial intelligence (AI) (Sanford & Moosa, 2015). On the other hand, the concept of "integrity" should be understood as a guarantee that information does not undergo changes or deletions as a result of errors or voluntary actions, but also as a result of malfunctions or damage of technological systems (Müller et al., 2018). In this case, the combination with RM is even stronger because data protection results in the mitigation of risks associated with accessing or using data improperly (Guha, 2018).

Digital innovation has not only brought new technologies such as the Cloud, the Internet of Things (IoT), machine learning, or AI to the market but has also centralized the importance of data to business managers (Ivanov et al., 2018; Wamba et al., 2015).

From an infrastructure point of view, storage unites the various individual aspects of a company's digital transformation. It represents the technological layer through which to distribute the data, making it available according to the speed and performance ideal for each type of business. Storage-related planning could be a risk for companies riding the wave of BD or AI: "data-intensive" tasks require adequate infrastructural support, but its programming may be insufficient for the most advanced workloads, resulting in operational risk resulting from data availability. On the other hand, overestimated planning involves risks, from economic to system management (Müller et al., 2018).

The intelligence of machine learning technologies helps you better manage the risks of data availability because it allows you to predict storage capacity and performance needs, and even model and upgrade hardware systems accordingly. In this context, RM becomes an element of value. The basic principle is the elimination of manual operations, which is now possible thanks to technologies that enable companies to collect and analyze data from any source, of any size and nature, and anywhere. The challenge for businesses is not in data storage but in data's availability, accessibility, and usability in order to be evaluated and exploited at multiple levels, by multiple people, with increasingly advanced tools, services, and applications (Martínez-Rojas et al., 2018).

In light of these considerations, this work aims to fuel the already existing, but still underdeveloped, debate on the implementation of AI and BD by companies as tools to support RM, offering a systemization of the state of the art and orienting academics toward this issue. The analysis, therefore, aims to investigate the advantages of adopting new technologies in RM systems, identifying the main applications and benefits that can come from the application of AI and BD. It is intended, therefore, to provide an integrated cognitive framework of what has been developed so far by the literature, in order to highlight the possible evolution of studies in the field.

In particular, we want to answer the following research question:

RQ: *What are the main issues that animate the scientific debate on artificial intelligence and big data as a tool to support risk management?*

We develop a literature review over the period 2010–2020. Our main findings underline that AI applications and exploiting the information potential of the large amount of data managed by companies are becoming increasingly popular (Vostrikov et al., 2019). AI is among the main tools to support the RM function (Chen et al., 2012), allowing more effective RM (Hirsch, 2018) and ensuring maximum reactivity and flexibility to anticipate unexpected events (Amaye et al., 2016; Engelseth & Wang, 2018).

This chapter is structured as follows: Section 2 outlines the methodology used; Section 3 outlines the main findings emerging from the literature review. Finally, Section 4 contains the conclusions of the work.

2 Methodology

To identify the main issues that animate the debate on AI and BD as a tool to support RM, we conduct a systematic literature review based on Mostaghel's (2016) approach. This analysis differs from that of the narrative type precisely because of its systematicity, being an objective analysis and replicable. Vicente-Saez and Martinez-Fuentes (2018) point out that a systematic analysis of literature is characterized by four steps:

1. Search—identification of studies
2. Appraisal—quality assessment of studies
3. Synthesis—data extraction
4. Analysis—data analysis

The literature analysis covers the period 2010–2020 and was carried out using the Scopus database (Vicente-Saez & Martinez-Fuentes, 2018). Following the application of the chosen methodology for research on Scopus, the articles were selected through the use of the keywords "risk management" in combination with the expressions "artificial intelligence" and/or "big data."

A total of three search queries were launched, selecting the default field of keywords as the default field of the database: article title, abstract, and keywords. The research conducted, without any restrictions on the type of contribution, was delimited with respect to the year of publication and the research area "business, management, and accounting." Once the database search was completed, all articles resulting from the search were considered. Subsequently, the common contributions to the various researches carried out were eliminated, up to the total number of articles to be analyzed (191 articles).

To identify all possible studies, a screening was conducted to assess suitability against the inclusion criteria, analyzing each article in its entirety. They were considered as irrelevant and therefore excluded from the analysis, if AI or BD in the RM process was not the main topic and did not find appropriate insight. Ultimately, 60 articles were considered (see Fig. 1).

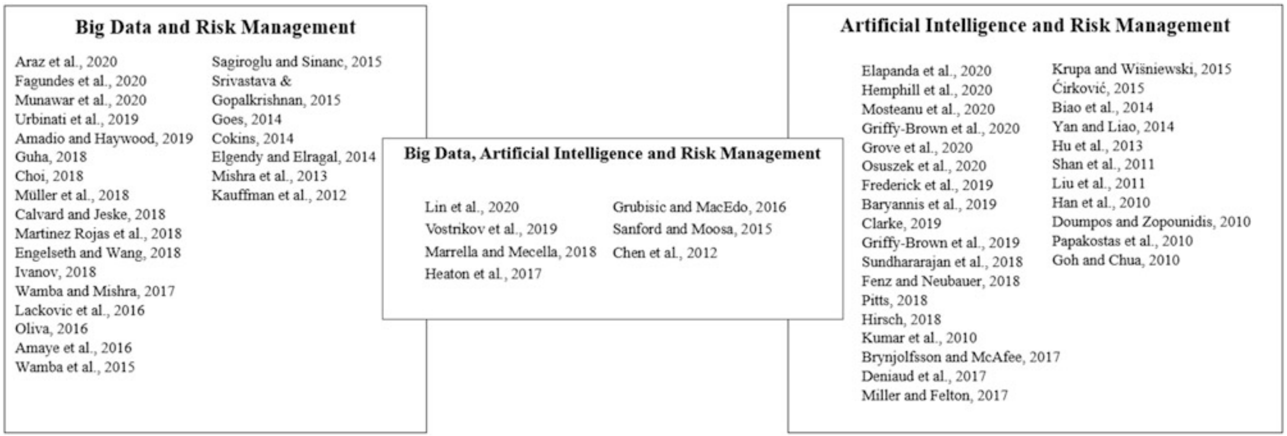


Fig. 1 List of articles included in the systematic literature review

3 Results

The following sections show the main results of the analysis, divided into three of the main research lines:

1. BD as a support tool for greater operational efficiency, cost reduction, and integrated risk mitigation
2. AI as a support tool for business decision-makers in the RM process
3. The impact of new technologies on RM

3.1 Big Data and Risk Management

BD has received significant attention in recent years "due to social networking, the internet, mobile telephony and all kinds of new technologies" (Kauffman et al., 2012) which create a constant flow of potential new insights to optimize the processes of data analysis and knowledge generation (Goes, 2014). In different studies (Sagiroglu & Sinanc, 2015; Srivastava & Gopalkrishnan, 2015) BD is defined as a huge and complex flow of structured, unstructured, and nonhomogeneous data from multiple sources facilitating data-driven decision-making.

In the literature, BD is often characterized by the five Vs: volume, variety, velocity, veracity, and value (Wamba & Mishra, 2017). The large volumes and high variety of BD due to the rise of the IoT have made it quite impossible to store and analyze all of this data with the help of the traditional database method, so new techniques and technologies have been developed that can handle the processing of BD and provide insights for decision-making (Choi, 2018).

BD has been utilized in various applications and services, ranging from e-commerce to social media to public sector and governmental organizations. This new phenomenon provides greater operational efficiency, cost reduction, and integrated risk mitigation (Guha, 2018; Mishra et al., 2013).

Regarding risk mitigation, the use of BD improves institutions' risk profiles and paves the way to approach risk in a profitable manner in each of the four key RM activities (identification, assessment, RM and control, and reporting) (Oliva, 2016). Furthermore, it reduces uncertainty in entrepreneurial decision-making with opportunity recognition and the creation of new value (Urbinati et al., 2019). Indeed, the competence of data analytics can assure the quality of that information (Cokins, 2014; Munawar et al., 2020), leading to better efficiency in RM and process optimization (Goes, 2014).

Data analytics facilitates the RM process (Engelseth & Wang, 2018), guaranteeing maximized responsiveness and flexibility to anticipate and respond to unexpected events (Amaye et al., 2016). In corporate businesses, risk assessment and management are the result of a proactive strategic approach to planning and identifying potential risks to business objectives (Amadio & Haywood, 2019). In RM it is essential to integrate traditional information sources with unstructured data acquired from various internal and external sources and to share them within the organization so as to allow the rapid identification and quantification of new risks and a transparency in reporting activities (Elgendy & Elragal, 2014).

The role of advanced tools such as data-sourcing tools is crucial, as well as data processing and retention. Also, data-management tools are fundamental in order to manage data access, storage, distribution, data quality, and, finally, data governance and control tools (Müller et al., 2018).

In general, companies today must increasingly show that they are "data-driven"; i.e., they must be capable of governing and enhancing their information assets and benefit from those of their customers, acquiring competitive advantages by optimizing their decision-making processes and operating model, as well as by developing new products and business models. Moreover, BD actually reinforces the need for an overall informed and appropriate RM strategy (Calvard & Jeske, 2018).

3.2 Artificial Intelligence and Risk Management

The information revolution that took place in the last 50 years, and which is still taking place, has led to exemplary progress, and the consequent multiplication of intellectual potential has affected the entire field of science.

AI is one of the most recent disciplines, formally established in 1956 and defined as the activity of building intelligent systems. The particular techniques of AI that are exploited can range from traditional symbolic AI, based on representations of mathematical or knowledge-based problems, to subsymbolic AI including, for example, fuzzy systems and evolutionary calculus, to statistical AI, which includes machine-learning approaches (Baryannis et al., 2019).

Han et al. (2010) examine the two most commonly used AI methods (multilayer network perceptron and radial basis function) to build a model of credit-rating applications. The Authors analyze the restrictive factors of neural network applications (exponential increase in variables) in order to improve the effect of neural network prediction models. These models can help companies with a large amount of intangible assets to have a greater chance of earning in the future and a lower chance of encountering financial problems (Doumpos & Zopounidis, 2010; Yan & Liao, 2014).

The explosion of machine learning in the general context of AI is thus transforming the relationship between human and machine in increasingly pervasive ways (Brynjolfsson & McAfee, 2017). There are several ways in which AI could be implemented in business systems, such as for managing emerging crises within critical infrastructure (Krupa & Wiśniewski, 2015), for information protection, as well as for the protection of human's and workers' rights (Goh & Chua, 2010; Papakostas et al., 2010).

However, the most important use is to create some sort of predictive analytics to identify ethical issues within an organization that could lead to reputational damage

(Grove et al., 2020). It is worth pointing out that, in addition to the potential impacts on society, these technologies create risks, which even in the business context are not easily identifiable or evaluable. To this end, recommendations and frameworks based on the use of technologies have been developed for RM in order to protect commercial interests, as well as the interests of its stakeholders and the entire company (Cirkovic, 2015; Griffy-Brown et al., 2019, 2020; Hemphill, 2020). Risk identification and management generally depend on the ability of managers and decision-makers to analyze multidimensional situations, mobilize their experience, and infer risks and opportunities (Frederick et al., 2019).

To ensure that the evolving risk profile of the domain is acquired over time, a formal approach to organizational learning is studied that uses the automatic adaptation capabilities of the parameters of the Bayesian network model (Lin et al., 2020).

There is currently extensive empirical research on intelligent decision-support models for risk analysis in software projects, such as an emerging management theory (Shan et al., 2011). Some scholars examined the software project's intelligent risk planning to help minimize the impacts of project risks and achieve a better project outcome than expected. Risk control actions can help develop strategies to mitigate the risks of other projects as well as being a valuable intelligent decision-support tool for project stakeholders to effectively control project risks by integrating risk analysis and planning (Hu et al., 2013; Osuszek & Ledzianowski, 2020).

Another area of application of AI, as a tool to support RM, concerns the supply chain. Given the vulnerability of supply chains to different types of risks, some scholars consider it appropriate to apply various computational intelligence techniques such as genetic algorithms in order to improve a firm's ability to react to changes in risk factors (Biao et al., 2014; Fagundes et al., 2020; Kumar et al., 2010; Liu et al., 2011).

Today, all real-world environments are gradually becoming cyber-physical, with the presence of connected devices and integrated ICT systems producing huge amounts of data and events that influence the implementation of computing processes in such environments (Mosteanu, 2020; Pitts, 2018). In this sense, companies are creating strategic alliances (Deniaud, 2017) or are investing heavily in AI research to explore future technologies that can lead to disruptive innovations (Sundhararajan et al., 2018).

3.3 Artificial Intelligence, Big Data, and Risk Management

With the development of new digital technologies, effective integrated modelling techniques and the introduction of new process management, knowledge, and data analysis tools are needed (Marrella & Mecella, 2018; Martínez-Rojas et al., 2018; Vostrikov et al., 2019).

Given the multiplicity of risks that companies face, firms need to implement new technologies globally and information innovation will be a valuable support in this regard. Time-varying behavioral characteristics and nonlinear dependency are widely observed in BD which challenge operating systems and RM processes (Grubisic & MacEdo, 2016; Sanford & Moosa, 2015).

In order to improve the operational accuracy of risk measures and integrate customer-behavior analysis, the Bayesian approach is a valuable tool for efficiently estimating multivariate risk measures in a dynamic framework (Araz et al., 2020; Chen et al., 2012; Lin et al., 2020). In addition, the use of deep hierarchical learning models for financial prediction and classification of problems can produce more useful results than traditional methods, detecting and leveraging interactions in data that are currently invisible to any existing financial economic theory (Heaton et al., 2017).

4 Conclusions and Future Research Lines

This chapter aims to carry out a systematic literature review with reference to the role of BD and AI in the RM process. It is therefore intended to provide an integrated cognitive framework of what has been developed so far by the literature, in order to highlight the possible future development pathways of studies in this area.

An analysis of the literature carried out on the Scopus database, referring to the period 2010–2020, revealed 60 relevant contributions, confirming that the international literature still has wide scope for further study. The systematic literature review conducted has led to the emergence of three prevailing research strands: (1) BD as a support tool for greater operational efficiency, cost reduction, and integrated risk mitigation; (2) AI as a support tool for business decision-makers in the RM process; and (3) the impact of new technologies on RM.

With respect to the first point, the conclusion that most scholars come to is that the use of the BD strategy improves the risk profiles of institutions and paves the way for addressing risk in a profitable way in each of the four key RM activities (Lackovic et al., 2016). Data analysis facilitates the RM process ensuring maximum responsiveness and flexibility to anticipate and respond to unforeseen events (Engelseth & Wang, 2018). Several authors consider it essential in RM to integrate traditional sources of information with unstructured data acquired from various internal and external sources and share them within the organization (Lackovic et al., 2016).

In regards to the second strand identified, the vast majority of the literature focuses on a specific application of AI known as machine learning. The use of machine learning will bring the predictive power of corporate risk surveillance to a much higher level of effectiveness (Hirsch, 2018). In addition to the potential impacts on society, these technologies create risks that are not easily identifiable or evaluable in the business environment. To this end, many authors have developed new RM models that executives could use to consider these technologies (Griffy-Brown et al., 2019, 2020). Other authors have made recommendations on the management of the technology, leading to its proper management in order to protect the interests of the company, but also those of its stakeholders (Clarke, 2019; Miller & Felton, 2017).

Finally, relating to the third point, it has emerged that analytical models and intelligent solutions based on the use of IT and methods of working with BD are becoming popular. In an increasingly dynamic and digital context, companies need to recognize the potential of new technologies and implement them globally (Vostrikov et al., 2019). AI is a valuable tool for efficiently estimating risk measures in a dynamic framework (Chen et al., 2012). In addition, the use of hierarchical deep-learning models for the financial prediction can produce more useful results than traditional methods, detecting and leveraging interactions in data that are currently invisible to any financial economic theory (Heaton et al., 2017).

Drawing a summary profile that also looks at future research possibilities on the topics investigated, it seems essential to gain a better understanding of the factors that influence the decision to implement new technologies to maximize business efficiency. An in-depth study in this sense would allow to understand why the implementation process has not yet exploded. In this regard, it would be interesting to identify and analyze all the factors (barriers or benefits) that could lead companies to use these tools, such as company size, available resources, or corporate governance structure.

Underlying this chapter is the belief that the adoption of AI and BD by companies can more effectively ensure the process of identifying, managing, and monitoring risks. Support from top management is needed in monitoring technologies and assessing their impact and strategic importance to the business. In this regard, the analysis reveals a space for scholars for research that, starting from the benefits offered by new technologies, tries to propose innovative solutions and frameworks suitable to support companies in the process of digitalization, perhaps illustrating successful experiences from selected case studies.

References

Amadio, W. J., & Haywood, M. E. (2019). Data analytics and the cash collections process: An adaptable case employing excel and tableau. *Advances in Accounting Education: Teaching and Curriculum Innovations, 22*, 45–70. https://doi.org/10.1108/S1085-462220190000022003.

Amaye, A., Neville, K., & Pope, A. (2016). BigPromises: Using organisational mindfulness to integrate big data in emergency management decision making. *Journal of Decision Systems, 25*, 76–84. https://doi.org/10.1080/12460125.2016.1187419.

Araz, O. M., Choi, T. M., Olson, D. L., & Salman, F. S. (2020). Role of analytics for operational risk management in the era of big data. *Decision Sciences, 51*(6), 1320–1346. https://doi.org/10.1111/deci.12451.

Baryannis, G., Validi, S., Dani, S., & Antoniou, G. (2019). Supply chain risk management and artificial intelligence: State of the art and future research directions. *International Journal of Production Research, 57*(7), 2179–2202. https://doi.org/10.1080/00207543.2018.1530476.

Biao, L., Liang, W., & Liang, L. (2014). A multi-agent-based research on tourism supply chain risk management. *Journal of Advanced Manufacturing Systems, 13*(3), 133–153. https://doi.org/10.1142/S0219686714500097.

Brynjolfsson, B. Y. E., & McAfee, A. (2017). Artificial intelligence for real. *Harvard Business Review*, (1), 1–31.

Calvard, T. S., & Jeske, D. (2018). Developing human resource data risk management in the age of big data. *International Journal of Information Management, 43*, 159–164. https://doi.org/10.1016/j.ijinfomgt.2018.07.011.

Chen, C., Gerlach, R., Lin, E., & Lee, W. (2012). Bayesian forecasting for financial risk management, pre and post the global financial crisis. *Journal of Forecasting, 31*, 661–687. https://doi.org/10.1002/for.1237.

Choi, T. M. (2018). Incorporating social media observations and bounded rationality into fashion quick response supply chains in the big data era. *Transportation Research Part E: Logistics and Transportation Review, 114*, 386–397. https://doi.org/10.1016/j.tre.2016.11.006.

Cirkovic, M. (2015). Linking simulation argument to the AI risk. *Futures, 72*, 27–31. https://doi.org/10.1016/j.futures.2015.05.003.

Clarke, R. (2019). Principles and business processes for responsible AI. *Computer Law and Security Review, 35*(4), 410–422. https://doi.org/10.1016/j.clsr.2019.04.007.

Cokins, G. (2014). Mining the past to see the future. *Strategic Finance, 96*(11), 23–30.

Deniaud, I. (2017). How risks and innovativeness influence the selection of partner in NPD alliances. In *IEEE 19th Conference on Business Informatics*, July. https://doi.org/10.1109/CBI.2017.29.

Dicuonzo, G., Galeone, G., Zappimbulso, E., & Dell'Atti, V. (2019). Risk management 4.0: The role of big data analytics in the bank sector. *International Journal of Economics and Financial Issues, 9*(6), 40–47. https://doi.org/10.32479/ijefi.8556.

Doumpos, M., & Zopounidis, C. (2010). A multicriteria decision support system for bank rating. *Decision Support Systems, 50*(1), 55–63. https://doi.org/10.1016/j.dss.2010.07.002.

Elgendy, N., & Elragal, A. (2014). Big data analytics: A literature review paper big data analytics: A literature review paper. *Lecture Notes in Computer Science, 2014*, 214–227. https://doi.org/10.1007/978-3-319-08976-8.

Engelseth, P., & Wang, H. (2018). Big data and connectivity in long-linked supply chains. *Journal of Business and Industrial Marketing, 33*(8), 1201–1208. https://doi.org/10.1108/JBIM-07-2017-0168.

Fagundes, M., Teles, E., Vieira de Melo, S., & Freires, F. (2020). Decision-making models and support systems for supply chain risk: Literature mapping and future research agenda. *AEDEM, 26*(2), 63–70. https://doi.org/10.1016/j.iedeen.2020.02.001.

Fenz, S., & Neubauer, T. (2018). Ontology-based information security compliance determination and control selection on the example of ISO 27002. *Information and Computer Security, 26*(5), 551–567. https://doi.org/10.1108/ICS-02-2018-0020.

Frederick, F., Lauras, M., Montreuil, B., Faugere, L., Gou, J., & Mu, W. (2019). Physics of organization dynamics: An AI framework for opportunity and risk management. *Proceedings of the 2019 IESM*. https://doi.org/10.1109/IESM45758.2019.8948167

Goes, P. B. (2014). Big data and IS research. *MIS Quarterly*, *38*(3), iii–viii.

Goh, Y. M., & Chua, D. K. H. (2010). Case-based reasoning approach to construction safety hazard identification: Case-based reasoning approach to construction safety hazard identification: Adaptation and utilization. *Journal of Construction Engineering and Management*. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000116

Griffy-Brown, C., Miller, H., Zhao, V., Lazarikos, D., & Chun, M. (2019). Emerging technologies and risk: How do we optimize enterprise risk when deploying emerging technologies? IEEE TEMSCON. https://doi.org/10.1109/TEMSCON.2019.8813743

Griffy-Brown, C., Miller, H., Zhao, V., Lazarikos, D., & Chun, M. (2020). Making better risk decisions in a new technological environment. *IEEE Engineering Management Review, 48*(1), 77–84. https://doi.org/10.1109/EMR.2020.2969121.

Grove, H., Clouse, M., & Xu, T. (2020). New risks related to emerging technologies and reputation for corporate governance. *Journal of Governance and Regulation, 9*(2), 64–74. https://doi.org/10.22495/jgrv9i2art4.

Grubisic, V. V. F., & MacEdo, J. C. (2016). Guidelines for development of risk identification expert system for product design. *Advances in Transdisciplinary Engineering, 4*, 895–904. https://doi.org/10.3233/978-1-61499-703-0-895.

Guha, P. (2018). Application of multivariate-rank-based techniques in clustering of big data. *The Journal for Decision Makers, 43*(4), 179–190. https://doi.org/10.1177/0256090918804385.

Han, L., Han, L., & Hongwei, Z. (2010). Combined model of empirical study for credit risk management. *IEEE, 1*, 189–192.

Heaton, J. B., Polson, N. G., & Witte, J. H. (2017). Deep learning for finance: Deep portfolios. *Applied Stochastic Models in Business and Industry, 33*(1), 3–12. https://doi.org/10.1002/asmb.2209.

Hemphill, T. A. (2020). The innovation governance dilemma: Alternatives to the precautionary principle. *Technology in Society, 63*, 101381. https://doi.org/10.1016/j.techsoc.2020.101381.

Hirsch, P. B. (2018). Tie me to the mast: Artificial intelligence & reputation risk management. *Journal of Business Strategy, 39*(1), 61–64. https://doi.org/10.1108/JBS-11-2017-0160.

Hu, Y., Du, J., Zhang, X., Hao, X., Ngai, E. W. T., Fan, M., & Liu, M. (2013). An integrative framework for intelligent software project risk planning. *Decision Support Systems, 55*(4), 927–937. https://doi.org/10.1016/j.dss.2012.12.029.

Ivanov, D., Dolgui, A., & Sokolov, B. (2018). The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics. *International Journal of Production Research*. https://doi.org/10.1080/00207543.2018.1488086

Kauffman, R. J., Srivastava, J., & Vayghan, J. (2012). Business and data analytics: New innovations for the management of e-commerce. *Electronic Commerce Research and Applications, 11* (2), 85–88. https://doi.org/10.1016/j.elerap.2012.01.001.

Krupa, T., & Wis□niewski, M. (2015). Situational management of critical infrastructure resources under threat. *Foundations of Management, 7*(1), 93–104. https://doi.org/10.1515/fman-2015-0028.

Kumar, S. K., Tiwari, M. K., & Babiceanu, R. F. (2010). Minimisation of supply chain cost with embedded risk using computational intelligence approaches. *International Journal of Production Research, 48*(13), 3717–3739. https://doi.org/10.1080/00207540902893425.

Lackovic, I. D., Kovsca, V., & Vincek, Z. L. (2016). Framework for big data usage in risk management process in banking institutions. *Central European Conference on Information and Intelligent Systems*, 49–54.

Lin, E. M. H., Sun, E. W., & Yu, M. T. (2020). Behavioral data-driven analysis with Bayesian method for risk management of financial services. *International Journal of Production Economics, 228*, 107737. https://doi.org/10.1016/j.ijpe.2020.107737.

Liu, L., Liu, S., & Chang, X. (2011). A study on framework of chemical industry supply chain risk management based on 3S and the internet of things. In *2nd AIMSEC* (pp. 4541–4543). https://doi.org/10.1109/AIMSEC.2011.6010451

Marrella, A., & Mecella, M. (2018). Cognitive business process management for adaptive cyber-physical processes. *Business Process Management Workshops, 132*, 429–445. https://doi.org/10.1007/978-3-319-74030-0.

Martínez-Rojas, M., Pardo-Ferreira, M. d. C., & Rubio-Romero, J. C. (2018). Twitter as a tool for the management and analysis of emergency situations: A systematic literature review. *International Journal of Information Management, 43*, 196–208. https://doi.org/10.1016/j.ijinfomgt.2018.07.008.

Miller, J. D., & Felton, D. (2017). The Fermi paradox, Bayes' rule, and existential risk. *Futures, 86*, 44–57. https://doi.org/10.1016/j.futures.2016.06.008.

Mishra, S., Modi, S. B., & Animesh, A. (2013). The relationship between information technology capability, inventory efficiency, and shareholder wealth: A firm-level empirical analysis. *Journal of Operations Management, 31*(6), 298–312. https://doi.org/10.1016/j.jom.2013.07.006.

Mostaghel, R. (2016). Innovation and technology for the elderly: Systematic literature review. *Journal of Business Research, 69*(11), 4896–4900. https://doi.org/10.1016/j.jbusres.2016.04.049.

Mosteanu, N. R. (2020). Artificial intelligence and cyber security – A shield against cyberattack as a risk business management tool – Case of European countries. *Quality, Access to Success, 21* (175), 148–156.

Müller, O., Fay, M., & vom Brocke, J. (2018). The effect of big data and analytics on firm performance: An econometric analysis considering industry characteristics. *Journal of Management Information Systems, 35*(2), 488–509. https://doi.org/10.1080/07421222.2018.1451955.

Munawar, H. S., Qayyum, S., & Ullah, F. (2020). Big data and its applications in smart real estate and the disaster management life cycle: A systematic analysis. *Big Data and Cognitive Computing, 4*(4), 1–53.

Oliva, F. L. (2016). A maturity model for enterprise risk management. *International Journal of Production Economics, 173*, 66–79. https://doi.org/10.1016/j.ijpe.2015.12.007.

Osuszek, L., & Ledzianowski, J. (2020). Decision support and risk management in business context. *Journal of Decision Systems, 00*(00), 1–12. https://doi.org/10.1080/12460125.2020.1780781.

Papakostas, N., Papachatzakis, P., Xanthakis, V., Mourtzis, D., & Chryssolouris, G. (2010). An approach to operational aircraft maintenance planning. *Decision Support Systems, 48*(4), 604–612. https://doi.org/10.1016/j.dss.2009.11.010.

Pitts, P. J. (2018). Artificial intelligence. *Journal of Commercial Biotechnology*, 2016. https://doi.org/10.5912/jcb766

PwC. (2020). *COVID-19: What risk functions can do right now*.

Sagiroglu, S., & Sinanc, D. (2015). Big data – A review. *IEEE, 10*(55), 1294–1298.

Sanford, A., & Moosa, I. (2015). Operational risk modelling and organizational learning in structured finance operations: A Bayesian network approach. *Journal of the Operational Research Society, 66*(1), 86–115. https://doi.org/10.1057/jors.2013.49.

Shan, M., Cai, C., & Ren, B. (2011). Research on the method of project configuration based on CBR. *2nd ICEMMS*, 482–485. https://doi.org/10.1109/ICEMMS.2011.6015724

Srivastava, U., & Gopalkrishnan, S. (2015). Impact of big data analytics on banking sector: Learning for Indian banks. *Procedia Computer Science, 50*, 643–652. https://doi.org/10.1016/j.procs.2015.04.098.

Sundhararajan, M., Gao, X. Z., & Vahdat Nejad, H. (2018). Artificial intelligent techniques and its applications. *Journal of Intelligent and Fuzzy Systems, 34*(2), 755–760. https://doi.org/10.3233/JIFS-169369.

Urbinati, A., Bogers, M., Chiesa, V., & Frattini, F. (2019). Creating and capturing value from big data: A multiple-case study analysis of provider companies. *Technovation, 84–85*(2018), 21–36. https://doi.org/10.1016/j.technovation.2018.07.004.

Vicente-Saez, R., & Martinez-Fuentes, C. (2018). Open Science now: A systematic literature review for an integrated definition. *Journal of Business Research, 88*, 428–436. https://doi.org/10.1016/j.jbusres.2017.12.043.

Vostrikov, A. V., Prokofeva, E. N., Goncharenko, S. N., & Gribanov, I. V. (2019). Analytical modeling for the modern mining industry. *Eurasian Mining, 2*, 30–35. https://doi.org/10.17580/em.2019.02.07.

Wamba, S. F., Akter, S., Edwards, A., Chopin, G., & Gnanzou, D. (2015). How 'big data' can make big impact: Findings from a systematic review and a longitudinal case study. *International Journal of Production Economics, 165*(2018), 234–246. https://doi.org/10.1016/j.ijpe.2014.12.031.

Wamba, S. F., & Mishra, D. (2017). Big data integration with business processes: A literature review. *Business Process Management Journal, 23*(3), 477–492. https://doi.org/10.1108/BPMJ-02-2017-0047.

Yan, J., & Liao, J. J. (2014). Incorporated intangible assets with a multiple-agent decision tree for financial crisis prediction. In *11th International Conference on Service Systems and Service Management, ICSSSM 2014 – Proceeding* (pp. 31–34). https://doi.org/10.1109/ICSSSM.2014.6874073.

Ethical Systems for Artificial Intelligence

Giovanni Vaia, Noor UL-Ain, Elisa Gritti, and Marco Bisogno

1 Introduction

Recent technological advancements have brought about rapid growth in Artificial Intelligence (AI) technology. AI is broad in nature and has been adopted by many different sectors such as manufacturing, health care, transport, communication, banking, commerce, etc. AI applications such as visual recognition, autonomous robots, autonomous vehicles, virtual assistants, predictive analysis, and interaction with the environment and humans are profoundly changing the reality in which we live.

AI technology is autonomous and able to operate without human assistance, and to learn and to identify patterns in order to make decisions. Such algorithmic decision-making has several advantages, but it has potential risks as well. For instance, in terms of advantages, the use of AI in the automobile industry permits the autopilot function for autonomous vehicles; while in commerce it enables tailoring of digital advertising. On the other hand, the Cambridge Analytica case turned the spotlight onto themes of privacy and ethical use of data arising from the firm's development of a system to target U.S. voters with personalized political advertisements in order to influence the outcome of elections (Greenfield, 2018) while Mann and O'Neil (2016) question the use of algorithms in employment decisions. The potential harm—intentional or unintentional—resulting from

G. Vaia (✉) · N. UL-Ain · E. Gritti
Università Ca' Foscari Venezia, Venice, Italy
e-mail: g.vaia@unive.it; noor.ulain@unive.it; elisa.gritti@unive.it

M. Bisogno
Università degli Studi di Salerno, Salerno, Italy
e-mail: mbisogno@unisa.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_10

algorithmic decision-making asks for clear ethical guidelines on which to base new regulations and legislation (Floridi, 2018).

AI computing power is made by algorithms and is therefore capable of creating its own rules, which might have an effect on the realities involved. Due to its power to change reality, it is crucial to structure a new, global, and complex debate on the ethical implications of AI, and embed regulatory paradigms of moral choices typical of a human society within the main three phases of AI: development, calculation, and output.

For some years now, various entities and expert groups across the globe have been working to develop ethical guidelines and moral systems to guide the design of AI and its impact on society. These initiatives have resulted in a growing number of AI principles and recommendations. The proliferation of guidelines from different entities highlights the prominence and complexity of the issue of ethics. However, the multiple approaches being used are causing a high degree of ambiguity and confusion. Therefore, it is important to have clear, structured ethical guidelines for the development, implementation, and use of AI.

Keeping this in mind, this chapter provides an overview and analysis of different ethical approaches emerging from the ethical declarations of different stakeholders—governmental, profit corporation, no-profit organization, and university or research centers—in order to draw up more structured guidelines and to provide future directions for both research and society.

2 A Review of Ethics Frameworks

To better understand the wide and fragmented frameworks of ethical guidelines for AI, 20 of the main documents were selected for an in-depth overview and comparison of the different approaches. The selection criteria followed a stakeholder approach view: governmental, profit corporation, no-profit organization, and university or research center.

For each stakeholder domain, the most impactful documents, as listed in Table 1, were selected according to the following criteria: relevance/size/reputation, impact in terms of dissemination; *and* transversality and numerosity participation of multiple entities in the construction of the guidelines.

2.1 Government Institutes

In 2018, *European Union (EU)* presented its first document on ethical principles promoting seven macro-principles that are part of a wider European plan to guide the development, technical, and cultural dissemination of AI, whereas the final document presented four ethical principles that are open and translated into concrete requirements.

Table 1 List of publications of ethical statements

Group	Stakeholder	Document	Country
Governmental institutions	European Group on Ethics in Science and New Technologies	Ethics Guidelines for Trustworthy AI	European Union
	Singapore National AI Strategy	Singapore AI Governance—Framework	Singapore
	AI Committee—UK House of Lords	AI in the UK: ready, willing and able?	UK
	Smart Dubai Office	Smart Dubai AI Ethics Principles and Guidelines	Emirates
	USA AI Task force	Guidance for Regulation of AI Applications	USA
Profit corporations	Google	AI at Google: our principles	USA
	Microsoft	Our approach to responsible AI	USA
	Telefonica	AI principles	Spain
	SAP	SAP's Guiding Principles for AI	Germany
	Partnership on AI	AI principles	International
University and research centers	Montreal University	The Montreal Declaration	Canada
	Future of Life Institute	Asilomar principles	USA
	AI4People—Oxford University (multistakeholder)	Ethical framework for a good AI society	UK
	The Royal Society	Machine learning, the power and promise of computers that learn by example	UK
	IEEE—Institute of Electrical and Electronics Engineers	Ethical Aligned Design principles	USA
No profit and international organizations	OECD	Principles on AI	International
	Vatican	Rome Call for AI ethics	Italy
	Amnesty International	The Toronto declaration	International
	UNESCO—COMEST	Report of COMEST on Robot Ethics	International
	The public voice, NGO	AI universal guideline	International

Singapore's Advisory Council on the Ethical Use of AI and Data developed a structured framework that includes research directions, governance, principles, and operational models. A first document, which is still in progress, was published in 2019.

The complex report drawn up by the House of Lords *Select Committee on A* and published in 2018 presents a comprehensive national strategic plan and offers guidelines for AI-based design, development, and work in the areas of healthcare and risk mitigation.

Smart Dubai, a government office, brings together a multi-stakeholder team of AI experts to apply knowledge in a concrete pilot project like the smart city of Dubai. Smart Dubai proposes four principles, divided into sub-principles.

Finally, *USA AI Task Force Guidance for Regulation of AI Applications* has published a document entitled AI for the American People and the US National Strategy on AI. The document is a "memorandum that provides guidance to all Federal agencies to inform the development of regulatory and nonregulatory approaches regarding technologies and industrial sectors that are empowered or enabled by AI and considers ways to reduce barriers to the development and adoption of AI technologies."

2.2 Profit Organization

Defining the fate of AI more than anyone else are the large companies designing widespread AI applications. Many companies have taken a stand by joining wider ethical bodies working on the subject in academic, governmental, commercial, or civil society spheres. A clear example of this is *Partnership on AI*, founded in 2017 by Google, DeepMind, Facebook, Amazon, Microsoft, and Apple.

Google, one of the most influential companies in the world, publicly communicated its commitment to AI ethics in June 2018 and reported seven objectives for AI applications as ethical principles and four AI applications that the company has chosen not to pursue.

Microsoft, in 2018, published a list of eight principles for an ethical approach to AI and guarantees its translation into day-to-day work through the AI, Ethics, and Effects in Engineering and Research (AETHER) Committee.

Telefónica S.A., one of the world's largest telecommunications companies, adopted the company's AI principles in October 2018. The company structured a three-pillar responsible approach toward the use of AI: employees' training on the social and environmental risks of AI; assessment on human right risks during the design phase; governance structure for risk-assessment in AI development.

SAP, a European multinational company for the production of management software and one of the leading companies in the world in the ERP sector, has appointed an advisory panel and ethics steering committee as a guarantee of its intention to ensure responsible AI. The company published an AI ethical principles list in 2018.

2.3 Universities and Research Centers

From the scientific entities, the first document on AI and ethics was called *Asilomar Principles*. Developed by the Boston-based Future of Life Institute (FLI), it provides 23 principles categorized into three areas: 5 items for research assumptions; 13 items for core ethics and values; and 5 items approaching long-term assumptions.

The Montreal Declaration for the Responsible Development of AI was developed by the University of Montreal in collaboration with the Fonds de recherche du

Québec in 2017. The document comprises 10 principles including privacy, autonomy, and prudence in the technical sphere, and equity, solidarity, and inclusion in the "humanistic" sphere.

AI4people is a committee of experts proposed to the European Parliament in February 2018 as the first multi-stakeholder forum bringing together all stakeholders interested in shaping the social impact of new AI applications. In 2020, it opened the way for the construction of common frameworks for the seven main sectors: automotive; banking and finance; energy; healthcare; insurance; legal services industry; media and technology.

The *Institute for Ethical AI and Machine Learning* is a UK-based research center that has developed eight ethical principles for machine learning applications and four steps for responsible implementation: empower individuals; empower leaders; empower industry sectors through industry standards; empower entire nations.

Finally, the second version of *Ethically Aligned Design* has advanced a public discussion on how we can establish ethical and social implementations for intelligent and autonomous systems and technologies, aligning them with defined values and ethical principles that prioritize human well-being in a given cultural context.

2.4 No-Profit and International Organizations

The *OECD Principles* on AI promote innovative and reliable AI respecting human rights and democratic values. The OECD's AI principles are the first such principles to be endorsed by governments. The OECD's AI principles complement existing OECD standards in areas such as privacy, digital security risk management, and responsible business conduct.

The *Vatican document on AI principles* considers the issue of advanced technology and AI. Since the 2010 Italian Episcopal Conference (IEC), the institution of the Catholic religion has included an internal line of thought about the relationship between religion and new technologies. On February 28, 2020, the document "Rome Call for AI Ethics" was signed in collaboration with the Pontifical Academy for Life, IBM, and Microsoft. The document promotes the term "algor-ethics" and argues that the power of technological change in society must necessarily be accompanied by a beneficial intention toward equality, equal rights, and social growth for all.

The human rights organization *Amnesty International* and digital rights group Access Now published a document in May 2018 to urgently protect human rights in the age of machine learning, AI, and advanced computing, with a focus on two main human rights; the right to equality and nondiscrimination, and the promotion of diversity and inclusion, which are explained through other specifications such as risk mitigation, transparency, and accountability.

In 2017, *UNESCO*'s world commission on Ethics of Scientific Knowledge and Technology (COMEST) published a report on robot ethics, demonstrating an interest in the AI system as the basis of robot interaction with humans and its ethical implications.

Finally, in 2018, *The Public Voice*, an international NGO promoting public participation and bringing together civil society leaders and international organizations like the ICDPPC, the OECD, and UNESCO, published a document proposing 12 principles intended to maximize the benefits of AI, to minimize risk, and to ensure the protection of human rights.

3 Analysis and Discussion

This section presents our analysis of the most important statements and expressions about the ethics of AI presented in 20 official documents from the main stakeholders. This analysis will help to develop considerations on the convergences and divergences found through the plurality of points of view.

Our analysis revealed a certain degree of fragmentation and confusion of such expressions. However, when analyzed in comparative mode, we sense the presence of a common direction, which is immediately replaced by a feeling of ambiguity, fragmentation, and lack of clarity.

Access to a unique reference for the ethical approach could be helpful in producing the practical guidance and regulations that each organization or government urgently needs to set up. Considering this, we undertook a thematic analysis of all the guidelines and traced high-level coding points to understand the different approaches used by the organizations to define their ethical principles.

The final step of our analysis consists of the proposal of an integrated list of principles from the most important documents available at the moment. As a result, we found five common themes (technology, security, human, ethics, and benefits) in all of the ethical principles documents. Using these common themes, following AI ethical approaches, we proposed AI-Tech, AI-security, AL-human centric, AI-ethical, and AI-benefits (also shown in Table 2).

1. AI-Tech Approach

The first approach, named *AI-Tech approach*, is used by 15 documents out of 20. Within the AI-Tech approach, the analysis found several similar principles pertaining to the issue of explainability, which is the ability to explain the logic of decisions, characterize the strengths and weaknesses of the decision-making process, and provide indications of their future behavior. The EU and AI4People documents and Smart Dubai project consider that AI must be “transparent and explainable”; the Royal Society publication and the Microsoft declaration have used three characteristics: understandable, interpretable, explainable.

On the other hand, privacy is an important architectural element inherent to AI systems due to the huge amounts of personal data. AI lives on data and information regarding our private lives, which comes from digital systems. Most of today’s daily activities create data that can be collected and analyzed by AI. For this reason, privacy is strictly related to AI as a pure technology approach and we found one

Table 2 Coding of ethical principles of AI

	1. AI-Tech approach (AI as pure technology)	2. AI-Human centric approach (AI as Human extension)	3. AI-security approach	4. AI-Ethical approach (AI as Humans)	5. AI-benefit approach
UE	Explicability	Respect for human autonomy, fairness	Prevention of harm	x	x
Singapore	Explainable, transparent	Human-centric, fair	Safety	x	x
UK	Intelligibility	Education, destroy or deceive humans	Data rights, avoid the power to hurt	x	Common good and benefit of humanity
Smart Dubai	Transparency, Explainability, intelligence, privacy	Fairness, freedom and dignity	Safe, secure and controllable, hurt, destroy or deceive,	Human values, accountability	Beneficial to society, inclusiveness
USA	Understandable Transparent. Accurate, reliable, and effective	Fairness	Safe, secure, and resilient Regularly monitored.	Accountable Responsible and traceable Lawful and respectful of our Nation's values	Purposeful and performance-driven
Google	Avoid creating or reinforcing unfair bias. Availability	x	Be built and tested for safety	Accountability (Be accountable to people)	Be socially beneficial
Microsoft	Reliability, privacy	Fairness	Safety, security	x	x
Telefonica	x	x	x	Human rights, responsibility	x
SAP	Quality, privacy	Human centric (We design for people)	Safety	Transparency and integrity, driven by values (We are driven by our values), less biasness (We enable business beyond bias), data protection	x
Partnership on AI	Understandable, interpret-able, explainable	Educate people and engage stakeholders	x	Accountable	Benefit and empower many people, maximize the benefits

(continued)

Table 2 (continued)

	1. AI-Tech approach (AI as pure technology)	2. AI-Human centric approach (AI as Human extension)	3. AI-security approach	4. AI-Ethical approach (AI as Humans)	5. AI-benefit approach
					and address the potential challenges of AI technologies, create culture of cooperation, trust, and openness to help us all better achieve goals
Montreal Declaration	x	Respect for autonomy	x	Well-being, solidarity, protection of privacy and intimacy, responsibility, equity, diversity inclusion	Sustainable development
Asilomar principles	Privacy	Personal privacy	Safety Human control Arms race	Failure/judicial transparency, responsibility, value alignment, human values, non-subversion	Shared benefit, shared prosperity
AI4People	Autonomy, capability caution, explicability, privacy	Preserving dignity, liberty, human control	Security	Well-being, preserving solidarity	Sustaining the planet, promoting prosperity
The Royal Society	Interpretability, verification and robustness, explicability, full analytics pipeline, privacy	Effective human–machine interaction	Safe, security and control, sensitive data	Transparency	x
IEEE ethical aligned design	x	x	x	Transparency, human-rights, accountability	x
OECD	Robust	x	Secure and safe	Well-being, transparency, human rights, responsible disclosure, democratic values and diversity, rule of law	Inclusive growth, sustainable development

Rome call for AI ethics (Vatican)	Reliability, privacy	x	x	Transparency, responsibility, impartiality, inclusion	x
The Toronto declaration amnesty international	x	Human rights Due diligence The right to an effective remedy	Identify risks	Right to equality and nondiscrimination, Preventing discrimination, Promoting diversity and inclusion Ensure transparency and accountability, enforce oversight, promoting equality	x
UNESCO—COMEST	x	Value of autonomy, value of privacy, do not harm, human dignity	x	Principle of responsibility, value of beneficence, value of justice	x
The public voice	Accuracy, reliability, validity, and replicability	Fairness obligation, right to transparency, right to human determination	x	Accountability obligation	x

unique declination for it within six ethical declarations: Smart Dubai, Microsoft, SAP, Asilomar principles, AI4People, and the Royal Society.

In fact, the coding of this section of ethical principles represents different declinations and nuances of an important ethical need: explicability, explainability, intelligibility, reliability, understandability, transparency, interpretability, robustness, and privacy. For all these reasons, AI as pure technology is a domain that still needs to be fully explained. To address this need, massive educational programs on AI systems are required. Companies must define a plan for AI by establishing an ethical framework and creating a common language to manage trust, to ensure data integrity among all stakeholders, and to guarantee that AI-based decisions are reliable and explainable.

2. AI-Security Approach

The second *AI-security approach* is documented by 12 out of the 20 documents analyzed. The analysis revealed that AI-security captures concepts such as “Safety,” “Safe secure,” “Be built and tested for safety,” etc.

Safety and security are perceived as very important issues in many documents on AI ethics. Fortunately, in reality, there are a limited number of fields of application in which current AI can be physically harmful to humans.

Security of AI mainly concerns systems security resulting from voluntary external attacks on systems or involuntary accidents, for example, caused by robots. The security topic is extremely vast but not yet defined in its entire complexity.

Safety and security are related concepts concerning different domains. Within the analysis conducted, we found that the Singapore publication, SAP, Google, and Asilomar principles only approach the topic through a “safety” approach. AI4People mentioned “security,” while Smart Dubai, the USA declaration, Microsoft, the Royal Society, and the OECD mentioned both “safety and security.” EU documents included within the principle “prevention of harm” the many domains touched upon in terms of security and safety.

3. AI-Human Centric Approach

The *AI-Human centric approach* where AI is perceived as a human extension is reported by 15 documents out of 20. According to our analysis, respect for autonomy, fairness, human-centric, freedom and dignity, human control, etc. are some of the declinations of AI as a human extension.

The principle of *autonomy*, highlighted by the EU, implies the “freedom of the human being, and control over and knowledge about ‘autonomous’ systems.” The Montreal Declaration further clarifies, “AIS must be developed and used with the goal of increasing people’s control over their lives and their surroundings.” “Autonomy” is also a principle promoted by UNESCO-Comest, Smart Dubai, and AI4people.

Another potential risk produced by AI as a human extension is a possibility of replicating the unfair bias distinguishing many humans. AI can create unfair bias only because humans are unfair and, as a human extension, AI cannot avoid reproducing this aspect. For this reason, fairness is not only an ethical principle to be applied to AI but a concrete technical aspect within the approach of AI as a human extension. Fairness is expressed within the documents published by: EU, Singapore, Smart Dubai, USA, and Microsoft.

4. AI: Ethical Approach

AI-Ethical approach (AI as Humans) is related to the previous one but placed on a different level. AI as humans is focused on the creation of shared values and the responsibility of AI as if it were a human.

AI-ethical approach was found in 16 out of 20 documents in the form of human rights and values, accountability, protection of privacy and intimacy, failure/Judicial transparency, right to equality and nondiscrimination, etc.

"Human values" is a very general category, difficult to define but open to all humanity. An interesting and more specific interpretation of the more general "values" was represented by *human rights*. The Smart Dubai document specified "we will give AI systems human values".

Accountability, indicated by partnership on AI and Google, is an important aspect defined as the acknowledgment and assumption of responsibility for actions, and the possibility of sharing responsibility for the potential risks or impacts that AI addresses. Accountability is strictly related to the meaning of "transparent" or "transparency" mentioned as a characteristic in the publications of SAP, Asilomar, the Royal Society, and IEEE Aligned Design.

The principle of *responsibility*, also coded in the AI ethical approach, is very general. The Montreal Declaration mentions that "the development and use of AIS should not contribute to diminishing the responsibility of human beings when making decisions." Responsibility was also highlighted by the European document.

5. AI: Benefit Approach

Finally, the last category, which regards the *AI-benefit approach,* is included in 8 out of the 20 documents. Often presented as the first-placed principles defining the main goal of every AI system, they include: common good and benefit of humanity; being socially beneficial, empowerment, common good and benefit of humanity, sustainable development, etc.

In the Google statement, the first principle is represented as: "*Be socially beneficial.*" Advances in AI will have transformative impacts in a wide range of fields including healthcare, transportation, manufacturing, and entertainment. In the AI ethical code developed by the UK government, the first principle is related to the "common good and benefit of humanity." A further interpretation of the positive impacts of AI systems is related to the concept of *sustainable* development, mentioned by OECD and the Montreal Declaration. One of the main trends in AI systems today involves their application in "smart" ecosystems such as the "smart city" and "smart mobility" etc. strictly related to social and environmental benefits such as reduction of waste, pollution, and energy consumption.

3.1 Proposed AI Ethical Principles

To provide a common frame of reference, we presented the main AI ethical characteristics under the five proposed AI approaches. Table 3 presents the main aspects with the aim of removing repetitions, nuances, and ambiguities when comparing the guidelines.

The analysis reveals that ethical principles related to *AI as pure technology* may consider aspects such as explainability, transparency, privacy, availability, reliability, quality, flexibility, and accuracy (Table 3). These characteristics allow the ethical aspects of the technological architecture of AI to be fully covered.

AI as human-centric approach relates to individual freedom, respect for human autonomy, fairness, and effective human–machine interaction. Autonomy is the full expression of the "human-in-the-loop" as a guideline to develop an ethical AI completely at the service of human beings, both in terms of inputs, calculation methods and outputs to be produced and its impact on human society. Fairness is also a transversal and central issue within the AI ethical approach. In addition, appropriate education on AI technology is also required.

AI-security approach represents aspects such as security, safety, control, prevention from harm, risk identification, and management. The EU definition of "prevention of harm" could be the best solution in order to remove ambiguities and to bring greater breadth but also clarity to this ethical issue. The concept englobes the "safety" and "security" dimensions essential for a complete understanding. Control and risk identification and management represent the full possibility of defining

Table 3 Proposed AI ethical principles

1. AI-Tech approach (AI as pure technology)	2. AI-Human centric approach (AI as Human extension)	3. AI-security approach	4. AI-Ethical approach (AI as Humans)	5. AI-benefit approach
Explainability	Individual's freedom	Harm prevention	Human values and human rights	Common good and benefit of humanity
Transparency	Respect for human autonomy	Safety	Accountability	Sustainable development
Privacy	Fairness	Security	Responsibility	Inclusive growth
Availability	Effective human–machine interaction	Control	Equality	Human empowerment
Reliability	Education	Risks identification and management	Well-being	Cooperative culture
Quality	–	–	–	–
Flexibility	–	–	–	–
Accuracy	–	–	–	–

areas of potential negative impacts of AI and of ensuring their control and avoidance through operational guidelines.

AI-ethical approach may consider human values and human rights, accountability, responsibility, equality, and well-being. Ethically Aligned Design proposes a clear and comprehensive specification of the need for AI development to guarantee the respect of human rights. Accountability and responsibility are also ethical expressions provided by many entities in response to the important need to provide rules and specifications on how to make information about AI applications transparent, available and shared among all stakeholders involved.

Finally, *AI-benefit approach* captures the beneficial aspects of AI such as sustainable development and growth, cooperative culture, and human empowerment as shown in Table 3. This final approach aims to better define the ultimate goal of the development, application, and dissemination of AI in contemporary society.

The ethical approach to AI is very complex, as demonstrated by the number of entities and experts committed to drawing up valid guidelines. We believe that the five approaches to AI ethics proposed can provide a complete vision of AI technical characteristics, its role within human society, and its potential negative impacts and positive purposes. This framework, completed through the high-density principles could represent a clear and disambiguous guideline for a transversal understanding of the ethics of AI and future development.

4 Conclusions

Many initiatives have been implemented by various stakeholders with the aim of understanding the ethical aspects of AI. We have taken a further step forward to achieve the quality and internationalization of ethical guidelines, unifying the plurality of reflections in a system that is comprehensive, clear, and detailed. This chapter has looked carefully at different ethical approaches and at ethical declarations developed by different stakeholders; government institutes, profit corporations, no-profit organizations, and universities or research centers. An analysis was carried out in order to draw up more structured guidelines and to provide future directions both for research and society.

In concrete terms, our observation showed that some of the proposed principles reach a high degree of specificity, while others are kept at a very generic level. In addition, some principles are grouped together, touching on very different issues, while some principles with similar analytical levels are separated. For example, the OECD reports as one unique principle the "rule of law, human rights, democratic values and diversity," while the Montreal Declaration divides "Democratic participation," "Equity," "Diversity," and "Inclusion." A similar approach is related to the AI ethical item "Human Rights" through which we could expect wide support for all 30 articles of the Universal Declaration of Human Rights. However, many documents report items such as "Human rights"; "Human Values"; "Benefit for Humanity," later adding more specific expressions or subcategories of human rights, but separating them as if they were something else, for example: "Human dignity," "Justice," "Equity"; "Fairness." This lack of alignment in the analytical plan of the proposal results in a perception of lack of clarity: are the organizations proposing a high level of abstraction principles? In this case, each principle would need a consistent subdivision or content explanation. Are the organizations proposing principles at a specific operational level instead? In this case, a greater delineation of the abstract categories of reference would be needed. In other words, a clear subdivision of the levels from the generic to the particular and from the particular to the generic would benefit the linearity of the reader's understanding and, above all, of those who will have to apply these principles in practice. Therefore, this chapter provides a common frame of reference for future studies by aggregating all the main AI ethical characteristics under the five proposed AI approaches.

References

Greenfield, P. (2018). The Cambridge Analytica files: The story so far. *The Guardian*. https://www.theguardian.com/news/2018/mar/26/the-cambridge-analytica-files-the-story-so-far

Floridi, L. (2018). Soft ethics, the governance of the digital and the general data protection regulation. *Philosophical Transactions of the Royal Society A, 376*, 20180081.

Mann, G., & O'Neil, C. (2016). Hiring algorithms are not neutral. *Harvard Business Review*. https://hbr.org/2016/12/hiring-algorithms-are-not-neutral

AI ethical Documents

AI4People. (2018). *Ethical framework for a good AI society: Opportunities, risks, principles and recommendations*.

Amnesty International. (2018). *The Toronto Declaration: Protecting the right to equality and non-discrimination in machine learning systems*.

The House of Lords Artificial Intelligence Select Committee. (2018). *Report on AI in the UK: Ready, willing and able?*

Comest, Unesco. (2018). *Preliminary report on the first draft of the recommendation on the ethics of artificial intelligence*.

European Commission. (2018). *European group on ethics in science and new technologies: Statement on artificial intelligence, robotics and 'autonomous' systems*.

European Commission. (2019) *High-level expert group on artificial intelligence, ethics guidelines for a trustworthy AI.*

Future of Life Institute. (2017). Asilomar principles.

Google; Sundar Pichai, CEO, Published Jun 7, 2018.

Microsoft, Responsible AI principles from Microsoft, Jan 2018.

Montreal Declaration. (2017). Université de Montréal & Fonds de recherche du Québec.

OECD – Council Recommendation on Artificial Intelligence.

US Office of Science and Technology. (2020) *Promoting the use of trustworthy artificial intelligence in government*. www.whitehouse.archives.gov

Pontificia Accademia per la Vita, Ibm e Microsoft. (2020). Rome Call for AI Ethics.

SAP, multinazionale europea per la produzione di software gestionale e una delle principali aziende al mondo nel settore degli ERP e in generale nelle soluzioni informatiche per le imprese.
Singapore's Artificial Intelligence Governance Framework. (2019). Infocomm Media development, Advisory Council on the Ethical Use of AI and Data – Singapore.
Smart Dubai. (2019). *AI ethics principles & guidelines*.
Task force Guidance for Regulation of Artificial Intelligence Applications US' national strategy – Guidance for Regulation of Artificial Intelligence Applications.
Telefónica, S. A. (2018). *AI principles of telefónica*.
The IEEE Global initiative on ethics of autonomous and intelligent systems, ethically aligned design: A vision for prioritizing human well-being with autonomous and intelligent systems.
The Institute for Ethical AI & Machine Learning, 8 machine learning principles of responsible AI.
The partnership on AI – Tenets.
The public voice, 2018 Universal Guidelines for Artificial Intelligence.
The Royal Society, 2017 Machine learning: the power and promise of computers that learn by example.
University of Oxford – Digital Ethics Lab, 2017, AI4People Proposal.
McKinsey, nota società di consulenza aziendale pubblica "Leading your organization to responsible AI", May 2019.

Blockchain

Laura Rocca, Monica Veneziani, Claudio Teodori, and Mariia Kopylova

1 Introduction

There is a huge amount of interest around blockchain technology with a lot of enthusiasm and skepticism; nowadays "blockchain" is an inflated term but there is little research, as far as we know, on the "real" impact of this technology on management systems. Blockchain is sometimes considered to be far away from practical diffusion; however, this chapter examines the implementation of technology innovation in a case study.

The intent of this chapter, in fact, is to try to understand blockchain's perspectives of development, its driver and barriers throughout a business case examining an efficient way of blockchain application beyond cryptocurrencies (in the fields of business and finance).

The case study methodology is applied to examine the practical changes that managers have to face in order to implement blockchain technology in everyday business as the changes needed from material-document flows to digital flows, the integration of different technology systems (with both suppliers-clients) that require time and further investments, the performance of existing systems used by businesses that are not able to operate at high speeds and behavioral issues of a transparent interaction environment and online-control of all of the processes; that is possible because the case study examined is a fully implemented blockchain solution in a large corporate business with an integrated financial sector.

As little is known about blockchain assimilation, the qualitative approach was chosen as an appropriate method of studying this phenomenon.

L. Rocca (✉) · M. Veneziani · C. Teodori · M. Kopylova
Department of Economics and Management, University of Brescia, Brescia, Italy
e-mail: laura.rocca@unibs.it; monica.veneziani@unibs.it; claudio.teodori@unibs.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_11

The empirical investigation is based on semi-structured interviews with key managers, collecting data from their organization's documents and website.[1]

Due to the specific features of the blockchain technology, it can be perfectly used in the case of a transaction-based shared system with multiple parties that want to ensure trust when generating transactions that cannot be then modified or deleted.

The crucial point of understanding the technology and its perspectives of development is underlining the difference between core types of blockchains or distributed ledgers: they can be permissionless (or public) and permissioned. Public blockchains are those involving cryptocurrencies, while permissioned can be either consortium or fully private. In order to streamline business processes efficiently, the companies that start implementing the technology tend to choose permissioned blockchains that become the key to enterprise blockchain solutions in business and finance as it is a closed ecosystem and can be controlled by a limited number of known participants of the network. This type of a blockchain can be used, for example, by institutions and companies that have to manage supply chains with a series of stakeholders, companies that have to manage suppliers and subcontractors, retail operators, banks, and others. In this case, a permissioned blockchain allows authorized participants of the network to update it in an independent and secure way so that all the other participants have an updated version of the ledger. Companies can define special rules for access and visibility of the data. This allows the protection of highly confidential and sensitive information in the business environment, ensuring high transaction speed as well. Moreover, permissioned blockchain solutions resolve the problem of transaction speed and do not require payment for transactions, while public blockchain transactions do cost, especially when higher speed is required.

So, the key features and structure of the blockchain allow it to be used for different kinds of value transactions. Currently, there is an explosive growth of blockchain applications in industries such as finance, health care, supply chain, insurance, government, and many others, with the banking and finance industry playing a leading role.

It is important to underline, though, that there has been a huge amount of hype surrounding the technology in the past years, so it becomes crucial to make the right choices distinguishing the real benefits and potential of the technology from hype and not consume resources in pointless experimentation and unsustainable solutions. Binding to the technology without analyzing the associated risks that include costs, security, and industry's regulation, can be really harmful. Blockchain is not a guarantee to obtaining specific benefits, a match is required between these specific purposes and accurate use cases to realize this scope.

[1]The organizations involved provide slides and schemes of the case study (translated from Russian into English by one of the authors).

Authors collected public documents from companies' press releases and articles from web sites about blockchain in the aviation sector (Accenture and BCG releases).

2 Drivers and Barriers of Blockchain: A Literature Review

A recent systematic review (Frizzo-Barker et al., 2020) describes the features of academic studies on blockchain technology in business literature. First of all, research on blockchain in business is still at an early stage as the publishing trend started to relevantly only from 2018. Blockchain literature is still in a nascent phase also in the auditing domain and in accounting journals (Lombardi et al., 2021).

Nevertheless, Frizzo-Barker et al. (2020) analyzed the extant literature of blockchain technology in business identifying some key features described below.

The geographic provenance of the authors of those papers is mostly from the USA (around 30%), then the UK, China, and Germany. Some characteristics of these papers are that the majority are conceptual one, with exploratory methods (63%) followed by theoretical frameworks (14%) and case studies (12%). Going deeply, these blockchain papers *"explored blockchain through the lenses of business ethics (Dierksmeier & Seele,* 2016*), innovation (Nowiński & Kozma,* 2017*) and capitalism and economics (Davidson et al.,* 2018*; Kniepert & Fintineru,* 2018*)"* (Frizzo-Barker et al., 2020, p. 6). That analysis covers the area of banking and finance, business, law, and ethical and social concerns. The content of the studies on blockchain in business mostly focused on the definition of blockchain, others focused on cryptocurrency but only 2% discussed the benefits of the technology. Frizzo-Barker et al. (2020) identify the most relevant benefits in the "*trust-free, transparent nature which eliminates the need for intermediaries*" (p. 9), then the security of the decentralized structure, finally efficiency and low transactional costs from a financial perspective.

In that review, there are no effective differences between a private and public blockchain or permissioned or permissionless blockchain. From a corporate viewpoint, Frizzo-Barker et al. (2020) illustrate the challenges and barriers of blockchain. The most common challenges are "*transparency and distributed form of governance*" that need standards and regulation. Moreover, interoperability is "*key to the widespread adoption of blockchain*" (p. 11). The barriers of blockchain diffusion are, instead, education, communication, technical issues to be solved, business models to be changed, and also the risks of fraud and crime behind the anonymity of protocols.

Moving from that systematic review a recent research discussed drivers and barriers of blockchain focusing on the differences between permissioned and permissionless blockchain (Helliar et al., 2020). That division is due to fact that these two different types of blockchain have different levels of diffusion over time (2007–2019).

According to Helliar et al. (2020), there are several drivers and barriers of blockchain in literature depending on the typology of innovation (permissionless and permissioned) and time (2016–2019). For example, a barrier for permissionless blockchain in an early stage of diffusion could become a driver for permissioned blockchain in a different time of development.

From a permissionless point of view the most common drivers are:

- Anonymity
- Disintermediation
- Trustworthy
- Self-interest

Otherwise, for permissioned blockchain the relevant drivers are:

- Governance (how blockchain could be governed and structured)
- Security
- Efficiency, low transactional costs, reduced lead time
- Provenance and smart contracts
- Transparency
- Trustworthy
- Industry 4.0, AI, machine learning
- Self-interest

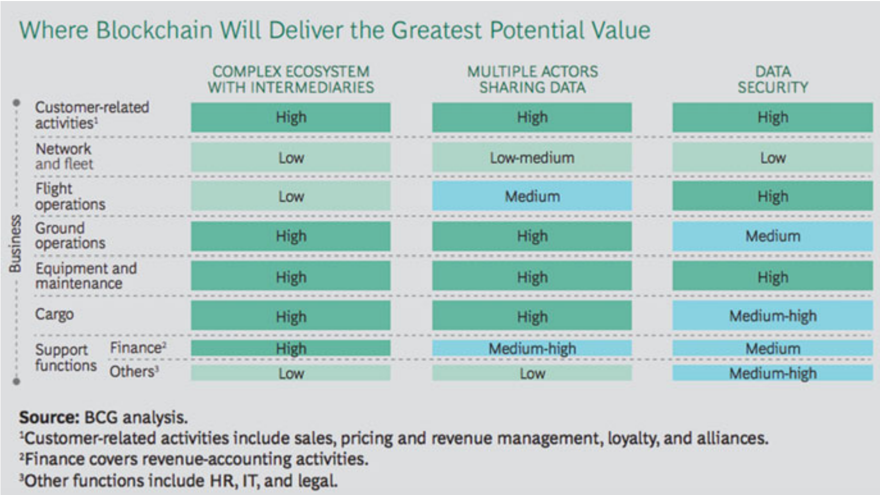
On the other side of the coin, there are also some barriers to blockchain diffusion as power capacity, governance, and legal framework for a permissionless landscape while in a permissioned focus the barriers could be compatibility and interoperability in different systems or lacking awareness and participants. As said in the introduction, businesses are likely to use permissioned blockchain since it can be easily managed and governed but two important barriers emerged from these kinds of applications: off-chain and proprietary information which are outside the blockchain and only known by an organization (Helliar et al., 2020). In other words, these relevant barriers are linked to data that are verified outside the blockchain and then put on it. So, the problem of misleading information is still there with permissioned blockchain. For example, a company certified the provenance of a component outside the blockchain (i.e., with an auditing company) and then put this data on the blockchain; thus, blockchain provides data verified and communicated - that are immutable and secure - but we do not know anything about the process of verifying outside the blockchain.

This framework of drivers and barriers is applied to a business case study to understand which main challenges blockchain will have to face with widespread diffusion in the economic system, from an empirical point of view.

3 A Case Study: Blockchain in Airlines

The case study is focused on a pilot project in the airlines system.

First of all, the potential of blockchain for airlines is discussed by Accenture in a recent report (Accenture, 2019) that states “the characteristics of the airline industry—and also the broader travel industry—align very well with the capabilities of the blockchain.”



Where Blockchain Will Deliver the Greatest Potential Value

Business		Complex ecosystem with intermediaries	Multiple actors sharing data	Data security
Customer-related activities[1]		High	High	High
Network and fleet		Low	Low-medium	Low
Flight operations		Low	Medium	High
Ground operations		High	High	Medium
Equipment and maintenance		High	High	High
Cargo		High	High	Medium-high
Support functions	Finance[2]	High	Medium-high	Medium
Support functions	Others[3]	Low	Low	Medium-high

Source: BCG analysis.
[1]Customer-related activities include sales, pricing and revenue management, loyalty, and alliances.
[2]Finance covers revenue-accounting activities.
[3]Other functions include HR, IT, and legal.

Fig. 1 BCG analysis (2019). Source: Bouffault et al. (2019)

The analysis reveals that blockchain technology could be useful for different operations in that sector, especially for ticketing, loyalty, security, identity, and maintenance.

About ticketing, an “e-ticket is, in essence, a database entry—information that would have been printed on a paper ticket dematerialized, stored in and called up from a massive database. The blockchain can tokenize this asset and further dematerialize it” (Accenture, 2019).

About loyalty, “in traditional loyalty points schemes, travelers often have to wait until points settle and accrue to use them, and they are limited on where they can spend them. By tokenizing loyalty points on the blockchain, travelers can get instant value by redeeming them on the spot” (Accenture, 2019).

About security and identity, the role of data privacy of passengers is important and blockchain could be a really secure line of information change.

About maintenance, blockchain technology “can offer a ‘virtual copy’ immutable record of the provenance of every part on the plane, every time it has been handled and by whom, from the beginning of the aircraft’s existence” (Accenture, 2019). This could be really helpful for the safety and security of the airplane and could lead to identifying each crash and responsibility.

The Boston Consulting Group analysis on the same sector (aviation) reveals the same findings of Accenture regarding the businesses where blockchain could have a greater potential (Fig. 1): sales, pricing, revenue management, loyalty, equipment, and maintenance (Bouffault et al., 2019).

Thus, in the airlines system blockchain technology could have a powerful impact, but what are the main challenges managers and companies have to face to put into practice this technology? The case study presented in this chapter tries to synthesize these efforts.

The case study regards two major Russian companies—S7 Airlines (one of the leading airline companies in Russia) and Alfa-Bank (the largest Russian private bank) and explains the application of this technology in business and finance. S7 Airlines[2] has become the first partner of the bank in blockchain-based technologies implementation in large corporate businesses. The companies started studying blockchain technology as a full-time business solution a few years ago and have successfully completed the first pilot project of a service payment execution through a letter of credit in December 2016. In 2019, there are two projects implemented as business processes on a Distributed Ledger platform, including Agent's case and Fuel case.[3]

This Agent's case is operating since 2017, it consists of selling airline tickets on blockchain to independent travel agents. As a rule, all over the world, such agents are small businesses, which creates a lot of payment risk for airline companies. Thus, the latter request deposits or bank guarantees that are not affordable for private agents.

The blockchain platform reduces risks of nonpayment, resolving the trust issue between the airline and the agents, and accelerates all business processes.

So how does it work? In a few words, when an agent makes a request to order a ticket, this request is registered on a Hyperledger blockchain platform with immediate confirmation of the sufficiency of funds on the agent's account using the bank's data. As soon as the confirmation is provided, the ticket is issued and the money is transferred automatically. In detail, the main steps of the process based on the blockchain platform are shown in the figure below (Fig. 2) and are the following[4]:

1. The Agent requests to purchase an airline ticket from S7 Airlines; ticket request data (amount, ticket number, etc.) is registered on the Hyperledger Fabric blockchain platform.
2. HLF (Hyperledger Fabric) refers to Alfa-Bank's system requesting if there is sufficiency of funds on the Agent's current account (to buy this particular ticket—the total balance of the account is not needed and remains unknown).
3. Alfa-Bank confirms the sufficiency of funds; the sufficiency of funds is received by the S7's system.
4. In case of sufficiency of funds on the Agent's account, S7 confirms that it is ready to issue the ticket and starts the process; when the ticket is issued, the information is recorded on HLF.
5. Smart contract refers to Alfa-Bank's system to perform money transfer from the Agent's account to S7's account; the result of the transaction is recorded on HLF.

[2]S7 Airlines is the brand of Siberia airlines. Siberia airlines, founded in 1957, is originated from the Tolmachevo United Air Unit and it has been using the brand name S7 for its flights since 2005.

[3]In this chapter only the Agent's case is studied.

[4]Information provided by Alfa-Bank and translated from Russian into English by one of the authors.

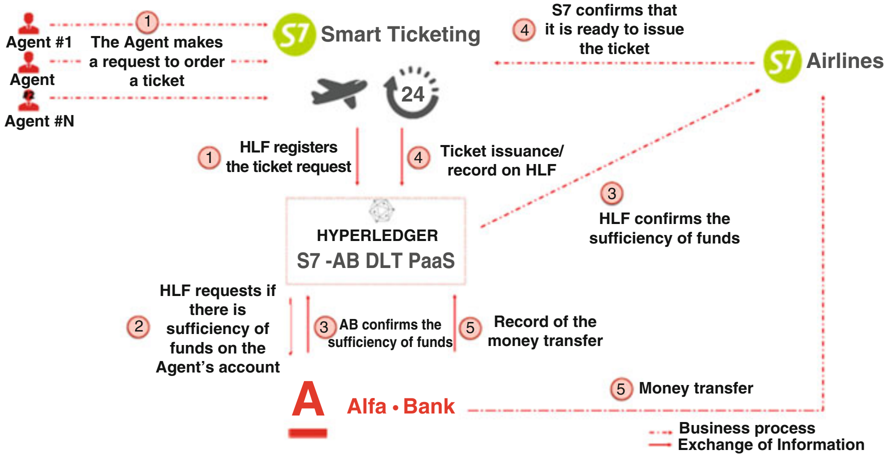


Fig. 2 Agent's project flow of information. Source: scheme provided by Alfa-Bank and translated from Russian

This process allows reduction of the risks for S7 Airlines: the only risk is that some modification happens to the Agent's account in this very short period of time between sufficiency of funds check, ticket issuance, and money transfer (normally the settlement requires less than a minute)—and in this case, the company's loss is one ticket only.

The practical impacts of this project are the speed of settlements that increases from 14 days to 23 s, the airline receives the payments immediately and the agents do not have to provide any financial guarantees. Moreover, there are opportunities for significant optimization of business processes both for the airline and its partners; as for the agents, this technology gives them the ability to work directly with the airline without providing additional financial guarantees (which are used in the traditional settlement scheme to reduce risks of nonpayment), and there is a reduction in the volume of circulating documents.[5]

It is important to point out that this B2B blockchain platform is already integrated with workflow systems and banks for payments execution (the Agent signs a special contract/agreement with their bank confirming that payments can be executed according to the described process). As for regulatory issues, the legal framework for implementing the platform is ready and in full compliance with the legislation (of the Russian Federation and other countries). There is no cryptocurrency on the platform (all the transactions are performed in rubles/euro), so there are not any legal issues.

In the Agent's case, the blockchain platform captures events such as orders, requests, and other data that trigger a series of further transactions: delivery or payment through smart contracts, automating trading operations.

[5]Source: S7 Airlines press release (28.07.2017).

The B2B DLT (Distributed Ledger Technology) platform Alfa-Bank_S7 is based on a Hyperledger Fabric (HLF) blockchain platform and has a number of purposes and advantages.

Initially, most of the projects were based on Ethereum protocol, as it is a simpler technology (in its public version) and is perfect for pilot projects. However, it was then changed to a Hyperledger Fabric blockchain platform for a series of reasons:

1. Transparency and impossibility to use public blockchain: when dealing with confidential information and choosing private/permissioned blockchain solution, it is necessary to build a security mechanism on top of Ethereum and that makes the technology much more complex—Hyperledger in this case might have an advantage as it is a better enterprise solution.
2. Data isolation through channels: Hyperledger platform creates so-called “channels” that provide the possibility to isolate data of different participants from each other, so that the data is seen only by authorized users of the network (even if all of them use the same platform)—this is a very important feature of the platform.
3. Transaction costs: private blockchains do not require payment for transactions.

Practical results and experience revealed by the companies’ managers during the interviews[6] have confirmed a series of observations regarding blockchain technology, its main advantages as well as specific practical barriers and limiting factors connected with it (which will be reported as follows). Moreover, the strategical importance and relevance of the technology for the companies has been confirmed.

The features of the blockchain technology that emerges in the project are:

- Smart contracts: a system of flexible smart contracts through which all processes are recorded: payments, financing, delivery, insurance.
- Immutability: data is recorded and stored in a distributed network—the data cannot be falsified or modified without the consent of each participant of the process.

[6]The Managers interviewed are the Head of Center for Innovations Research & Development in Alfa-Bank (Moscow, Russia) and the CEO of S7 TechLab. Interviews were recorded in November 2018 (interview with S7 CEO LabTech is recorded in English, interview in Alfa-Bank is translated from Russian), typed up and translated.

Interview questions:

1. In your opinion, which are the best and most promising business cases for blockchain technology/DLT and why?
2. Do you have practical experience of this technology implementation in business and which are the results?
3. Which are the most significant advantages of the technology?
4. Risks/challenges/barriers?
5. How much blockchain technology is relevant/strategically important for your organization and why?
6. Thinking of blockchain technology, which is a scale of investment by your organization?
7. Do you think blockchain (beyond cryptocurrencies) is overhyped?

- Financial service: built-in payment service allows to perform transactions and payment between the parties automatically as a result of the smart contract execution.
- Online 24/7/365: the system works online without human intervention, including settlements with counterparties.

Thus, the advantages of the blockchain system are:

- Acceleration of document flow (of information exchange)
- Reduced operational costs
- Reduced transaction costs in logistics
- Peer-to-peer information exchange on orders, payments, and shipments
- Credit mechanism for procurement financing

The practical experience from this case study has confirmed that blockchain solution is valid and can be successfully implemented within enterprises increasing efficiency and trust between participants in a permissioned version. However, managers in this case study underline that it is crucial to get a better understanding of the technology (interviewee: "*This risk—not understanding what blockchain is—is similar to the risk that we encountered when cloud technologies first began to come out and when you told companies to host their data on the cloud, they immediately shut the door. And in fact, even now it is very difficult to talk about cloud technology*") and which are the use cases for its adoption in business and finance (interviewee: "*Each participant has its own infrastructure and, as experience has shown, often it is not automatized enough for the installation of digital solutions. A blockchain solution implementation is always a big IT-project and it is important to do an evaluation of the existing systems first and their compatibility with the blockchain in terms of operational speed, otherwise it will be impossible to carry out further integration of different and previously absolutely independent systems with their own servers and business processes. Integration into an external server is impossible without automatization and this might require significant investments. At this point it is important to do a correct evaluation of ROI and possible future benefits for the company compared to all the investments needed*"). Fundamentally, the use case implies a transaction-based shared system with multiple writers/readers where participants need to ensure trust when generating transactions and where these transactions cannot be then modified or deleted.

There have also been some limiting factors revealed for the blockchain technology development in business and finance. These factors include paper document flow and some manual processes that have to be abandoned within enterprises, the need for integration of different systems that require time and further investments, the performance of existing systems used by businesses that are not able to operate at high speeds, behavioral issues of transparent interaction environment and online-control of all of the processes, reputational risks of the technology that is overhyped and initially connected with highly volatile cryptocurrencies.

4 Conclusions

The study shows that organizations have to change their business model, in terms of a hard processing shift, in order to fully implement blockchain. In fact, the study confirms that the blockchain solution can be successfully implemented within enterprises increasing efficiency and trust between participants but the use case has to be appropriate. Empirical results show that even if a use case is valid, each participant needs to optimize their business processes (including, for example, electronic document flow) before the blockchain solution can be implemented. Thus, integration can require a more significant investment compared to the development of smart contracts. As one of the managers interviewed pointed out "*when talking about blockchain technology we should remember that there are two sides to the coin. On one hand, it brings advantages such as reduction of costs and increased efficiency of the processes. On the other hand, the old systems that companies have been using have to be modernized and be ready for the implementation... Our experience shows that implementation of a blockchain project requires a team that can go beyond standard and familiar business practice and has a high level of design thinking. It is really difficult to create such a team that has a broad vision and is able to find agreement*."

Another outcome confirmed by the case study is that the role of intermediaries or third parties such as banks is not eliminated completely (as is often said when explaining blockchain benefits), but rather transformed into a partner-integrator role that provides the counterparties' discipline control and settlements speed.

That reveals some struggles to overcome in order to shift to blockchain as the paper document flow and some manual processes that have to be abandoned within enterprises, and the need for integration of different systems that require time and further investments. The case also reveals that the performance of existing systems used by businesses that are not able to operate at high speeds could be a barrier to blockchain implementation.

Compared to par. 1.2, the case study confirms that efficiency, low transactional costs, reduced lead time and smart contracts are drivers of blockchain diffusion, at the same time, barriers are compatibility and interoperability between different systems that have to be integrated.

In conclusion, firms that would like to apply blockchain as smart technology in their businesses have to know what main issues they have to manage. The case study synthesizes some relevant shifts that a company could face to use blockchain as a core technology.

A long road is ahead to fully implement blockchain in businesses' daily life.

This chapter has some research limitations as these findings are related to only one case study in a defined country. Although the case study is exploratory, it is a first step analysis that ought to be deepened to verify if the drivers and barriers identified in that empirical study could also be found in other business cases. Moreover, the airlines system is a potential wide sector for blockchain adoption and diffusion, as the companies in this sector operate globally.

Future research will aim to compare blockchain applications in different sectors in various countries to discover if the technology has diverse potential in some areas as, for example, in the agri-food sector or in some countries where there is a higher level of blockchain diffusion (i.e., Estonia) in order to understand why and how blockchain is diffused. Finally, future studies could also focus on the role of accountants and auditors in companies' adoption of blockchain (Lombardi et al., 2021).

References

Accenture. (2019). *The potential of blockchain for Airlines – Accenture*. Accessed September 2020, from https://www.accenture.com/us-en/insight-potential-blockchain-technology-for-airlines

Bouffault, O., Burchardi, K., Bender, J. P., Gopalakrishna, D., Gauche, F., & Paboudjian, C. (2019). What could blockchain do for airlines? *BCG Analysis*. Accessed September 2020, from https://www.bcg.com/publications/2019/what-could-blockchain-do-airlines.aspx

Davidson, S., De Filippi, P., & Potts, J. (2018). Blockchains and the economic institutions of capitalism. *Journal of Institutional Economics, 14*(4), 639–658. https://doi.org/10.1017/S1744137417000200.

Dierksmeier, C., & Seele, P. (2016). Cryptocurrencies and business ethics. *Journal of Business Ethics, 152*, 1–14.

Frizzo-Barker, J., Chow-White, P. A., Adams, P. R., Mentanko, J., & Ha, D. (2020). Blockchain as a disruptive technology for business: A systematic review. *International Journal of Information Management, 51*, 102029.

Helliar, C., Crawford, L., Rocca, L., Teodori, C., & Veneziani, M. (2020). Permissionless and permissioned blockchain diffusion. *International Journal of Information Management, 54*, 102136. https://doi.org/10.1016/j.ijinfomgt.2020.102136. ISSN: 0268-4012.

Kniepert, M., & Fintineru, G. (2018). Blockchain technology in food—Chain management—An institutional economic perspective. *Scientific Papers: Management, Economic Engineering in Agriculture & Rural Development, 18*(3), 183–201.

Lombardi, R., de Villiers, C., Moscariello, N., & Pizzo, M. (2021). The disruption of blockchain in auditing – A systematic literature review and an agenda for future research. *Accounting, Auditing & Accountability Journal*. https://doi.org/10.1108/AAAJ-10-2020-4992 (forthcoming).

Nowiński, W., & Kozma, M. (2017). How can blockchain technology disrupt the existing business models? *Entrepreneurial Business and Economics Review, 5*(3), 173–188. https://doi.org/10.15678/EBER.2017.050309.

Websites of the Companies

https://alfabank.com (Alfa-Bank)

https://www.s7.ru/en (S7 Airlines)

S7 Airlines News, 28.07.2017. https://www.s7.ru/en/about/news/s7-airlines-inpartnership-with-alfa-bank-has-launched-a-new-ticket-sales-solution-based-on-ethereum/

A Disruptive Innovation of Blockchain in Finance and Banking: A Jump into the Future

Rosa Vinciguerra, Francesca Cappellieri, and Michele Pizzo

1 Introduction

In an asset exchange transaction, the individual who gives loses the possession. The asset gets off the "*control of who leaves it*" to enter "*the control of whoever receives it*." In contrast, in the internet world, all digital assets are indefinitely replicable. Therefore, they cannot be treated as assets in the strict sense, as they are not under the exclusive control of an individual/entity and are not scarce resources. In such a scenario, blockchain technology can extend to the digital world the concept of uniqueness for an asset, traditionally prerogative of the real world.

Indeed, when a digital asset is exchanged through blockchain technology, it is not anymore available for those who sell it but only for those who buy it.

In definitively, blockchain technology is a mathematical system that re-proposes the concept of scarcity in the digital world, allowing the exchange of assets immune to the risk of replication in a transparent and traceable way. Satoshi Nakamoto (2008) was the first to hypothesize how traditional economic thinking could be declined through the use of digital techniques (cryptography, transmission protocols, time stamping), giving rise to a new concept of "crypto-economy."

He designed a decentralized electronic cash transaction system to solve double-spending issues and improve information verification security.

The basic idea of blockchain technology is to build a distributed database shared between participants, to record data of transactions.

R. Vinciguerra (✉) · M. Pizzo
Università della Campania – Luigi Vanvitelli, Caserta, Italy
e-mail: rosa.vinciguerra@unicampania.it; michele.pizzo@unicampania.it

F. Cappellieri
Università della Calabria (UNICAL), Rende, Italy
e-mail: francesca.cappellieri@unical.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_12

They validate the transactions in the system through their verification, preventing fraudulent ones. Once the blockchain creates and accepts a record, it cannot be altered anymore (Zhao et al., 2016) unless the entire structure is invalidated.

In practice, blockchain gathers entries into blocks in chronological order, guaranteeing its integrity by using cryptography.

Blockchains belong to the Distributed Ledger Technologies (DLT), based on distributed registers that allow reading and modification by multiple parties participating in the network. More specifically, DLT refers to all those digital, technological, infrastructural systems that make it possible to reach a consensus on changes to a distributed register in the absence of a trustworthy central entity. Thus, through blockchain technology and DLT, individuals can trade ownership as a receipt of ownership or bearer instrument. Whether ownership of a share in a company, or a home mortgage, once an item exists on the blockchain, it is easy to identify, manage, and trade without the need for a trusted third party (Kehr et al., 2017). Therefore, the distributed ledger, governed by a decentralized logic, irreversibly keeps track of all transactions. The connection between all nodes of this network is in a peer-to-peer manner.

DLT is essentially asset-agnostic, meaning the technology can provide the storage, recordkeeping, and transfer of any asset. This asset-agnostic nature of DLT has resulted in a range of possible applications currently being explored for use in the finance and banking industry. The applications of blockchain technologies are not limited to cryptocurrencies (Kussy et al., 2018), but they can change transactions' mechanisms in everyday life.

To our knowledge, despite the increasing number of research articles on the topic, there is still a lack of systematization of the most relevant literature. Therefore, we believe that a review of the literature on blockchain's applications in the financial and banking sectors be helpful to identify current research trends, benefits, and practical implications of its preliminary implementations.

The chapter proceeds as follows. Section 2 introduces the disruptive innovation of blockchain technology. Section 3 shows the main blockchain applications in the financial and banking industry. Section 4 illustrates some of the practical implementations and their implications.

2 A Disruptive Innovation of Blockchain in Finance and Banking

Many international institutions and national banks have directed close attention to blockchain implementation and explored its application in various fields. This innovation in data storage and information transmission might fundamentally transform the existing operating models of finance and economy. Its widespread use might lead to a new round of technological innovations and industrial transformation within the FinTech industry (Mu Qi-Guo, 2016a, 2016b).

The world is witnessing a FinTech revolution (Mackenzie, 2015; Gomber et al., 2018), supported by the availability of capital both for start-ups, in the form of venture capital, and for incumbents, by the introduction of new business models, but mainly by the widespread diffusion of innovative product and technologies.

In this revolution, blockchain has supported the improvement of efficiency and achievement of multiple niche markets (Ashta & Biot-Paquerot, 2018), delivering for the first time fully digital financial services (Kehr et al., 2017).

Blockchain represents the bridge between traditional and new finance because it:

– Simplifies the integration of banks with the world of cyber-physical systems and digital assets
– Serves as a tool for optimizing current operations
– Eembodies the foundation upon which digital finance itself is built

This new technology has a positive impact on the efficiency of financial markets, although some drawbacks correlated to its application. On the one hand, it contributes to the emergence of new financial instruments; on the other hand, it decreases capital and transaction costs.

Blockchain is a type of technology that can connect with a variety of scenarios. It can achieve asset digitization and point-to-point value transfer, thereby reconstructing the financial infrastructure (Guo & Liang, 2016).

In particular, there are many different applications of blockchain technology in the financial industry. Market and banking players and technology companies attempt to implement blockchain-based models in payment transactions, clearing and settlement, integrating traditional systems and institutions. In the finance sector, the blockchain can make equity trades faster and more secure, paving the way for more open and competitive trading. In the banking sector, this new technology embodies an innovative solution (Kakavand et al., 2017; Peters & Panayi, 2015) for the retail and wholesale segments (Valverde & Fernández, 2019).

It is worthy to note that although blockchain may modify or cancel some roles of intermediaries in payments, clearing, and settlement, it does not necessarily kill the need for coordination or centralization of certain functions by trusted intermediaries in controlling frictions.

3 Blockchain Application in the Banking and Financial Industry

Many financial institutions have started to apply blockchain technology to financial transactions to reduce associated costs and raise operational efficiencies, especially in the financial note, cross-border payment, and asset-backed securitization (Wu & Duan, 2019). Consistently, Yli-Huumo et al. (2016) argue that the advantages of blockchain technology, such as decentration, openness, autonomy, tamper-resistant information, and anonymity, can compress the operation cost of commercial bank and, at once, enhance the efficiency of capital utilization.

We will present the principal blockchain use cases and related DLT in the financial and banking industry during the following discussion.

3.1 Cross-Border Payments

Cross-border payments allow for the transfer of funds between two or more countries or regions. They shall take the form of credit (and sometimes debit) transfers that convert funds from bank to bank through a series of bank correspondence relationships, often with a multiple fee rating. Currently, the most common payment instrument is the foreign currency, and the traditional payment system is the cross-border interbank payment.

Principal cross-border payments include bank telegraphic transfer, transfer by remittance company, credit card payment, and third-party payment. The involvement of many commercial parties and intermediaries, typical of these payment methods, compromises their operational efficiency. Thus, the application of blockchain technology can alleviate the drawbacks associated with the slow, indirect, and costly settlement of cross-border payments and reduce transaction risks. Consequently, both central banks and private institutions started to exploit the new emerging opportunities by exploring applications for blockchain-based payments (Bott & Milkau, 2017).

The large card operators and other electronic payment instruments are already developing and testing blockchain technology to shorten settlement times for national and, above all, international payments.

In concrete terms, it is possible to create a global point-to-point payment system based on blockchain technology.

Besides, the ability to share ledgers across geographic distances and time zones that characterizes the blockchain could eliminate the need for intermediaries required to perform cross-border payments. Thus, it enables peer-to-peer payments, reduces transaction costs and risks by excluding third-party financial institutions. In particular, the blockchain application could provide containing settlement costs and frictions related to timing predictability. Indeed, it allows (almost) real-time transactions with the advantages of greater transparency and traceability (Buitenhek, 2016).

It could also positively impact small and medium-sized banks, which offer cross-border payment services but lack the relationships to process them directly. In particular, the technology could compress the frictions related to the reliance on larger institutions and the costs associated with maintaining these relationships.

It is possible to set up a global foreign exchange settlement system based on blockchain technology. Introducing a gateway system allows dealing with the trust issues between parties in the transfer payment (Wu & Duan, 2019). The relationship between the gateway and the party reflects a kind of debtor–creditor relationship. For example, party A remits money to party B by blockchain. At first, as a creditor for party A and a debtor for party B, the gateway is responsible for clearing the debtor–creditor relationship between party A and party B. With the application of blockchain technology, the distributed ledger stores the debtor–creditor relationship on several servers and overcomes the limits of the current payment system.

3.2 Credit and Lending

The use of the blockchain can add value to the credit and lending area too.

Indeed, this new disruptive technology can improve the decision-making process of lenders (Rosati & Čuk, 2019).

Currently, financial institutions are often required to make risk-management decisions based on limited data, obtainable from a few brokerages and agencies. Indeed, the assessment of creditworthiness relies on historical records of financial transactions of the potential borrowers.

In other circumstances, the total absence of any non-cash financial transactions does not allow the bank to assess creditworthiness. These are the cases of unbanked, underbanked, and microenterprises. In this scenario, the blockchain technology offers the potential for pooling large volumes of data that can be anonymized and protected by the ledger's encryption protocols (Mc-Kinsey, 2019), supporting the bank in the acquisition of information to make credit decisions.

The Blockchain models can serve the credit scoring processes creating disintermediated trusted data marketplaces that securely connect information providers, borrowers, and lenders (Roman & Gatti, 2016), depressing default rates, with relevant economic benefits (Byström, 2016).

Moreover, the adoption of this technology, allowing the execution of trustless peer-to-peer transactions, can replace both traditional (i.e., Banks, credit unions) and new (i.e., peer-to-peer lending platforms) intermediaries, with a consequent reduction of transaction costs of lending and business financing (Larios-Hernández, 2017). For example, the blockchain can serve in enabling the disintermediated crowdfunding campaigns called Initial Coin Offerings (ICOs). The latter is the process that allows an entity to borrow money through the use of this innovative technology, excluding the engagement of many intermediaries and centralized exchanges (Yu et al., 2018) guarantees all blockchain-based transactions are transparent and reliable.

The conduction of an ICO requires the generation of a token-based economy, in which the blockchain token has some form of value for investors. A company builds a product or a service around a token. In this setting, the token is a project-specific currency, a form of utility (utility token), or security (security token) that can provide some form of profit participation to investors. Utility tokens are the most widely used token structure for ICOs (Ante et al., 2018).

Initial coin offerings (ICOs) have emerged as a relevant financing tool for blockchain-based entrepreneurial ventures (Feng et al., 2019). A growing number of start-ups use ICOs, instead of traditional IPOs, to support early-stage funding. While IPOs are expensive and highly regulated, ICOs are lightly or non-regulated, with thereby lower operating costs.

3.3 Clearing and Settlements

Benos et al. (2017) argue that blockchain may impact the post-trade cycle in many ways:

– *Reducing reconciliation and data management costs*: the adoption of blockchain technology, through the use of a distributed and shared record among the relevant participants, can simplify and automate many processes involved in the post-trade cycle, decreasing the need for reconciliation.
– *Flexible settlement times*: the current lengthiness of settlement cycles, due to the adoption of banks' back-office processes, legal arrangements, and liquidity management practices, can be overcome through the use of DLT. De Meijer (2016) asserts that blockchain technology offers the opportunity to improve the speed of transaction settlements. Indeed, in such a scenario, the application of this technology would make it possible to reduce the settlement period of securities transactions, with positive effects on the exposure to settlement risk by the participants.
– *Automated clearing*: the use of the technology, allowing the sharing of relevant information among all the participants, could potentially lead to the elimination of a clearing agent, reducing costs and operational risks. Indeed, through the introduction of compensation algorithms, the calculation of reciprocal obligations could take place simultaneously.
– *Direct ownership*: in today's market setting, may happen that investors are not the direct owners of the securities they trade. In such cases, they hold them through a chain of custodians who perform an intermediary function between issuers and investors. The adoption of DL technology, allowing the issuance of securities in the form of digital tokens, could facilitate direct ownership, pursuing greater transparency in the markets, and a consequent reduction in intermediation costs, as well as of legal and operational risks.
– *Traceability and transparency*: one of the main strengths of the DL technology is its ability to record data in an immutable way. This feature is crucial mainly in this use case as it allows tracking the history of any recording, including its changes if any. Besides, the technology will lead to sharing the costs related to the maintenance of the information storage infrastructures, eliminating the problems associated with duplicate records of commercial details and resulting costs (Mills et al., 2016).
– *Security and resilience*: DLT is a decentralized system, with no single point of failure. As a result, it is more resilient to cyber-attacks. The use of cryptographic

signatures to access data and the encryption of the elements of the ledger can enhance the security of any transactions.

By paying attention to securities, commodities, and derivatives transactions, the distributed and consensus-forming aspects of DLT could allow multiple parties to agree on terms of exchanges in a lower time than the expected one for the existing processes. Since the parties involved can agree more quickly, the possible frictions in the processing are eliminated and, consequently, delays and operational costs (Mills et al., 2016). The application of this technology allows the transfer of assets in one step and the creation of escrow accounts, which interact or are within a peer-to-peer network. These assets will remain on one side of the transaction until the execution of the other side is confirmed.

3.4 Financial Inclusion

An additional field susceptive to achieve vast advantages from the implementation of blockchain technology is inclusive finance. Indeed, the limitations of the conventional financial system leave room for the use of alternative blockchain-based models to overcome financial exclusion issues.

It is worth clearing that the absence of bank branches and automatic teller machine (ATM) coverage does not fully explain the financial exclusion phenomenon. Indeed, high account fees and prohibitive bank costs can inhibit access to financial services, particularly for low-income households (The World Bank, 2016; Federal Deposit Insurance Corporation, 2016).

Through the use of tokens, blockchain technology grants access to an alternative financial services portfolio that the existing financial system may not fulfill. In such a scenario, the implementation of the blockchain does not compete but rather complements a gap currently neglected by the formal financial system expanding access to customer groups not served by ordinary banks. It stands out as a solution when traditional banking is not an option.

With special attention to low-income countries, the emerge of some critical points of financial exclusion displays significant opportunities for applying blockchain (Larios-Hernández, 2017):

– *Cash preferences*. Informal in-cash savings mechanisms, as peer-to-peer transactions, are customary amongst financially excluded people (unbanked individuals). While these preferences appear to be a disincentive to approach the traditional financial system, the current mobile banking provides reasons to move from cash to a digital mobile money economy. People understand technology's advantages in theft protection, speed, and accessibility (Donovan, 2012).

  Countries with limited banking infrastructures and consequent cash dependency could apply blockchain technology as a safe network for holding and transferring money (Scott, 2016).

- *Lending practices*. Borrowing is a common practice in low-income groups to finance investments (Collins et al., 2009). It occurs mainly by employing disintermediated peer-to-peer local transactions—instead of lending from financial institutions—as in the rotating savings and credit associations (ROSCA) case. Under this mechanism, every community member commits to funding with a fixed charge of a communal pot; subsequently, each member takes the pot one time. Under these assumptions, blockchain technology can create trustworthy social lending club platforms, enabling informal practices to become inclusive, low-cost, and reliable. It can reduce transaction costs preventing individuals in informal networks to be exploited by local usury or induced to work in slavery.
- *Money transfer habits*. Traditionally, money transfers take place through bank accounts. Recently, mobile devices have facilitated the transfer of funds and reduced transaction costs, removing the barriers to financial inclusion on the supply side. Nevertheless, mobile banking is still an underdeveloped sector because of challenges related to acceptance and lack of trust (Daştan & Gürler, 2016; Lotfizadeh & Ghorbani, 2015). This scenario shows a significant space for the blockchain that taking advantage of its trusty and accessibility features could positively affect efficiency.
- *Problems of identifying informality*. The lack of legal identity, affecting many people in the current institutional setting (Dahan & Gelb, 2015), prevents access to conventional financial services (for example, access to credit). This circumstance prompts people to access informal networks based only on mutual knowledge and trust. These informal social circles can seize the opportunity offered by blockchain technology where the financial identity depends on institutional reputation instead of not formalized relationships (Tapscott & Tapscott, 2016). Indeed, the blockchain structure gives a formal identity to each node (individual) included in its network. Thus, its mechanism gives the chance to overcome the current obstacle, recognizing the validity of reputation-based peer-to-peer networks as a form of identification.

3.5 Information-Sharing

The blockchain has emerged as a potentially disruptive, general-purpose technology for companies and governments to support information exchange (Yli-Huumo et al., 2016).

Each transaction is verified by the consensus of the majority of participants in the system, and, once entered, information can never be erased (Crosby et al., 2016). This new technology can design an environment for digital contracts, and verifiable and immutable peer-to-peer data shared in a cloud service, eliminating the need for third-party intermediaries to validate and protect financial transactions (Swan, 2015). This blockchain-based solution can provide additional cybersecurity-related benefits (Smith & Dhillon, 2019) such as ownership, transparency, and auditability of data, and fine-grained access-controls (Zyskind et al., 2015), compressing the risk of manipulation and system failures (Ølnes et al., 2017).

Within this application, the DLT's ability to maintain tamper-proof records may provide innovative sharing information across entities, such as independent auditors and supervisors (Mills et al., 2016). For example, through the DLT, auditors or supervisors could gain read-only access to specific sections of the distributed ledger. Thereby, it allows service providers and end-users to satisfy regulatory reporting requirements more efficiently.

4 Real-World Blockchain Use Cases

Many banking institutions have chosen to work together in consortiums to implement blockchain technology.

An outstanding example is Practical Settlement Money (UCS—Utility Coin Settlement), created in 2016 by UBS Swiss Bank in partnership with ten other banking institutions (State Street, MUFG, Barclays, Credit Suisse, HSBC, and Canadian Imperial Bank of Commerce). UCS represents a cryptocurrency in the traditional sense, conceived to organize financial agreements—as a full-fledged analog of bitcoin—but with limited circulation only between financial institutions trading on the securities market. The project relies on a closed blockchain distributed ledger is held by a limited number of trusted parties.

Since 2015 the R3 consortium involving 70 banks (like Barclays, Goldman Sachs, J.P. Morgan, and UBS) has implemented the Corda project.

In 2018, Corda was tested as an international banking system of corporate customer data, as required by the KYC ("Know Your Customer") policy, to speed up and reduce the identification process costs, creating a universal common banking data exchange infrastructure. Moreover, in 2019 it became an international symbol plan in the SWIFT system by using Rope Platforms. Its protocol differs from the traditional distributed ledger as access to the system is provided only to authorized participants and because there is no provision for issuing their cryptocurrencies.

Although the R3 and UCS projects share some participants, they are not partnerships because they have different purposes and compete in technical solutions.

Another relevant pattern in the field of the application of this technology to the financial sector is the Ripple project. Designed as a protocol in 2004, it has acquired a commercial form since 2012. Ripple is the most mature project creating an alternative payment system and positions itself as a tool for deposit savings and international regulations. It is organically combined with the existing network of banking and foreign exchange institutions to provide further effective combinations, mainly for making transfers, payments, accounting for debts and bonds. The Ripple platform guarantees the execution of payments in no more than 3–4 min, while the SWIFT system can take several days. It created for banks and payment system providers a platform that gives them a common infrastructure as a convenient way to send and receive money around the world, allowing transactions in any fiat currency, other assets, including the Ripple cryptocurrency (XRP).

Many other blockchain applications support loans, factoring, trade finance, and supply chains.

The German Commerzbank tested Marco Polo, a blockchain-based trade finance platform designed to increase security, reduce customer identification costs, and improve transferring and verifying information procedures. Marco Polo's blockchain allows trading partners to agree in advance and correct details of the delivery and payment of products. The buyer's bank then verifies the transaction via Marco Polo and posts a conditional payment commitment. When information is entered into the platform, the system verifies compliance with the agreements previously reached (in the form of a "smart contract"). If data are proper, the payment process starts automatically.

Additionally, JPMorgan launched its Quorum Platform blockchain based on Ethereum. In 2018, JPMorgan—together with IBM, Cisco and Microsoft—also launched its proprietary cryptocurrency (JPM), designed to transact between customers on the JPMorgan Chase payment network.

In 2019, Alfa-Bank, with Kvartplata 24, put into operation a blockchain accounting service for utilities. The Ak Bars Bank joined the Accounting for Electronic Mortgages' project of the FinTech Association's in the same period. In this circumstance, it also carried out the first mortgage transaction on the Masterchain platform, which is being developed by the Russian Central Bank together with other partners. As a pilot project, Ak Bars is developing a digital bank guarantee, reducing the period for its issuing to 10 min and its cost by about 20%.

These applications shed new light on an area that should be a significant concern of policy-makers and bank and financial practitioners, considering the central role blockchain will play on the bank of the future.

References

Ante, L., Sandner, P., & Fiedler, I. (2018). Blockchain-based ICOs: Pure hype or the dawn of a new era of startup financing? *Journal of Risk and Financial Management, 11*(4), 80.

Ashta, A., & Biot-Paquerot, G. (2018). FinTech evolution: Strategic value management issues in a fast-changing industry. *Strategic Change, 27*(4), 301–311.

Bank for International Settlements and World Bank Group, Committee on Payment and Market Infrastructures and The World Bank (2016). Payment Aspects of Financial Inclusion.

Benos, E., Garratt, R., & Gurrola-Perez, P. (2017). The economics of distributed ledger technology for securities settlement. *Ledger, 4*.

Bott, J., & Milkau, U. (2017). Central bank money and blockchain: A payments perspective. *Journal of Payments Strategy and Systems, 11*(2), 145–157.

Buitenhek, M. (2016). Understanding and applying blockchain technology in banking: Evolution or revolution? *Journal of Digital Banking, 1*(2), 111–119.

Byström, H. (2016). *Blockchains, real-time accounting and the future of credit risk modeling*. Department of Economics, Lund University.

Collins, D., Morduch, J., Rutherford, S., & Ruthven, O. (2009). *Portfolios of the poor: How the world's poor live on $2 a day*. Princeton University Press.

Crosby, M., Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). Blockchain technology: Beyond bitcoin. *Applied Innovation, 2*(6–10), 71.

Dahan, M., & Gelb, A. (2015). *The identity target in the post-2015 development agenda*. The World Bank.

Daştan, I., & Gürler, C. (2016). Factors affecting the adoption of mobile payment systems: An empirical analysis. *Emerging Markets Journal, 6*(1), 17–24.

De Meijer, C. R. W. (2016). Blockchain and the securities industry: Towards a new ecosystem. *Journal of Securities Operations and Custody, 8*(4), 322–329.

Donovan, K. P. (2012). Mobile money, more freedom? The impact of M-PESA's network power on development as freedom. *International Journal of Communication, 6*, 2647–2669.

Federal Deposit Insurance Corporation (2016). FDIC 2015 National Survey of Unbanked and Underbanked Households, October 20, https://www.fdic.gov/householdsurvey/2015/2015report.pdf.

Feng, C., Li, N., Wong, M.H. F., & Zhang, M. (2019). Initial Coin Offerings, Blockchain Technology, and White Paper Disclosures, March 25, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3256289.

Gomber, P., Kauffman, R. J., Parker, C., & Weber, B. W. (2018). On the Fintech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services. *Journal of Management Information Systems, 35*(1), 220–265.

Guo, Y., & Liang, C. (2016). Blockchain application and outlook in the banking industry. *Financial Innovation, 2*(1), 1–12.

Kakavand H., De Sevres N. K., Chilton B. (2017). The blockchain revolution: An analysis of regulation and technology related to distributed ledger technologies, Social Science Research Network (SSRN), New York, NY, USA, Tech. Rep. 2849251, 1–27

Kehr, H., Tonkin, G., & Bihler, R. (2017). The unbanked don't need more brick and mortar banks. In *Shaping the digital enterprise* (pp. 139–156). Springer.

Kussy, M. K., Pobirchenko, V. V., Shutaieva, E. A., & Kakutich, Y. Y. (2018). Blockchain technologies as a stimulator of institutional transformations of the world financial system. *International Journal of Engineering and Technology, 7*(3.14), 354–359.

Larios-Hernández, G. J. (2017). Blockchain entrepreneurship opportunity in the practices of the unbanked. *Business Horizons, 60*, 865–874.

Lotfizadeh, F., & Ghorbani, A. (2015). A multi-dimensional model of acceptance of mobile banking. *International Journal of Management, Accounting, and Economics, 2*(5), 414–427.

Mackenzie, A. (2015). The Fintech revolution. *London Business School Review, 26*(3), 50–53.

McKinsey. (2019). *Blockchain and retail banking: Making the connection*.

Mills, D., Wang, K., Malone, B., Ravi, A., Marquardt, J., Chen, C., Badev, A., Brezinski, T., Fahy, L., Liao, K., Kargenian, V., Ellithorpe, M., Ng, W., & Baird, M. (2016). *Distributed ledger technology in payments, clearing, and settlement, finance and economics discussion series 2016–095*. Board of Governors of the Federal Reserve System.

Mu Qi-Guo. (2016a). *First report on survey of blockchain technology: Potential to disrupt all industries* [J]. Report by Chuancai Securities Co., Ltd.

Mu Qi-Guo. (2016b). *Second report on survey of blockchain technology: Evolution of blockchain technology* [J]. Report by Chuancai Securities Co., Ltd.

Nakamoto, S. (2008). *Bitcoin: A peer-to-peer electronic cash system*. https://bitcoin.org/bitcoin.pdf

Ølnes, S., Ubacht, J., & Janssen, M. (2017). Blockchain in government: Benefits and implications of distributed ledger technology for information sharing. *Government Information Quarterly: An international journal of information technology management, policies, and practices, 34*(3), 355–364.

Peters, G. W., & Panayi, E. (2015). Understanding modern banking ledgers through blockchain technologies: Future of transaction processing and smart contracts on the internet of money. In *Banking beyond banks and money* (pp. 239–278). Springer.

Roman, D., & Gatti, S. (2016). *Towards a reference architecture for trusted data marketplaces: The credit scoring perspective*. In Open and Big Data (OBD), International Conference on IEEE (pp. 95–101).

Rosati, P., & Čuk, T. (2019). Blockchain beyond cryptocurrencies. In T. Lynn, J. Mooney, P. Rosati, & M. Cummins (Eds.), *Disrupting finance* (Palgrave studies in digital business & enabling technologies). Palgrave Pivot.

Scott, B. (2016). *How can cryptocurrency and block-chain technology play a role in building social and solidarity finance?* Working paper no. 2016-1. UNRISD.

Smith, K. J., & Dhillon, G. (2019). Assessing blockchain potential for improving the cybersecurity of financial transactions. *Managerial Finance, 46*(6), 833–848.

Swan, M. (2015). *Blockchain: Blueprint for a new economy*. O'Reilly Media.

Tapscott, D., & Tapscott, A. (2016). *Blockchain revolution: How the technology behind bitcoin is changing money, business, and the world*. Penguin.

Valverde S.C., & F.R. Fernández (2019). The future of blockchain in the European banking system. Funcas SEFO,8(1), 21–29.

Wu, B., & Duan, T. (2019). The application of blockchain technology in financial markets. *Journal of Physics Conference Series, 1176*, 042094.

Yli-Huumo, J., Ko, D., Choi, S., Park, S., & Smolander, K. (2016). Where is current research on blockchain technology? A systematic review. *PLoS One, 11*(10), e0163477.

Yu, T., Lin, Z., & Tang, Q. (2018). Blockchain: The introduction and its application in financial accounting. *The Journal of Corporate Accounting and Finance, 10*, 37–47.

Zhao, J. L., Fan, S., & Yan, J. (2016). Overview of business innovations and research opportunities in blockchain and introduction to the special issue. *Financial Innovation, 2*(28). https://doi.org/10.1186/s40854-016-0049-2.

Zyskind, G., Nathan, O., & Pentland, A. (2015). *Decentralizing privacy: Using Blockchain to protect personal data*. Security and Privacy Workshops IEEE (pp. 180–184).

Human Capital Vulnerability and Cybersecurity Risk Management: An Integrated Approach

Matteo La Torre, Manuela Lucchese, and Daniela Mancini

1 Introduction

There is a long-standing claim that cybersecurity and digital information system protection is primarily a technological issue falling into the information technology (IT) domain. However, researchers and practitioners have increasingly acknowledged that cybersecurity practice implies a set of activities within an organisation that goes over the cyber realm and IT profession (Mancini, 2003, p. 152; Carlton et al., 2019; Malatji et al., 2019).

Over time, the empirical evidence about cyber threats and accidents demonstrates that human and behavioural factors are usually the main vulnerability and cause of cybersecurity accidents (Vroom & von Solms, 2004). Cyberattacks based on social engineering (SE) techniques are at the forefront of cybersecurity. They represent the close and mutual linkage between the social, behavioural, and technological dimensions of cybersecurity (Verizon, 2017). SE is a phenomenon that comes from the sociological field and is a tactic used to induce users to perform certain desired actions to get specific information or/and access the network.

Campbell (2019, p. 1130) explains that SE is a "simple low cost and high benefit in committing the crime". It is performed "through various forms of online

M. La Torre (✉)
Department of Economic Studies, University "G. d'Annunzio" of Chieti-Pescara, Pescara, Italy
e-mail: matteo.latorre@unich.it

M. Lucchese
Department of Economics, University of Campania "Luigi Vanvitelli", Caserta, Italy
e-mail: manuela.lucchese@unicampania.it

D. Mancini
Faculty of Law, University of Teramo, Teramo, Italy
e-mail: dmancini@unite.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_13

communications, technology and deception techniques to persuade and trick individuals to grant access to the company network" (Campbell, 2019, p. 1130). A widespread SE attack is phishing, which aims to get personal and confidential information from users by leveraging fake requests that look familiar, urgent, or trustworthy. Therefore, being a psychological tactic to manipulate people to perform actions within a fraud scheme, SE is sly as hackers take advantage of people's emotions—curiosity, empathy, fear, greed, excitement and trust (La Torre et al., 2018).

While targeting single workers, a SE-based attack can more likely harm the entire organisation due to the many chances to breach a network coming from many employees. However, auditing employees' human behaviour is challenging and usually failing in cybersecurity practices (Vroom & von Solms, 2004). La Torre et al. (2018) argue that cybersecurity risks can harm companies' intellectual capital by deprecating the value of their human, structural and social capitals. Conversely, intellectual capital is also a means to protect organisations by developing proper structural and human capital (La Torre et al., 2018).

This chapter examines this twofold role of human capital of being both a vulnerability and strength in cybersecurity risk management (RM). We analyse the implications of preventing and managing cybersecurity risks from human behaviour for corporate governance, auditing and internal control systems. We address the effects and the possible solutions in defining a strategy for cybersecurity RM based on human capital vulnerability.

We review the recent literature on cybersecurity risk and internal control to enrich the understanding of their relationship with human capital. We selected the most updated practical documents and academic literature on RM and corporate governance. Then, we focused on the academic articles dealing with both cybersecurity issues and human capital. Our review proposes some recommendations to align firms' corporate governance and internal control systems to human-related cybersecurity risk.

The chapter is structured as follows. In Sect. 2, we review and discuss the literature on RM, corporate internal control and the integration of cybersecurity into the whole risk governance. Then, we discuss the security threats and vulnerability of human capital and their implications for cybersecurity practices. Section 3 offers some recommendations for integrated cybersecurity risk governance and control. Section 4 concludes the chapter.

2 Corporate Internal Control and Cybersecurity Risk Management

2.1 *Risk Management and Corporate Internal Control System*

Companies are developing the awareness that cybersecurity is essential for a successful business strategy. This need became compelling over the COVID pandemic with increased digitalisation to guarantee entities' survival and operations continuity. Therefore, cybersecurity RM has become one of the main concerns for companies, financial institutions, law enforcement and regulators (Aguilar, 2014; Hall & Wright, 2018). Cybersecurity governance represents a critical challenge in defining an effective RM system that encompasses cyber threats (AICPA, 2017; Islam et al., 2018; Kahyaoglu & Caliyurt, 2018). While companies are aware of the risks from external hacking or cyberattacks, many fail to adopt adequate security controls into their organisations (Luo et al., 2013). Thus, theoretically, cybersecurity concern has entered into the domain of organisations' RM practices.

Enterprise Risk Management (ERM) is an RM approach that may ensure the managing of ever-increasing corporate uncertainty. The COSO ERM framework (2017) remarks on RM's crucial role in defining a successful strategic plan. Applying ERM to strategy is the best approach for untangling the art and science of making well-informed choices (COSO, 2017). From this perspective, the risk is assessed based on its potential effect on an established strategy to understand its relevance and viability (COSO, 2017).

This holistic approach links performance, strategy and risk governance and considers the organisation as a system (Capalbo & Clarke, 2006; Signori & Rusconi, 2009; Alexander et al., 2019), where functions are seen as a whole and not in silos (Rubino & Vitolla, 2014; Florio & Leoni, 2017). The new ERM Framework fosters a paradigm change by considering the risk dimension as a part of a whole for better strategic planning.

Based on this view, an effective cybersecurity RM should depend on an adequate architecture of internal corporate governance mechanisms and a successful RM strategy that includes and controls the cyberthreats (Allegrini & D'Onza, 2003; Ferramosca et al., 2017). Thus, cybersecurity practice cannot be limited to the IT domain and extends beyond its organisational department. It needs to become a matter of corporate governance.

The CEO and the Board of Directors are the main actors in risk governance. They ensure effective RM and coordinate the other defence lines (Leech & Hanlon, 2016). Once the Board has assessed and understood the overall picture of risks, it requests a plan of actions to address the risks. Accordingly, the Boards must monitor and be continuously updated on the residual risk status (von Solms & von Solms, 2018). However, they do not always acknowledge the extent of their cyber responsibilities. In a world where data breaches occur far too often, the Boards must understand their cyber-related governance responsibilities (Van Schaik et al., 2020).

The European Confederation of Institutes of Internal Auditing (ECIIA) and Federation of European Risk Management Association (FERMA) highlighted the importance of defining roles and responsibilities in corporate governance, risk management and cybersecurity management. Thereby, they proposed a governance framework in the digital context. This framework is based on the 2015 OECD principles in "*OECD Recommendation—Digital Security Risk Management for Economic and Social Prosperity*", and the Three Lines of Defence promoted in the joint FERMA-ECIIA's document entitled "*Audit and Risk Committees—News from EU Legislation and Best Practices published*" in 2014. For successful cyber risk governance, the framework suggests five actors acting at different organisational levels, as discussed below (FERMA, 2018).

The *Board* (or the *CEO*) must ensure the company's long-term viability and future development and makes the decisions concerning the challenges from digitisation. Therefore, this top-level actor has to provide the organisation with the capability to address this challenge with proper resources and support. There is a need for coordination across functions to provide an integrated response to ensure the organisation's resilience to cyber threats. The Board and senior managers must define the scale, nature and complexity of the response and be adequately informed to make decisions.

The *Risk Committee* reports to the Board and operates at an enterprise level addressing all the risks crossing all the organisational functions.

The *Cyber Risk Governance Group* (CRGG) is an executive body dedicated to assessing cyber risks. It should be coordinated by a Risk Manager, who should manage the identification, assessment, quantification and mitigation of cyber risks following the overall ERM. In resuming the first and second lines of defence, the CRGG is formed by representatives of all the functions involved in managing cyber risks, such as the IT department, HR, Data Management, Communications, Finance and Legal, the Data Protection Officer (DPO) and the Chief Information Security Officer (CISO). The Risk Manager assists the other functions in establishing procedures, processes and training. The CRGG presents cyber risk mitigation plans to the Risk Committee and the Board. These plans include the investments in cybersecurity, insurance solutions, and key performance indicators for benchmarks. Moreover, the CRGG also works with the Internal Auditors to share information about the ERM and ensure that the mitigation plans are auditable.

The *Internal Auditors* provide an independent assurance that the first and second lines of defence comply with their design. They also check its consistency with the information security programme.

The *Audit Committee* is responsible for the overall efficiency and effectiveness of cyber control and monitoring. Last, the Risk Committee and the Audit Committee ensure that the same language is spoken across all the functions and provide a joint opinion to the Board.

These actors, and especially the Board, have to consider that cyber risks can represent a threat or an opportunity, depending on whether intellectual capital is considered merely an asset exposed to risks or a protection management tool (La Torre et al., 2021; Renaud et al., 2019). This view is coherent with the definition of risk by COSO ERM framework (2017). Risk comes from an uncertain event that may affect an entity's ability to achieve its strategy and objectives. Thus, this event may have a positive (opportunity) or a negative (threat) impact on enterprise goals.

Because of their investments in sophisticated technologies, companies must face new risks to be considered in their internal control system (Shain & Penzler, 2003; Ferramosca et al., 2017). These changes require cybersecurity RM to be integrated with the ERM programme to ensure a comprehensive view to support decision-making (Baldoni & Montanari, 2016).

Malatji et al. (2019) state that the most important information and cybersecurity vulnerability exploitations often depend on the fragmentation of the security management systems. Cyber risks are managed using different tools, techniques, and policies suggested by employees with different cybersecurity capabilities (Malatji et al., 2019). The CISO suggests developing an overall Cybersecurity/risk management strategy by aligning the socio-technical systems cybersecurity outcomes with specific security requirements and strategic objectives. The different RM steps (i.e., gathering, identifying, and classifying cybersecurity data, defining and analysing practices, prioritising and defining the action plan, and then implementing and monitoring the plan) are held according to socio-technical dimensions (Malatji et al., 2019). This sociological dimension encloses not only the most procedural and organisational components that should characterise cybersecurity RM. It also represents the increasing vulnerability coming from human beings within organisations.

2.2 Cybersecurity Threats and the Vulnerability of Human Capital

Cybersecurity scholars encouraged the holistic approach to ERM Framework (2017) we discussed above (Ifinedo, 2012) to integrate the technical and sociological dimensions (organisational structure and human capital) (Malatji et al., 2019). However, empirical evidence demonstrated that auditing the human behaviour of employees is usually difficult in practice and can make a cybersecurity RM ineffective (Vroom & von Solms, 2004).

Previous studies argue that cyber threats can damage companies' intellectual capital (La Torre et al., 2018). Yet, companies can develop their intellectual capital to protect their organisations and operations. Structural capital should be designed and developed by defining procedures, processes and information systems to reduce cyber vulnerability (La Torre et al., 2018). Human capital should be aware of cyber threats and security breaches and behave to prevent and respond to security incidents (La Torre et al., 2018). This perspective embraces a concept of human capital that includes employees' skills, behaviours and knowledge. Hence, intellectual capital can be both the victim and the countermeasure in cybersecurity. However, human capital and human behaviours are challenging to cybersecurity management and represent a significant vulnerability.

The need to assess and manage people's vulnerability to cyber threats is due to several factors, such as human behaviours and human psychological traits. For example, the diffusion of personal mobile devices and the BYOD ("bring your own device") practices has increased the cases of malicious access into organisations' networks and frequent data leaks (von Solms & von Solms, 2018). Nevertheless, psychological factors also affect human judgement and behaviour and obstruct human cognition in detecting threats and avoiding security breaches.

SE is a widespread tactic hackers use to manipulate human judgements and perform a fraud scheme to deceptively get confidential information (Campbell, 2019). Campbell (2019, p. 1131) highlights that, differently from direct network hacking, "SE attacks exploit human decision making and trust to persuade the victim in inadvertently divulging sensitive information". Even though there are frequent recommendations for identifying SE attacks, they are challenging to be detected and managed. Their fraud scheme usually leverages people's emotions that can be hardly controlled—e.g., panic, trust, anxiety and fear.

Such a vulnerability of human capital, implying human cognition and capability, is the rationale explaining the need for integrating the social and technological facets in implementing a cybersecurity framework for RM. In this regard, Malatji et al. (2019) developed a framework to fill the socio-technical gaps in organisational cybersecurity practices. This framework emphasises the social, technological and environmental dimensions of cybersecurity to understand the interaction between technical systems and humans (Malatji et al., 2019). The authors conclude that only people-centred approaches influence better and holistic cybersecurity systems and solutions, and a socio-technical system can optimise the alignment between humans and technology (Malatji et al., 2019).

Despite this holistic approach to cybersecurity RM, human vulnerability remains because top-down and compliance-based systems alone can hardly influence organisations' soft dimension and protect organisations from SE deception. Non-IT practitioners can still lack the knowledge and skills to align their cognition and behaviours to technological threats (Carlton et al., 2019). Campbell (2019) concludes that three solutions and strategies can inhibit SE deception:

- A balanced control of both technology and behaviours
- Implementing user policies, programmes, practices and procedures
- Continuous education and training for users.

This last solution aims to change people's awareness and cognition, gradually changing the organisation culture by instilling ethical attitude, awareness, self-control and accountability. These elements shape an informal control that can support and make effective the formal control coming from the whole RM system and cybersecurity governance.

3 Implications for an Integrated Cybersecurity Risk Governance and Control

In the previous section, we advocate the need for an integrated ERM system that include cybersecurity RM. Such a holistic view elevates the cybersecurity issue to the top organisational level, involving different actors and organisational functions. This approach requires aligning cybersecurity practices and solutions to the whole organisation RM and strategy.

We also found that academic research claims that managing cybersecurity risk governance requires considering both the technical and non-technical issues of cybersecurity. Managing non-technical security defence means including sociological and environmental factors in the organisation's control system, like procedural, behavioural and environmental factors (Malatji et al., 2019). However, despite such a holistic approach to cybersecurity, controlling human behaviour remains challenging to protect the organisation from cyber threats. The vulnerability of humans remains a challenging factor to manage. Therefore, cybersecurity risk governance and its internal control need to include formal (e.g., procedures, systems and technologies) and informal controls to change human capital and make it aware and resilient to cyber threats (Campbell, 2019).

This section offers some recommendations for an integrated cybersecurity risk governance and control based on the previous literature and practice. Thereby, we discuss the implications for three levels of actions: corporate governance and control; auditing and internal procedures; training and awareness.

3.1 Corporate Governance and Control

The holistic approach for ERM and cybersecurity RM involves a great Board of Directors/CEOs' awareness. A survey on the Board's members evidences that over 51% have a strong understanding of regulatory compliance for cybersecurity (Tysiac, 2014). Proviti's (2015) survey illustrates that Board's engagement in the cybersecurity issue is the main robust cybersecurity measures. However, cybersecurity RM must extend beyond the Board level.

A Board with security expertise can be a prerequisite for an effective cybersecurity management programme. Although the cybersecurity issue is usually a task for the audit committee, the companies operating in the technology industries have a dedicated a cyber-risk committee that focuses on cybersecurity and other RM issues (Islam et al., 2018). Thus, a decisive engagement of the Board is essential for managing cybersecurity risks successfully.

The Board's engagement can ensure that cybersecurity RM becomes a task involving the entire organisation, fostering great collaboration across the organisational functions. In turn, all the functions in the first, second, and third defence lines must work together to ensure that the Board is aware and can understand the overall picture to perform its task (FERMA, 2018). The Board can establish procedures, systems and auditing processes involving the whole organisation. Nonetheless, the Board's engagement is also needed to change the organisational culture and approach to cybersecurity. Top-level managers' leadership can change the soft dimensions of cybersecurity practices.

3.2 Auditing and Internal Procedures

A successful cybersecurity RM depends on the security programme's design, implementation and control, as defined in the overall ERM programme. Campbell (2019) demonstrates the importance of establishing internal guidelines, policies, and procedures to create best practices in organisations. These policies should explain the employees' actions, behaviours and responses, while the practices should involve regular testing with continuing education.

Schuessler (2009) stresses the importance of creating countermeasures in threat elimination, risk mitigation or curbing computer crime that might dissuade individuals from committing unintentional acts from SE attempts. This needs to introduce several levels of consequences for infractions if policies and practices are not followed. Policies, procedures and standards should be settled as an integral part of the entity mission with relevant implications on the governance, budget support and compliance (Landoll, 2017). The leading practices and procedures include monitoring, authentication, password management, security programmes and enforcing and rewarding practices on user reporting, user recognition and user practice (Campbell, 2019). These actions should involve the entire entity and balance security and operational goals.

A successful cybersecurity programme also depends on adequate controls. According to the managerial audit literature, Internal Audit (IA) provides many benefits, such as effective internal controls (Lin et al., 2011), better risk assessments (Allegrini & D'Onza, 2003; Asare et al., 2008), the prevention of management misconduct (Ege, 2015; Prawitt et al., 2012) and greater external audit efficiency (Pizzini et al., 2015). Concerning cybersecurity, the IA can support the audit committee and other Board's members to develop a comprehensive internal audit plan that addresses cyber risks (Deloitte, 2017; Islam et al., 2018).

The IA assists the Board of directors and its audit committee in providing both assurance and consulting services for RM and updating the ERM (Sarens & De Beelde, 2006; Walker et al., 2002). There is evidence of close interactions between internal audit and the Chief Risk Officer (Beasley et al., 2005). The ECIIA-FERMA cybersecurity framework suggests significant cooperation between IA and CRGG (FERMA, 2018). Islam et al. (2018) point out that the extent of security/cybersecurity audit by Internal Audit Function (IAF) affects IAF competence related to governance, risk and control. Moreover, they found that IAF skills (governance, risk and compliance) impact the extent of security/cybersecurity in the audit process. Their evidence shows that the degree of integration between ERM processes and the

IAF has no impact on the extent of cybersecurity focus on the audit process. Their study provides early evidence of a positive effect on cybersecurity audit when there is the Board's support in reviewing the governance policies. This evidence demonstrates the need for internal auditing in designing and performing cybersecurity RM.

3.3 Training and Awareness

In addition to the Boards' engagement and the audit task, promoting people's training and awareness in the entire organisation is essential to fostering changes in people's behaviour and reducing human vulnerability. Vroom and von Solms (2004, p. 191) argue that there is the need to find an alternative method to "behavioural auditing when policing the employee is not necessary" or useful. Instead, a soft/informal approach can change the organisational culture and make employees aware of security threats. This is the case in preventing SE attacks.

Hinson (2008) defines SE control through three consecutive stages: pre-incident, para-incident, and post-incident. Companies should increase the entire organisation's culture to face the pre-incident stage through training and awareness programmes. Such a programme often includes training on topics, like codes of conduct, secure behaviour models, employee's responsibilities, resources for security, security and incident responses, and role-specific security matters.

In the para-incident stage, employees' surveillance is essential to detect SE attacks when they occur. Standardised procedures for reporting security incidents are communicated through the IT Help Desk, or a dedicated "whistleblowers' hotline" for confidential reporting. Reporting SE incidents can benefit the long run of the cybersecurity programme because the employee involved in the incident can receive support. The company can then think about what to do after and share his experience with other employees for training purpose (Hinson, 2008). Instead, if SE attacks are ignored, the security manager can never know and assess their risk's extent.

In sum, there is a need to balance technical and non-technical controls (ISO/IEC 27002: 2005), formal and informal control (Campbell, 2018) for adopting cybersecurity risk governance and control. Formal controls include organisational policies outlining responsibilities and supervision, while informal control acts on people's behaviour by fostering ethics, accountability and awareness (Dhillon et al., 2007). This informal control, along with its training and awareness programme, can enhance the soft dimension of cybersecurity risk governance to make it effective.

4 Conclusions

Recently, digital transformation has been significantly changing organisations through the widespread implementation of digital technologies. This transformation brings together some opportunities and risks, unfortunately. Digital technologies can improve efficiency, effectiveness, competitiveness and create value (Scornavacca, 2019); but they are also sources of cybersecurity threats and vulnerabilities. Therefore, the "dark" side of digital transformation requires designing and implementing effective cybersecurity RM systems.

This chapter offers an overview of the current state of the literature and practice in that field. We embrace the ERM approach and human capital perspective to propose an integrated model for cybersecurity risk governance and control. The ERM approach suggests that the cybersecurity strategy must be linked to risk and performance to create an integrated system. Consequently, the cybersecurity RM subsystem includes pre-, para- and post-events measures.

Meanwhile, the human capital lens from the intellectual capital framework suggests that firms' countermeasures should be based not only on technological and IT solutions but also on the organisation's soft variables and human capital, especially in SE attacks. By embracing this approach, we advocate three levels of actions for effective cybersecurity: corporate governance and control; auditing and internal procedures; training and awareness.

Our contribution lies in applying the intellectual capital theory to problems that, at first, appears to be concerning the IT domain and requiring technological solutions only. While arguing that solving these problems requires an interdisciplinary approach, a business administration lens based on the human capital perspective can provide a valuable and comprehensive reading of the problem and its solutions. Thus, we call for future empirical research into auditing and corporate governance to examine the hidden facets of corporate internal controls for cybersecurity and the human factors in cybersecurity RM.

References

Aguilar, L. A. (2014, June). *Boards of directors, corporate governance and cyber-risks: Sharpening the focus*. In Cyber Risks and the Boardroom conference, New York Stock Exchange. Retrieved from www.sec.gov/news/speech/2014-spch061014laa

AICPA. (2017). *Description of criteria for management's description of the entity's cybersecurity risk management program*. American Institute of Certified Public Accountants.

Alexander, D., Fiondella, C., Maffei, M., & Spanò, R. (2019). Reporting comprehensive income: The incoherencies of the IASB system and the possible contribution of Economia Aziendale. *Accounting in Europe, 16*(3), 340–359.

Allegrini, M., & D'Onza, G. (2003). Internal auditing and risk assessment in large Italian companies: An empirical survey. *International Journal of Auditing, 7*(3), 191–208.

Asare, S. K., Davidson, R. A., & Gramling, A. A. (2008). Internal auditors' evaluation of fraud factors in planning an audit: The importance of audit committee quality and management incentives. *International Journal of Auditing, 12*(3), 181–203.

Baldoni, R., & Montanari, L. (2016). *2015 Italian cyber security report*. CIS Sapienza University of Rome and CINI Cyber Security National Lab.

Beasley, M. S., Clune, R., & Hermanson, D. R. (2005). Enterprise risk management: An empirical analysis of factors associated with the extent of implementation. *Journal of Accounting and Public Policy, 24*(6), 521–531.

Campbell, C. C. (2019). Solutions for counteracting human deception in social engineering attacks. *Information Technology and People, 32*(5), 1130–1152.

Capalbo, F., & Clarke, F. (2006). The Italian economia aziendale and chambers' CoCoA. *Abacus, 42*(1), 66–86.

Carlton, M., Levy, Y., & Ramim, M. (2019). Mitigating cyber attacks through the measurement of non-IT professionals' cybersecurity skills. *Information and Computer Security, 27*(1), 101–121.

Committee of Sponsoring Organisations (COSO). (2017). *Enterprise risk management integrating with strategy and performance—Executive summary*. Retrieved from https://www.coso.org/Documents/2017-COSO-ERM-Integrating-with-Strategy-and-Performance-Executive-Summary.pdf

Deloitte. (2017). *Cybersecurity and the role of internal audit: An urgent call to action*. Retrieved from www2.deloitte.com/us/en/pages/risk/articles/cybersecurity-internal-audit-role.html

Dhillon, G., Tejay, G., & Hong, W. (2007, January). *Identifying governance dimensions to evaluate information systems security in organisations*. In 2007 40th Annual Hawaii International Conference on System Sciences (HICSS'07) (p. 157b). IEEE.

Ege, M. S. (2015). Does internal audit function quality deter management misconduct? *The Accounting Review, 90*(2), 495–527.

FERMA. (2018). *At the junction of corporate governance & cybersecurity*. Retrievable at https://www.eciia.eu/wp-content/uploads/2019/02/FERMA-Perspectives-Cyber-risk-governance-09.10.2018_0.pdf

Ferramosca, S., D'Onza, G., & Allegrini, M. (2017). The internal auditing of corporate governance, risk management and ethics: Comparing banks with other industries. *International Journal of Business Governance and Ethics, 12*(3), 218–240.

Florio, C., & Leoni, G. (2017). Enterprise risk management and firm performance: The Italian case. *The British Accounting Review, 49*(1), 56–74.

Hall, A. A., & Wright, C. S. (2018). Data security: A review of major security breaches between 2014 and 2018. *Federation of Business Disciplines Journal, 6*, 50–63.

Hinson, G. (2008). Social engineering techniques, risks, and controls. *EDPAC: The EDP Audit, Control, and Security Newsletter, 37*(4–5), 32–46.

Ifinedo, P. (2012). Understanding information systems security policy compliance: An integration of the theory of planned behaviour and the protection motivation theory. *Computers and Security, 31*(1), 83–95.

Islam, M. S., Farah, N., & Stafford, T. F. (2018). Factors associated with security/cybersecurity audit by internal audit function. *Managerial Auditing Journal, 33*(4), 377–409.

ISO/IEC 27002. (2005). *International standard—Information security—Security techniques—Code of practice for information security management*. ISO/IEC.

Kahyaoglu, S. B., & Caliyurt, K. (2018). Cyber security assurance process from the internal audit perspective. *Managerial Auditing Journal, 33*(4), 360–376.

La Torre, M., Dumay, J., & Rea, M. A. (2018). Breaching intellectual capital: Critical reflections on big data security. *Meditari Accountancy Research, 26*(3), 463–482.

La Torre, M., Botes, V. L., Dumay, J., & Odendaal, E. (2021). Protecting a new Achilles heel: The role of auditors within the practice of data protection. *Managerial Auditing Journal, 36*(2), 218–239.

Landoll, D. J. (2017). *Information security policies, procedures, and standards: A practitioner's reference*. CRC Press.

Leech, T., & Hanlon, L. (2016). Three lines of defense versus five lines of assurance: Elevating the role of the board and CEO in risk governance. In *The handbook of board governance: A comprehensive guide for public, private, and not-for-profit board members* (pp. 335–355). Wiley. https://doi.org/10.1002/9781119245445.ch17.

Lin, S., Pizzini, M., Vargus, M., & Bardhan, I. R. (2011). The role of the internal audit function in the disclosure of material weaknesses. *The Accounting Review, 86*(1), 287–323.

Luo, H., Lin, Y., Zhang, H., & Zukerman, M. (2013). Preventing DDoS attacks by identifier/locator separation. *IEEE Network, 27*(6), 60–65.

Malatji, M., Von Solms, S., & Marnewick, A. (2019). Socio-technical systems cybersecurity framework. *Information and Computer Security, 27*(2), 233–272.

Mancini, D. (2003). Le frodi informatiche. In M. Allegrini, G. D'Onza, D. Mancini, & S. Garzella (Eds.), *Le frodi aziendali. Frodi amministrative, alterazioni di bilancio e computer crime*. FrancoAngeli.

Pizzini, M., Lin, S., & Ziegenfuss, D. E. (2015). The impact of internal audit function quality and contribution on audit delay. *Auditing: A Journal of Practice and Theory, 34*(1), 25–58.

Prawitt, D. F., Sharp, N. Y., & Wood, D. A. (2012). Internal audit outsourcing and the risk of misleading or fraudulent financial reporting: Did Sarbanes-Oxley get it wrong? *Contemporary Accounting Research, 29*(4), 1109–1136.

Protiviti. (2015). *The battle continues—Working to bridge the data security chasm*. Retrieved from www.protiviti.com/sites/default/files/united_states/insights/2015-it-security-privacy-surveyprotiviti.pdf

Renaud, K., Von Solms, B., & Von Solms, R. (2019). How does intellectual capital align with cybersecurity? *Journal of Intellectual Capital, 20*(5), 621–641.

Rubino, M., & Vitolla, F. (2014). Corporate governance and the information system: How a framework for IT governance supports ERM. *Corporate Governance, 14*(3), 320–338.

Sarens, G., & De Beelde, I. (2006). Internal auditors' perception about their role in risk management. *Managerial Auditing Journal, 21*(1), 63–80.

Schuessler, J. H. (2009). *General deterrence theory: Assessing information systems security effectiveness in large versus small businesses*. University of North Texas.

Scornavacca, E. (2019). Trarre valore dagli ecosistemi digitali. In D. Mancini (Ed.), *Aziende come ecosistemi intelligenti. Profili informativi, gestionali e tecnologici*. FrancoAngeli.

Shain, H., & Penzler, O. (2003). Greater scrutiny and higher standards transform internal audit. *Bank Accounting and Finance, 16*(5), 3–7.

Signori, S., & Rusconi, G. (2009). Ethical thinking in traditional Italian Economia Aziendale and the stakeholder management theory: The search for possible interactions. *Journal of Business Ethics, 89*, 303–318.

Tysiac, K. (2014). *Technology plays a role in board members' top two concerns*. Retrieved from www.cgma.org/magazine/2014/jul/201410602.html

Van Schaik, P., Renaud, K., Wilson, C., Jansen, J., & Onibokun, J. (2020). Risk as affect: The affect heuristic in cybersecurity. *Computers and Security, 90*, 101651.

Verizon. (2017). *2017 data breach investigations report*. Verizon.

von Solms, B., & von Solms, R. (2018). Cybersecurity and information security–What goes where? *Information & Computer Security, 26*(1), 2–9.

Vroom, C., & von Solms, R. (2004). Towards information security behavioural compliance. *Computers and Security, 23*(3), 191–198.

Walker, P. L., Shenkir, W. G., & Barton, T. L. (2002). *Enterprise risk management: Pulling it all together*. Institute of Internal Auditors Research Foundation.

Smart and Resilient Cities: Best Practices from Disaster Risk Management Strategies

Hiroko Kudo, Antonio D'Andreamatteo, Massimo Sargiacomo, Carlo Vermiglio, and Vincenzo Zarone

1 Introduction

Currently, 55% of the world's population resides in an urban area, and more than 40% lives in medium large and megacities (United Nation Department of Economic and Social Affairs, UNDESA, 2019). Moreover, the number of megacities increased from 10, in 1990, to 33, in 2018 (UNDESA, 2019). These urbanization trends, climate change, natural and human-made disasters, and extreme weather events pose unprecedented challenges on cities and reveal the vulnerability of local governments in coping with these wicked problems (Rittel & Webber, 1973; Head, 2008; Head & Alford, 2015).

Indeed, over the past 30 years, more than 2.5 million people have died, and almost $4 trillion has been lost to natural disasters, with global losses quadrupling from $50 billion a year in the 1980s to $200 million in the past decade (https://research.un.org/en/disaster/statistics). The massive impact of these events demonstrates how cities and entire regions—although mirroring reactions in the aftermath

H. Kudo
Faculty of Law, Chuo University, Tokyo, Japan
e-mail: hirokokd@tamacc.chuo-u.ac.jp

A. D'Andreamatteo · M. Sargiacomo
Department of Business Administration, University "G.D'Annunzio" of Chieti-Pescara, Chieti, Italy
e-mail: antonio.dandreamatteo@unich.it; massimo.sargiacomo@unich.it

C. Vermiglio
Department of Economics, University of Messina, Messina, Italy
e-mail: cvermiglio@unime.it

V. Zarone (✉)
Department of Economics and Management, University of Pisa, Pisa, Italy
e-mail: vincenzo.zarone@unipi.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_14

of such exceptional catastrophic events (Sargiacomo et al., 2014; Sargiacomo, 2015)—lacked significant initial planning and preparedness in the management of disaster's risks, leading to massive damages and losses. Concentrated economic activities and population in cities have realized high efficiency and increasing productivity; indeed, more than 80% of global GDP is generated in cities (The World Bank, 2020); however, any disastrous events leave a strongly negative impact because of these concentrations.

These data explain why urban resilience assumed a pivotal relevance in academic literature and call for a change of course in urban policymaking through a better link between resilience and urban smartness (Zhu et al., 2020). The frequency and intensity of such events in the last decades (e.g., tsunami, earthquakes, floods, droughts) have imposed a significant shift in how cities frame disasters into their policy agenda, strengthening urban resilience to these massive challenges. Consistently, many countries started a policy shift from a disaster-reactive mentality to the proactive management of natural and climate-related hazards. This renewed approach is mainly rooted in prevention, preparedness, and literacy initiatives to boost community resilience to disaster risks and enhance urban smartness in coping with disasters (Vermiglio et al., 2020).

Both themes, smart city and disaster risk management (DRM), can therefore be studied under the lens of resilience, which represents a common interpretative key, widely discussed in the academic debate (Godschalk, 2003; Papa et al., 2015; Hernantes et al., 2019).

Assuming resilience as the common conceptual nexus between smart city and disaster risk management, we employed the document analysis method (Bowen, 2009) to answer the following research question: which are the best strategies so far emerged at the urban level to prevent and plan against natural disasters? First, we highlight some tenets of the studies on smart city and resilient city, their relationship, the concept of smartness, resilience, and sustainability, and "smart urban governance," especially among public management and urban studies literatures.

2 Background

In the last decades, the concepts of urban resilience and smartness have drawn the attention of many scholars, giving rise to several paths of research and favoring the dissemination of narrowed approaches that rarely assume a holistic view (Angelidou, 2014; Desouza & Flanery, 2013; Anthopoulos, 2015). Whilst urban resilience should be properly understood as "*the ability of an urban system—and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales—to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity*" (Meerow et al., 2016, p. 39), a smart city could be thought as an urban space where "*the creation, integration, combination, development and effective leverage of resources and assets towards innovation,* *attractiveness, competitiveness, sustainability, and liveability*" is "*facilitated and accelerated by the ubiquitous use of advanced information and communication technologies with local government playing key investigating roles in this process*" (Scholl & AlAwadhi, 2015, p. 2356).

Although the concepts of smart city and resilient city relate to each other, the literature developed independently, with a prevalent concern on the former (Zhu et al., 2020). Scholars recognize smart cities as a fuzzy concept (Ruhlandt, 2018) and resilience as a vague word (Meerow et al., 2016)—this state-of-the-art leading to ambiguous results both on research and practice. They also highlighted the myopia of implementing smartness as a goal, rather than a means to reach a better performance (Bereskova & Nijkamp, 2018), and a lack of 'appropriate governance arrangements' toward urban smartness (Ruhlandt, 2018).

Among others, Desouza and Flanery (2013) highlighted the relevance of an appropriate designing, planning, and managing of resilient cities, stressing the importance of considering resilience as a planning concept and an unavoidable concern for cities organizing to be smart. Notwithstanding this and other suggestions of the literature (Papa et al., 2015; Hernantes et al., 2019), the latest evidence shows a low level of urban resilience in (Chinese) smart cities, although there would be a positive impact on the resilience of infrastructure, economics, and institution (Zhu et al., 2019). However, the connection between smart city and the resilient city is ambiguous, since, according to the available literature, while the effects of the latter on smart city would always be positive, on the contrary, the results of promoting smartness on resilience could be mixed (Zhu et al., 2020). The concept of a smart city has also been connected to environmental issues, suggesting a broadened label of "smart sustainable cities" (i.e., eco-city, Ahvenniemi et al., 2017). Components of smart sustainable cities refer to the planned use and location of green spaces, waste disposal and recycling, air quality targets, traffic congestion, water management, and use of natural resources.

In the accounting literature, these topics have been almost completely neglected (with the exception of Argento et al., 2020), although more studies have been developed in public management (Brorström et al., 2018; Herscovici, 2018; Grossi et al., 2020) and urban studies areas. In these latter areas, it has been highlighted how the dissemination of "smart city" models depends on socio-technical structures and relations that foster the creation of an enhanced idea of "smart urban governance" (Meijer & Bolivar, 2016; Meijer, 2018; Šiugždinienė et al., 2019; Nesti, 2020) centered on citizen's engagement in the decision-making process, on ICT-based tools for safer cities and on collaborative models that sustain value creation at urban level (Misuraca et al., 2012; Castelnovo et al., 2015; Scholl & AlAwadhi, 2016; Dameri & Benevolo, 2016; Granier & Kudo, 2016; Viale Pereira et al., 2018; Webster & Leleux, 2018).

Above all, the promotion of a smart *and* resilient city (Papa et al., 2015; Fujinawa et al., 2015; Zhu et al., 2020), sustained by appropriate governance mechanisms, could offer the proper framework to deal with the aforementioned challenges.

Building upon these heterogeneous streams of literature, in the following sections we explore the content of resilience plans that could both deepen our understanding of possible city strategies to prevent and respond to natural and human-made disasters, as well as inform decision-makers on how to strengthen the readiness and preparedness of their cities.

3 Methodology

We used document analysis (Bowen, 2009) to understand the rationale and critical aspects of urban resilience strategy of large cities, the importance attached to disaster risk management within the "resilience discourse" and drivers of "city smartness" within the resilience strategies of the local governments under exam. First, we selected organizational and institutional reports from two primary databases, the UN INFORM Risk Platform (UNIRP) and the 100 Resilient Cities Strategies (100RCs), then examined the content of those reports (content analysis) to extract data and identify significant themes concerning the strengthening of urban resilience by the selected cities.

The UNIRP is a tool developed by the Joint Research Center of European Commission within a joint-program of the UN Inter-Agency Standing Committee Reference Group on Risk, Early Warning and Preparedness and the European Commission. The UNIRP provides an index through which assess country risk profile based on the interactions among three main dimensions—hazard and exposure, vulnerability, and lack of coping capacity—to obtain a list of countries that bring the highest level of exposure to natural hazards.

The 100RCs is a program launched by the Rockefeller Foundation in 2013, in partnership with ARUP, as part of its Global Centennial Initiative in the wake of Hurricane Katrina and Superstorm Sandy in the US. 100RCs was born out of the idea that local governments needed help planning disasters and combating persistent societal risks and vulnerabilities. The program is based on the Resilient City Index, built on different dimensions (health and well-being, economy and society, infrastructure and environment, leadership and strategy) and aimed to guide those cities interested in promoting urban resilience.

For each country selected from the UNIRP, we checked the adoption of disaster risk management strategies and plans at both the national and local levels.

Next, we focused on major cities within the selected countries, which adopted resilient urban strategies according to the 100RCs. Assuming that the chosen cites shared a similar methodology for issuing their strategies, we could analyze them within a common theoretical background.

Matching the evidence from these two databases (UNIRP and 100RCs Resilient Cities Strategies) gave us a final sample of seven countries and seven city resilient strategies.

4 Resilient City Examples

We determined country risk profile drawing information from the Inform Risk Index, a global, open-source risk assessment for humanitarian crises and disasters to ensure data reliability.

The Index considers 50 different indicators to measure hazards and peoples' exposure to them, vulnerability, and the resources available to help people cope and creates a risk profile for every country. Each country has a rating between 0 and 10 for risk and all its components, which is easy to compare (Fig. 1).

We selected 19 countries that show the highest score in terms of "hazard and exposure" to natural disasters, excluding dimensions that are not adequately related to natural disasters—i.e., conflict risk, human disasters, terrorism.

As a result, we obtained the sample shown in Table 1 here below.

Starting from this sample, we analyzed the urban level, intending to verify the presence of an urban resilience strategy that takes into account disaster risk management.

To enhance the degree of comparability among cases, we focused our attention on major cities which have been involved in the 100 Resilient Cities.

The theoretical foundation of the 100RC program lies in the Resilient City Index, designed in partnership with the consultancy firm ARUP, to enable cities to measure and monitor the multiple factors that contribute to their resilience. The main dimensions of the index are shown in Table 2.

The primary purpose of the Index is to diagnose strengths and weaknesses and measure relative performance over time. It provides a holistic articulation of city resilience, which is further developed in 12 goals and 52 indicators that are critical for city resilience.

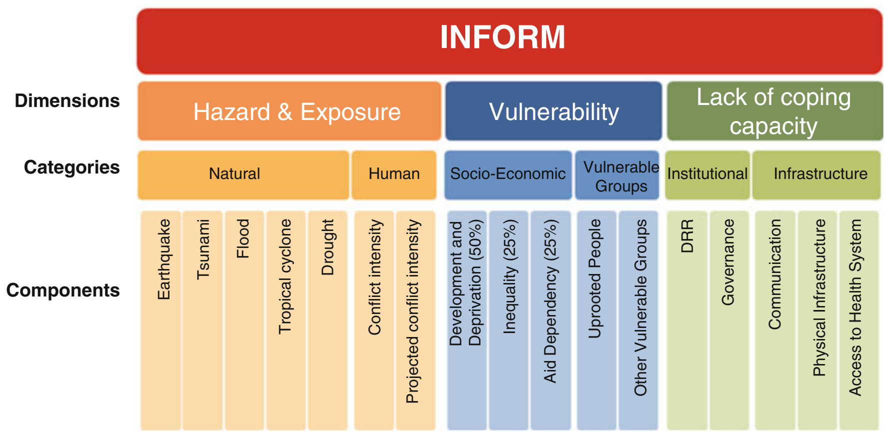


Fig. 1 INFORM Risk Index

Table 1 List of countries with the highest "hazard and exposure" score to natural disasters

Country	ISO3	Earthquake	Flood	Tsunami	Tropical cyclone	Drought	Epidemic	Natural
(a–z)	(a–z)	(0–10)	(0–10)	(0–10)	(0–10)	(0–10)	(0–10)	(0–10)
Philippines	PHL	10.0	7.2	9.3	9.5	4.1	6.6	8.4
Bangladesh	BCD	9.2	10.0	8.2	6.9	4.7	7.6	8.2
Japan	JPN	10.0	3.9	10.0	10.0	0.5	3.4	8.1
India	IND	8.3	8.4	8.1	7.2	7.0	7.4	7.8
Myanmar	MMR	9.1	9.9	8.9	5.6	1.0	6.5	7.8
Indonesia	IDN	8.9	8.1	9.7	6.1	3.4	7.0	7.7
China	CHN	7.2	8.4	9.2	8.1	4.6	5.8	7.5
Pakistan	PAK	9.3	8.8	6.7	3.8	5.2	7.8	7.4
Viet Nam	VNM	4.1	10.0	7.4	7.9	4.3	6.8	7.4
Peru	PER	9.9	6.4	9.3	0.0	4.5	5.3	7.1
Haiti	HTI	9.7	4.3	6.3	7.2	3.8	7.3	7.0
Ecuador	ECU	9.8	6.7	9.2	0.0	3.6	4.9	6.9
Somalia	SOM	1.6	7.5	8.1	1.0	10.0	6.3	6.9
Iran	IRN	9.6	6.4	6.9	1.8	6.1	6.3	6.8
Afghanistan	AFG	9.7	7.2	0.0	0.0	8.4	6.9	6.7
Colombia	COL	9.6	6.8	7.9	4.1	1.9	5.4	6.7
Dominican Republic	DOM	9.7	4.6	6.4	7.9	0.5	5.9	6.7
Guatemala	GTM	9.8	5.1	7.4	4.5	3.8	5.6	6.7
Mexico	MEX	8.6	7.2	6.6	7.7	3.3	4.9	6.7

Source: INFORM Risk Index (2020)

Table 2 Dimensions of Resilient City Index

Dimension	Meaning
Health and well-being	Ensuring the health and wellbeing of everyone living and working in the city
Economy and society	Creating social and financial systems that enable urban populations to live peacefully, and act collectively
Infrastructure and environment	Physical, natural, and technological systems that provide critical services, protect and connect urban citizens
Leadership and strategy	Informed, timely, inclusive, integrated, and iterative decision-making process in cities

Source: The City Resilience Index, The Rockefeller Foundation, Arup (2014)

The 12 goals determine the city's ability to withstand a wide range of shocks and stresses and refer to multiple interconnected features shown in the following diagram, which describe the rationale of the Index (see Fig. 2).

Among the selected countries listed in Table 1, we narrowed our research scope to those that jointly presented a disaster risk management plan and a city resilience strategy developed under the 100RC Framework.

In the light of this criterium, the resulting sample consists of the following countries/cities (Table 3).

At this stage, we focus on the City Resilience Strategic Plan to assess the relevance of the leading topics of our study—disaster risk management and smart city—within the RC Plans. In this regard, we propose three levels of score (low—medium—high) for evaluating the relevance of the aforementioned topics (Table 4).

5 Findings

The analysis of the selected resilient cities plans based on the INFORM Risk Index reveals the following features of a well-designed strategy.

First, resilient city strategies in these cities show a clear focus on all four dimensions shown in Table 2: *health and well-being, economy and society, infrastructure and environment, leadership and strategy*. City resilience is indeed a holistic concept and includes individual, societal, political, and institutional dimensions along with the physical dimension such as infrastructure and technology.

Second, Disaster Risk Management can be found and is present in all four dimensions; however, it appears with different relevancies among examined Resilience City Strategies. It is possible to observe strong focuses on preparedness, community engagement and participation, confirming the major theoretical discussions explored in previous studies. Indeed, disaster preparedness is stressed in many strategies, highlighting especially the importance of awareness, engagement, and capacity building of the community.

Fig. 2 Performance of cities based on 12 goals of City Resilience Index. Source: City Resilience Index website (2020)

Table 3 Selected Resilient Cities for analysis

Country	Resilient city strategy
Japan	Toyama
India	Chennai
Indonesia	Jakarta
China	Deyang
Vietnam	Da Nang
Mexico	Mexico City
Colombia	Medellin

Third and concerning the above point, digital innovation, especially the employment of ICT and data, plays an essential role in developing these strategies. Indeed, many of the city plans note that using smart and digital technologies enables not only community engagement, participation in the disaster risk management and collaboration of citizens, but also “fuelling urban growth, enhancing the quality of public services and fostering effective governance.” For example, Mexico City Resilient Strategy highlights the importance of improvement and innovation in public facilities and transportation systems to cope with eventual disasters and changing conditions, using data and digital communication tools. At the same time, Toyama Resilient Strategy explores the potentiality of an “open data platform that enables public and private data to be opened” and utilized for public transportation and utilities. ICT can also act as a “catalyst” that stimulates and/or accelerates the learning processes of the citizens and community as a whole, strengthening urban resilience to disaster risks, since new digital communication tools, including social media and apps, can be easily utilized by the general public.

Last but not least, *smartness*, from the point of view of human, technology, and governance, is only partially integrated into the discourse of Disaster Risk Management, while *smartness* has been strongly associated with the smart city discourse. Indeed, smart technologies are embedded in disaster risk management initiatives in merely four cases (Toyama, Danang, Mexico City, and Medellin) and especially in their public infrastructure and transportation system.

Various strategies highlight that effective disaster management needs smart governance, based on cross-sectoral collaboration and intergovernmental relations, smart people and community, supported by capacity building and educational programs, community preparedness, and literacy within the whole Disaster Risk Management cycle. In relation to this, smart governance in these strategies has to fuel knowledge and adaptation, stimulate collaboration across local and national governments, and with citizens, community, and business, to cope with the transboundary dimension of natural hazards.

The analyzed strategies show that disaster risk management requires smart people, smart technology, and smart governance, confirming the interconnection between smart city and resilient city in practice. In the next section, we draw on these findings proposing some concluding remarks.

Table 4 Disaster risk management and smart city principles in resilient city strategies

Country	National and local strategy for DRM	100 resilience city strategy relevance of DRM	Takeaway message for DRM	Relevance of smart city issues	Takeaway messages for smart and resilient approach to DRM
Japan	✓	*Toyama Resilient Strategy* **High relevance** – Disaster Preparation and Response Initiatives – Resilient infrastructure – Neighborhood Disaster Prevention Associations	1. Community awareness about different kinds of shocks impacting the city 2. Resilience as a principle of infrastructure design and management 3. Community engagement and adoption of sensor data, online maps, citizen reporting, social media and others emerging technologies for disaster preparedness and response	**High** 1. "Comprehensive Smart City" 2. 30 years Smart City Plan 3. Integrated Lifeline Platform	1. AN Open data platform that enables public and private data in Toyama to be opened and real-time regarding e.g., public transportation and utilities, tourism, and disaster control
India	✓	*Chennai Resilient Strategy* **High relevance** Disaster preparedness is amongst the five pillars of Chennai Resilience Strategy. Four main actions have been identified 1. Leveraging data and technology to cope with disasters more efficiently 2. Specifically address challenges faced by vulnerable groups living in disaster-prone areas	1. Reference to the use of DRR methods and exploitation of digital technologies i.e., sensors, big data analytics, multi-hazard maps, flood monitoring and mapping; early warning systems 2. Community engagement as a tool of "Disaster preparedness and Response Plan"	**Medium** 1. Smart technologies for "co-building city's resilience" 2. App for communication and citizen engagement 3. Open governance portal 4. "Smart initiatives" for enhancing the quality of public utilities	1. The vision for Chennai in the new future is '*Enlightened. Just. Integrated.*' It means city leaders and citizens think holistically, ecologically, and with foresight, as well as act proactively and smartly to manage and respond to risks and vulnerabilities

		3. Support small and medium scale businesses through a combination of economic and non-economic measures to help them cope better with disasters 4. Build capacity across government and community to ensure everyone is better prepared in the event of disasters			
Indonesia	✓	*Jakarta Resilient Strategy* **High Relevance** Disaster preparedness is one of the three pillars of Jakarta Resilience Strategy. Main actions identified 1. Enhancing Education on Disaster and Climate Change 2. Conducting Risk Evaluations of Shocks and Stress with Participatory Approaches 3. Updating Disaster and Climate Change Mitigation and Adaptation Plans 4. Mainstreaming Disaster and Climate Change Issues in the Public Policy Making Process 5. Controlling Groundwater Usage 6. Promote Tolerance in Diversity	1. Implementing collaborative approach to solve urban issues 2. Enhancing Education on Disaster and Climate Change 3. Crowd-Sourcing App and web-based platform to improve disaster preparedness	**Medium** 1. “Jakarta Smart city 2025”	1. A strategy which focuses heavily on: smart living, with reference to services and utilities such as waste, electricity, water, and housing; smart mobility, with the use of ICT for traffic management; smart environment, to tackle the problems of pollution; smart economy, also based on the development of tourism; smart governance, with the use of internet-based platforms for better use of services; smart people, focusing on education, health, and family planning

(continued)

Table 4 (continued)

Country	National and local strategy for DRM	100 resilience city strategy relevance of DRM	Takeaway message for DRM	Relevance of smart city issues	Takeaway messages for smart and resilient approach to DRM
China	✓	*Deyang Resilient Strategy* **Medium high relevance** – Disaster issue is mentioned in the pillar: “safe and livable city with strong resilience to earthquake” – Reference to both “prevention” and “disaster reduction capacity of buildings in villages and towns” Initiatives as: – “Action plan for quality census of rural houses” – Standardization of seismic reconstruction	1. Main (and only) stress related to disaster management is about earthquake 2. Specific focus on “earthquake prevention and disaster reduction system”	**Low** 1. No smart city plan, only a reference to a document titled: “Deyang Rural Revitalization Strategic Development Plan”	1. The pillars of the strategy are related to: urban planning, safety, livability, green and sustainability 2. The issue of smartness is not dealt with in the document 3. Unsystematic reference to tech – Using Technology for sewage treatment and water quality monitoring. – Data platform supporting “rural revitalization strategic development plan”
Vietnam	✓	***Da Nang Resilient Strategy*** **Very high relevance** – Natural disasters as a main source of shocks (typhoons, floods, flash floods, inundation, drought, saline intrusion) – Preparedness is a specific pillar of the resilience strategy (“A prepared city”) – Specific action plans for disaster (especially typhoon)	1. Great awareness of exposure to disasters and development of various resilience assessments over time 2. Preserving socio-economic development despite the frequency of occurrence of natural disasters 3 Detailed explanation of financial resources allocated for disaster response	**Very high** 1. There is a pillar of the strategy titled: “a connected city” 2. Data and communication infrastructure supporting disaster management 3. Other initiatives as the institution of a labor market online database	1. Many links between smartness, technology, and disaster management 2. Relevant investment in hydro-meteorologic monitoring and early warning system 3. Community engagement around information communication for disaster management

		prevention, response and recovery Initiatives as: – Monitoring and early warning systems for flood risk – Improving housing quality – Promotion of awareness and education to increase community resilience (i.e., “human cities initiative,” repainting storm-resistant housing)			4. Vulnerability assessment of housing to storm
Mexico	✓	***Mexico City Resilient Strategy*** **Very high relevance** – Disasters are among the major threats for MXC – Main targets of the resilience strategy are framed within disaster risk management and adaptation plan – Improve mobility planning for emergency and disaster situations – Promote private sector participation in building urban resilience to disasters	1. Collaboration with the private sector to enhance government’s capabilities toward disaster risk reduction and recovery 2. Public facilities and transport systems transportation are conceived to withstand disruptive or unexpected events and adapt to changing conditions	**Med-High** 1. Innovative transportation projects, technologies, and the smart use of data to improve integrated and sustainable mobility system. 2. Increase spatial social equality to generate precedents for smart development, sustainability, and resilience practices	1. Create a platform to facilitate the communication of risk information to the public and to enable citizens to build citizen networks for the construction of adaptive capacities and urban resilience 2. Consolidate the digital communication tools for disasters
Colombia	✓	*Medellin Resilient* **Medium high relevance** – Sustainable and Risk-Prepared Medellín – Disaster risk management as a flagship initiative of the resilience Strategy	1. Find the best way to mitigate economic losses and adverse effects caused by natural and human-made disasters 2. Strengthen community participation in disaster risk management	**Low** 1. Increase the community’s participation in the city’s planning processes through digital technology	1. Strengthen community risk management through the local committees and the construction sector, to generate greater use of risk prevention technologies and techniques and of Early-

(continued)

Table 4 (continued)

Country	National and local strategy for DRM	100 resilience city strategy relevance of DRM	Takeaway message for DRM	Relevance of smart city issues	Takeaway messages for smart and resilient approach to DRM
			3. Promote the revision, update, and implementation of the building codes, primarily in schools, health centers and housing		Warning System to promote disaster risk management

6 Discussion and Conclusion

The literature review shows that references to the smart city domain are mostly catchwords rather than systemic and combined approaches aimed to frame and contrast critical natural disasters and climate-related hazards. On the other hand, the concept of disasters in these connections mainly refers to the scenarios of testing smart city models/projects rather than public policy issues, thereby showing a retrospective view (post-disaster topic) and mistaken judgments of the severity of these wicked problems. On the contrary, a proactive and holistic smart governance approach is necessary over the entire disaster risk management cycle.

Indeed, the analysis of the selected resilient cities and their strategies based on the INFORM Risk Index shows that readiness and preparedness, response and adaption, and recovery or adjustment are all important aspects; however, the stresses on preparedness are well noted among them. Resilience City Strategies mostly focus on disaster preparedness, while their relevancies for typical smart city issues vary; however, the analysis of various dimensions of these strategies shows that “RSC can integrate the construction and management of SC and RC into a futuristic city that integrates “smart” in daily operations with “resilience” in disaster scenarios” (Zhu et al., 2020).

Based on findings from the selected strategies, we can argue that there is enough space for enriching the view of a smart city by broadening the focus to *smart and resilient* cities, because they encompass both the human and ICT dimensions, which are considered as irreplaceable pillars of future cities. In this regard, *awareness* and *preparedness* of both public institutions and local communities, including citizens, to face current and future disasters are key success factors for renewed smart and resilient city governance, as it is already highlighted by the available literature on (just) smart urban governance (see the background section).

The tricky part is translating and giving substance to these principles as operational smart and resilient city governance. Big Data analytics, Internet of Things (IoT), social media platforms and other smart and emerging technologies are key to boost resilience, provide in-depth and earlier understandings of disasters and improve response capacities and recovery actions in emergencies. Thus, smart and resilient governance is needed, to give substance to collaborative approaches, interorganizational routines and coordination mechanisms, stimulating knowledge transfer and capacity building toward reducing disaster risks. These principles have steered international institutions to mainstream a renewed and proactive approach based on *disaster risk reduction,* which has spread worldwide since the Hyogo Framework for Action (UN, 2007) and the Sendai Framework for Action (UN, 2015).

The literature and the analysis of the selected strategies confirm the importance of “*peoples’ dimension*,” which includes participation, involvement, dialogue, and, above all, collaboration among citizens, community, and government. In this sense, a smart, and the thus resilient city is a co-designed and co-produced city, the result of a participatory process of all stakeholders. Rising awareness, capacity building and development, and education of citizens and community are starting points. The *smartness*, in this regard, is to build smart people and create a smart collaborative scheme. Indeed, collaborative planning and standardization efforts for resource availability and disaster response and recovery planning (Anthopoulos, 2015) have integrated smart technologies and systems into a city's physical, environmental, and social systems to enhance disaster resilience by improving robustness, redundancy, resourcefulness, and rapidity.

The ambiguity of the concept of *smartness*, at the same time, acts as possibilities as well as an issue. Indeed, the resilient city strategies adopt a "holistic paradigm," that no longer considers disasters as unpredictable events with serious humanitarian consequences and that impose mainly recovery actions, but as situations to which the community and governments can prepare. In their view, a holistic view assumes a more strategic focus throughout the whole disaster management cycle, pointing out the interactions between various systems (physical, technological, human, social, and institutional) and causes (natural, human-made, environmental), promoting a shift from a disaster-reactive mentality to the proactive management of natural hazards. This approach is mainly rooted in prevention, preparedness, and literacy initiatives, to boost community awareness and urban smartness, which include capacity building and development, leading to co-design and co-creation.

Although exploring the best practices extracted combining the UNIRP AND 100RCs database allowed us to highlight the salient features in planning a resilient urban area, also suggesting the necessity of a higher level of smartness, our study has some limitations. Firstly, the extracted strategies are based on a unique framework, the one by 100RCs, and other approaches or strategies are not evaluated in our study. Secondly, we assessed just the above-mentioned RC plans, while other related documents and sources of information from the selected cities could shed light on other features about strategies in preventing natural disasters. Coherently, more studies, especially applying multimethod research approaches, and more case studies are needed to deepen the analysis and our understanding. Further, more studies should be done on how large cities and megacities can overcome the criticalities in the planning phase, as well as in implementing the planned strategies. Finally, valuable knowledge would be retrieved by investigating the emergency response in the occurrence of a natural or human-made disaster, in those areas which had previously effectively planned to be smart *and* resilient cities.

Sources

100 Resilient Cities Strategies. https://www.rockefellerfoundation.org/report/city-resilience-framework-2/

INFORM Risk Platform. https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk

References

Ahvenniemi, H., Huovila, A., Pinto-Seppä, I., & Airaksinen, M. (2017). What are the differences between sustainable and smart cities? *Cities, 60*, 234–245.

Angelidou, M. (2014). Smart city policies: A spatial approach. *Cities, 41*, 3–11.

Anthopoulos, L. G. (2015). Understanding the smart city domain: A literature review. In *Transforming city governments for successful smart cities* (pp. 19–21). Springer.

Argento, D., Grossi, G., Jääskeläine, A., Servalli, S., & Suomala, P. (2020). Governmentality and performance for the smart city. *Accounting, Auditing and Accountability Journal, 33*(1), 204–232.

Bereskova, K., & Nijkamp, P. (2018). Smart cities: A challenge to research and policy analysis. *Cities, 78*, 1–3.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9*(2), 27–40.

Brorström, D., Argento, D., Grossi, G., Thomasson, A., & Almqvist, R. (2018). Translating sustainable and smart city strategies into performance measurement systems. *Public Money and Management, 38*(3), 193–202.

Castelnovo, W., Misuraca, G., & Savoldelli, A. (2015). Citizen's engagement and value co-production in smart and sustainable cities. In *International conference on public policy* (pp. 1–16). Milan.

Dameri, R. P., & Benevolo, C. (2016). Governing smart cities: an empirical analysis. *Social Science Computer Review, 34*(6), 693–707.

Desouza, K. C., & Flanery, T. H. (2013). Designing, planning, and managing resilient cities: A conceptual framework. *Cities, 35*, 89–99.

Fujinawa, Y., Kouda, R., & Noda, Y. (2015). The resilient smart city (a proposal). *Journal of Disaster Research, 10*(2), 319–325.

Godschalk, D. R. (2003). Urban hazard mitigation: Creating resilient cities. *Natural Hazards Review, 4*(3), 136–143.

Granier, B., & Kudo, H. (2016). How are citizens involved in smart cities? Analysing citizen participation in Japanese "Smart Communities". *Information Polity, 21*(1), 61–76.

Grossi, G., Meijer, A., & Sargiacomo, M. (2020). A public management perspective on smart cities: 'Urban auditing' for management, governance and accountability. *Public Management Review, 22*(5), 633–647.

Head, B. W. (2008). Wicked problems in public policy. *Public Policy, 3*(2), 101.

Head, B. W., & Alford, J. (2015). Wicked problems: Implications for public policy and management. *Administration & Society, 47*(6), 711–739.

Hernantes, J., Maraña, P., Gimenez, R., Sarriegi, J. M., & Labaka, L. (2019). Towards resilient cities: A maturity model for operationalizing resilience. *Cities, 84*, 96–103.

Herscovici, A. (2018). New development: Lean thinking in smart cities. *Public Money and Management, 38*(4), 320–324.

Meerow, S., Newell, J. P., & Stults, M. (2016). Defining urban resilience: A review. *Landscape and Urban Planning, 147*, 38–49.

Meijer, A., & Bolívar, M. P. R. (2016). Governing the smart city: a review of the literature on smart urban governance. *International Review of Administrative Sciences, 82*(2), 392–408.

Meijer, A. (2018). Datapolis: A public governance perspective on "smart cities". *Perspectives on Public Management and Governance, 1*(3), 195–206.

Misuraca, G., Broster, D., & Centeno, C. (2012). Digital Europe 2030: Designing scenarios for ICT in future governance and policy making. *Government Information Quarterly, 29*, S121–S131.

Nesti, G. (2020). Defining and assessing the transformational nature of smart city governance: Insights from four European cases. *International Review of Administrative Sciences, 86*(1), 20–37.

Papa, R., Galderisi, A., Vigo Majello, M. C., & Saretta, E. (2015). Smart and resilient cities. A systemic approach for developing cross-sectoral strategies in the face of climate change. *TEMA Journal of Land Use, Mobility and Environment, 8*(1), 19–49.

Pereira, G. V., Parycek, P., Falco, E., & Kleinhans, R. (2018). Smart governance in the context of smart cities: A literature review. *Information Polity, 23*(2), 143–162.

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*(2), 155–169.

Ruhlandt, R. W. S. (2018). The governance of smart cities: A systematic literature review. *Cities, 81*, 1–23.

Sargiacomo, M. (2015). Earthquakes, exceptional government and extraordinary accounting. *Accounting, Organizations and Society, 42*(2), 67–89.

Sargiacomo, M., Ianni, L., & Everett, J. (2014). Accounting for suffering: Calculative practices in the field of disaster relief. *Critical Perspectives on Accounting, 25*(7), 652–669.

Šiugždinienė, J., Gaule, E., & Rauleckas, R. (2019). In search of smart city governance: The case of Lithuania. *International Review of Administrative Sciences, 85*(3), 587–606.

Scholl, H. J., & AlAwadhi, S. (2015). Pooling and leveraging scarce resources: The smart eCity gov alliance. In *2015 48th Hawaii international conference on system sciences* (pp. 2355–2365). IEEE.

Scholl, H. J., & AlAwadhi, S. (2016). Creating smart governance: the key to radical ICT overhaul at the city of munich. *Information Polity, 21*(1), 21–42.

The World Bank. (2020). *Urban development overview*. Last update April 20, 2020, from https://www.worldbank.org/en/topic/urbandevelopment/overview

United Nations. (2007). *Hyogo framework for action 2005–2015: Building the resilience of nations and communities to disasters*. https://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf

United Nations. (2015). *The Sendai framework for disaster risk reduction 2015–2030*. https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

United Nations, Department of Economic and Social Affairs, Population Division. (2019). *World urbanization prospects 2018: Highlights (ST/ESA/SER.A/421)*.

Vermiglio, C., Kudo, H., & Zarone, V. (2020). Making a step forward towards urban resilience. The contribution of digital innovation. In *International symposium: New metropolitan perspectives* (pp. 113–123). Springer.

Webster, C. W. R., & Leleux, C. (2018). Smart governance: opportunities for technologically-mediated citizen co-production. *Information Polity, 23*(1), 95–110.

Zhu, S., Li, D., & Feng, H. (2019). Is smart city resilient? Evidence from China. *Sustainable Cities and Society, 50*, 101636.

Zhu, S., Li, D., Feng, H., Gu, T., Hewage, K., & Sadiq, R. (2020). Smart city and resilient city: Differences and connections. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery, 10*(6), e1388.

Toward Resilient Smart Cities: The Experience of Genoa

Renata Dameri, Francesca Manes-Rossi, and Sara Moggi

1 Introduction

Over the last 10 years, smart cities began to flourish across the world with an increase in the use of advanced technologies, especially in most industrialized countries to meet urbanization challenges (Dameri & Ricciardi, 2015; Matos et al., 2017). European funds, in particular, supported this trend, and several calls for innovative projects supported pilots in European cities. These projects are aimed at developing best practices and competencies to be reused in the same city and eventually replicated in other cities (European Parliament, 2014).

Following the phase of pioneering smart cities, municipalities are now re-examining their current needs and priorities to implement smart solutions. Driving toward sustainable and resilient cities, these solutions are targeted to improve economic, social, and environmental conditions. However, European smart cities often appear as a collection of best-of-breed solutions without a comprehensive

While the paper is the result of a joint effort of the authors, the individual contributions are as follows: Renata Dameri wrote Sects. 4 and 6, Francesca Manes-Rossi wrote Sects. 1 and 2, and Sara Moggi wrote Sects. 3 and 5.

R. Dameri
Department of Economics, University of Genoa, Genoa, Italy
e-mail: dameri@economia.unige.it

F. Manes-Rossi (✉)
Department of Economics, Management, Institutions, University of Naples Federico II, Naples, Italy
e-mail: manes@unina.it

S. Moggi
Department of Business Administration, University of Verona, Verona, Italy
e-mail: sara.moggi@univr.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_15

smart city strategy and adequate knowledge management (Israilidis et al., 2019). Furthermore, there is inadequate knowledge of how a smart city can undertake necessary changes to transform into a resilient city. To fill this gap, the present study aims to identify the levers in the process that steers the evolution toward a resilient smart city (Viitanen & Kingston, 2014). To this end, one of the EU projects developed in the city of Genoa (the so-called R2Cities) was selected as a case study. It represents a rare example of how a smart city project implementation can foster city transformation toward resilience, enhancing stakeholder engagement (Dameri, 2014).

The research design is based on the interventionist approach (Jöonsson & Lukka, 2007), due to the direct involvement of one of the authors in the project under observation.

The case study illustrates how a smart city project can lead to the development of a sustainable and resilient city through the adoption of stakeholder engagement tools. It also provides the scope of further reflections by scholars and policymakers on possible synergies derived from previous experiences facilitating sustainable growth. There has also been discussion on the possibility of using smart city projects to capitalize knowledge, competencies, and skills that can be reused in further projects toward a resilient city, adhering to the needs of the community (Uziene, 2013).

The paper continues as follows. Section 2 provides a literature review on the evolution of smart cities toward resilient cities. Section 3 covers the research methodology, explaining the main characteristics of the interventionist approach. Section 4 introduces the context and presents the case under observation. Section 5 covers discussion and conclusions that present the findings and discuss the results under the lens of the literature on resilient smart cities.

2 The Evolutionary Path from Smart to Resilient City and Beyond

Today, the smart city is the best known innovative urban strategy to manage rapid urbanization (Anthopoulos, 2015). In the last 20 years, literature about smart cities has been constantly growing—emerging as a cross-cutting theme involving scientists, managers, and governments as well as environmentalists and sociologists. The comprehensive urban strategy, however, suffers from two weaknesses: a blurred definition and lack of integration.

Caragliu et al. (2011) stated that a city is smart "*when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance*" (Caragliu et al., 2011, p. 70).

The distinctive quality of a smart city can be identified both in the ability to provide infrastructures and services that ameliorate the citizens' lives. Additionally, it should be able to create a network including private and public partners whose activities improve the social, economic, and environmental conditions of the community by taking advantage of innovation and technology (Meijer & Bolívar, 2016). Therefore, a smart city involves merging ICT and other technologies to reduce the environmental impact of all the urban infrastructures and facilities and collect and communicate data to improve the quality of services.

The local government oversees the smart city initiatives, mobilizing human capital in collaboration with different actors (Meijer & Bolívar, 2016). Firms and citizens should also be strongly committed and involved based on defined strategies (Dameri & Benevolo, 2016). However, only a few smart cities have defined their strategies (Vanolo, 2014). In most cases, smart cities emerge as the results of disparate smart projects and are often not coordinated (Mora et al., 2019). Moreover, the lack of an integrated vision prevents the replication and dissemination of the outcomes of pilots and the proliferation of positive effects.

Environmental protection is one of the key challenges in smart projects, involving several technologies for renewable energy sources, waste management systems, and zero-emission buildings along with electric vehicles (Alawadhi et al., 2012; Dameri, 2014). A sustainable city indeed gives primary consideration to the environment and balances this objective with economic development and social welfare. Urban sustainability has also been increasingly considered as a topic of primary importance with the inclusion of "Sustainable cities and communities" among the 17 sustainable development goals of the United Nations (UN). Furthermore, resilience has garnered significant attention which is described as the capacity of cities to recover from disaster and mitigate and adapt to climate change (Elmqvist et al., 2019).

City resilience is a pivotal aspect of urban quality of life and closely related to smart cities from several perspectives such as the use of innovative technologies, environmental preservation, and careful territorial governance providing the utmost attention to people's safety (Antrobus, 2011). The link between smart cities and resilience has attracted increasing interest from researchers all over the world, as both smart and resilient cities face similar problems of global phenomena including rapid urbanization and climate change (Elmqvist et al., 2019). However, a *resilient smart city* is based on the interaction between a multitude of actors who could cooperate with each other and share goods and services. Notwithstanding the ability of residents to self-organize their activities, local government should maintain a leading and coordinating role in involving different stakeholders in the project to achieve smart city goals, balance different interests, and avoid contrasting or overlapping activities (Argento et al., 2019).

The main features distinguishing a resilient smart city have been identified as follows. First, the need to manage urban environmental footprint (Martikka et al., 2018). A smart city aims to reduce the environmental impact to fight against climate change, whereas a resilient city aims to face the consequences of climate change on people, infrastructure, and the natural environment (Hespanhol, 2017). These two urban visions can complement each other in implementing a strategy that can prevent shocks, and when not possible, deal with them (Moraci et al., 2018).

Second, the resilience of smart infrastructures (Fujinawa et al., 2015). Facilities, buildings, ICT platforms, and databases are expected to be resilient, and thus more affordable in the context of a smart city (Jo et al., 2019). The use of ICT in smart cities is also seen as an instrument to face shocks and build decision support systems for managing risks and improving the ability of cities to recover from a disaster (Poncela et al., 2014). The most interesting feature pertains to the role that the implementation of a smart city could play in creating resilience in urban areas. For example, pollution reduction owing to smart energy solutions and smart mobility systems. However, this approach is challenging in an era where climate change has a greater impact on cities, people, and businesses (Lazaroiu & Roscia, 2018; Zhu & Li, 2019).

Scholars, questioning whether a smart city is also a resilient city, discussed the essential conditions to implement a resilient city (Sharifi, 2020). A well-conceived, integrated urban plan remains fundamental to create synergies between different smart solutions (Moraci et al., 2018). A resilient smart city has both infrastructural and social objectives, where the local government offers leadership while citizens and other actors are strongly involved (Martikka et al., 2018; Aurigi & Odendaal, 2021). Furthermore, the economic consequences of managing a city with a combination of smartness and resilience should be considered (Martikka et al., 2018).

3 Methodology

The research is based on the interventionist approach which is attributable to the active involvement of one of the authors of the paper in the empirical context. It has been used as a research asset, offering theoretical and practical insights (Jöonsson & Lukka, 2007).

The interventionist approach to a research methodology offers the advantage of combining pragmatic and theoretical perspectives and activating collaboration between concrete experiences and theoretical observation (Bracci, 2017; Baard & Dumay, 2018). A key feature of interventionist research is the direct involvement of a researcher with managers of the target organization to solve real problems by putting theories into action (Baard & Dumay, 2018). Furthermore, this methodology enables to capture the “flow of life of the case” (Jöonsson & Lukka, 2007, p. 388). Unlike traditional case study research, interventionist research goes beyond the findings from interviews and data analysis, as the researcher has the opportunity to learn directly from field observation. For these reasons, the interventionist approach makes it possible to overcome the research–practice gap, thereby inducing academics in solving problems in greater depth and applying theories and knowledge to complement the implicit knowledge of practitioners (Baard & Dumay, 2018).

In the analyzed case study, the interventionist researcher was a Deputy Mayor at the Municipality of Genoa for Welfare and Social Housing from 2012 to 2014. She was in charge of the implementation of an EU project (R2Cities), playing a leading role in improving the energy efficiency of a large district of social housing.

Besides the technical and political objectives of the project, the interventionist researcher aimed to develop a unique innovation process. Following Argyris' types of interventionists applicable to practical problems (Argyris, 1970), she suggested a process innovation involving different categories of stakeholders to obtain the best results from the project. Given the controversies raised by the project, she decided to create a set of tools to foster stakeholder engagement and sensitize citizens' consciousness to the usefulness of the project. Additionally, she coordinated most of the meetings related to the project at both local and international levels.

Furthermore, during the course of her work in this field, she collected empirical experiences to develop a replicable implementation framework. More specifically, the researcher's introduction to main innovation is related to the role of stakeholders and ways to involve them and mitigate tensions emerging from different categories of stakeholders.

From 2014 to 2017, the interventionist researcher changed her role from deputy mayor to a personal counsellor for the mayor to implement smart city projects. In this new role, she had the opportunity to verify the possible ways to replicate the R2Cities project framework to set up similar projects in other districts. Since 2018, she has been a coordinator of the "Economic and Social Roundtable for Resilience" in the city of Genoa. This new and broader role offers her an opportunity to study and implement resilient city plans while investigating the links between smart city projects and resilience.

4 The Case Analysis

This study analyses the EU project R2Cities. The project started in 2011 following a European call for Smart Cities and communities to design replicable strategies for implementing the renovation of large-scale districts toward more sustainable living and achieving nearly zero-energy cities.

As with other EU projects, R2Cities proposed protocols and practices that could be replicated to achieve similar results. This project is based on the development of a framework to implement smart strategies for building energy renovation to turn a specific local context into a new resilient one over time. This has been achieved considering three cases located in different countries, climate conditions, and users' habits, demonstrating the framework and its impacts on a real context. The three demo sites include Kartal (Turkey), Valladolid (Spain), and Genoa (Italy). This study is focused on the case developed in Genoa, the capital of Liguria and one of the largest cities in Italy and the Mediterranean Sea with the largest seaport in Italy.

Genoa is one of Europe's pioneer smart cities, funded by several EU initiatives for smart programs. The purpose of these programs is to start a long-term smart strategy to face several problems emerging in a post-industrial urban context. In 2011, after the first round of calls, Genoa was the leading city in Europe for EU funding. It had a portfolio of 5.5 ml/€, amounting to 8% of the total amount of EU funding for these calls. In the following years, the Municipality had constantly increased both the amount of money and the number of smart projects, covering all aspects of a smart city.

In this metropolitan area, the case of the social housing district of "Lavatrici" (literally, washing machines in Italian) was chosen as the site for the smart renovation project development. This area was developed in the 1980s and the ownership is divided among many private and public owners. The population of these buildings consisting of 700 flats is mixed in terms of age, culture, and ethnicity.

Residents bewail the high energy costs (four or five times higher than the rent) and the discomfort of their apartments due to the lack of good insulation along with dampness and damage caused by rain. To address these issues, the interventions embedded the installation of two new boilers and a centralized unit that delivers hot water to 162 households. Additionally, the temperature control units recorded the consumption in some apartments, monitoring improvement in the indoor climate. As a result, the site saved 47% of thermal energy, thus ensuring an important improvement for the environment. In the second phase, the renovation consisted of the substitution of windows and doors, redesigning of heating plants, and installation of temperature sensors.

The project development was based on four main pillars.

Firstly and most importantly, an *innovative strategy* to promote stakeholder engagement was implemented during the entire process of renovation.

To manage social tensions and the resistance of citizens against the renovation project of R2Cities, the researcher and her team introduced a *set of tools*. It constituted the pivotal process innovation implemented by the interventionist researcher (Baard & Dumay, 2018). They have organized thematic city councils specifically devoted to discussing the project promoting broad participation of the residents. Council counselling was also activated to carefully listen to citizens' needs. Open roundtables in the "lavatrici" area were organized together with the city councillor for urban planning and social policies. Furthermore, seminars were set up to allow engineers from the municipality to explain technical details to citizens. All these tools, combined with a wider stakeholder engagement involving the entire local community such as industrial players, small and medium enterprises, research organizations (e.g., universities and laboratories), public institutions, local administration, and no-profit entities, produced progressive consensus around the project. In this sense, the community was often highly involved in taking decisions about the project development.

It was also pivotal to *search for cost-effective solutions* for the whole improvement of the energy performance of the four buildings, considering the district as an ecosystem (e.g., standard indicators, new diagnosis approach, redesign of existing energy technologies in a systemic approach, and urban energy plans). A team consisting of both public servants and consultants from public and private institutions cooperated in defining technical solutions.

The *development of measures* permitting control over the implementation of the project in its phases and their results were further a fundamental pillar. The project was coordinated with a strategic plan for social policies to ensure durable social and urbanistic results.

Finally, the project was based on the *replicability of the developed strategy.* Also, the entire framework was based on a systematic approach to achieving an impact at the European level. The proposed framework includes tools such as Integrated Project Delivery, Building Information Modelling, Life Cycle Assessment, Life Cycle Cost, and simulation software. It also provides recommendations and guidelines adapted to different types of stakeholders for the whole construction process (best practice book).[1] However, it is important to note that the replicability of the project is limited by the existing financial resources.

5 Discussion

The R2Cities project developed in Genoa (Italy) offers food for thought to better understand how a smart city project can be implemented. It also helps comprehend to what extent a smart city project can create the ideal ground for a resilient smart city. The interventionist researcher also played an important role in this project, given the capability to merge theoretical knowledge and practical experience. Her role also supported and coordinated the technical knowledge of practitioners, thereby enabling them to put theories into action (Baard & Dumay, 2018).

In the case of R2Cities, the project uses several innovative technologies to create smart buildings and collect data and information on energy consumption for reducing the urban environmental footprint (Martikka et al., 2018). However, the project aimed to not only implement a technological solution but also solve a social problem. In the beginning, the project overcame several obstacles, as it was opposed by the tenants of the buildings who are incapable of understanding the importance of the project or perceiving the positive impact of technical solutions on their daily lives. Due to their opposition, the project was at a standstill.

To overcome this situation, the interventionist researcher suggested the active involvement of the main actors, giving the primacy to the tenants rather than the technicians. Consequently, the project was implemented involving the residents and their representatives such as the neighborhood committee, the union of tenants, political parties, and environmental associations. Partners including the University of Genoa, technology suppliers, and homebuilders were also active in the project. The municipality maintained the network guidance to avoid fragmentation or inconsistencies (Argento et al., 2019).

The project implementation was constantly monitored at the international level, comparing the local situation with the city's partners in the project (for details see the R2Cities website). One of the project outcomes is a "Book of practice," recording the

[1]The best practice book is available at the R2Cities project at the present link: http://r2cities.eu/project/the_project.kl

processes and activities conducted during the project implementation. It was also written to support further similar smart projects, thus favoring replicability.

Additionally, the project also ensures energy conservation and CO_2 emission reduction along with the realization of smart buildings, allowing improvements in terms of environmental protection (Alawadhi et al., 2012; Dameri, 2014).

The project implementation also enables the creation of intangible assets such as a large set of data, information, and procedures for engineering and governance. The process innovation introduced by the interventionist researcher and her team was a challenging component of the project. It constituted a legacy based on which a new resilience plan for Genoa was built subsequently.

The interventionist researcher was committed to gathering information from different sources, collecting divergent views, opinions, positions, and experiences from heterogeneous actors. She explored these divergences to solve conflicts and break the deadlock by experimenting the innovative governance solutions. The main outcome was the end of the primacy of technical goals in smart city projects, emerging from a cycle of analysis and interventions. Notably, these interventions are supported by the City council, tenants' committee, and practitioners. Furthermore, the subsequent approach supported the development of critical managerial knowledge and practical understandings that enabled change and provided skills for the new ways of operation.

The process finally closed at the beginning of 2018, producing a set of important outcomes derived mostly from the interventionist approach.

Moreover, with the adoption of different tools proposed by the interventionist researcher and her team, improved collaboration between different actors emerged as a pivotal element in the project development. Thus, it confirmed the points highlighted in the literature (Meijer & Bolívar, 2016). More specifically, political discussion arising from the complexity of the project and tools used to reduce tensions and oppositions from citizens represents an experience. Subsequently, a different and permanent stakeholder engagement can be created from this experience. Positive attitudes among house tenants, positive relationship between tenants and municipality, the long-standing committee supporting decisions about district management and maintenance, and long-term cooperation between the municipality, the University of Genoa, and a pool of innovative firms in the hi-tech sector are all legacy. And, this legacy can be operationalized in future projects.

This experience also supports the municipality in developing a clear strategy for the resilience plan, linking future actions to a common vision (Dameri & Benevolo, 2016). This new plan, which started when R2Cities was nearing completion, is intended to improve the city's capacity to face all kinds of shocks, especially frequent climatic challenges such as floods. The Resilience Plan for Genoa has been built using different stakeholder engagement tools developed during the R2Cities Project. The project re-embedded the tools into practice to construct a sustainable vision of the future city.

To summarize, this study identified three main themes of the R2Cities project development and the following resilience plan for Genoa. First, the adoption of *new technologies* leads to the creation of smart infrastructures, which in turn brought

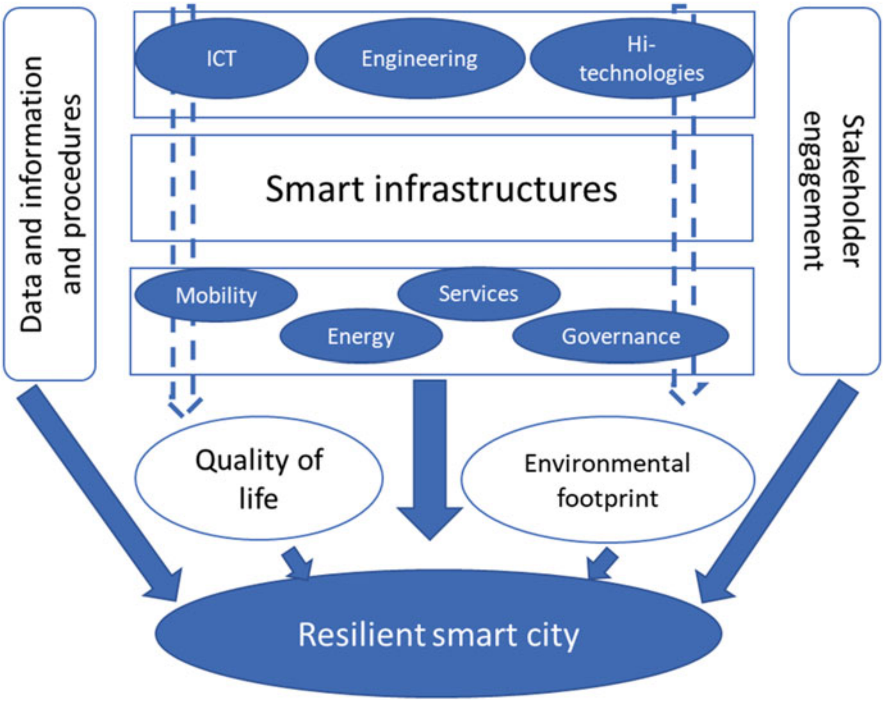


Fig. 1 Smart city implementation

changes in public services with the use of advanced technologies. Second, *political changes* occurred throughout the whole project. The interventionist researcher and her team introduced a process *innovation in decision-making* through the adoption of different tools supporting citizen involvement and wider stakeholder engagement. The adoption of these tools resulted in improved consciousness of citizens concerning the project and their role in governing the city. This innovation leaves a pivotal legacy for the creation of a resilient smart city. Third, the possibility to *replicate* the experience in other smart projects and as a background for developing a resilience plan for the city. As such, the project is not an end in itself but a foundation to establish new practices and produce a framework on which future projects may be based.

Figure 1 shows the key elements leading the implementation of a smart city to a more resilient smart city.

Engineering, ICT, and other innovative technologies are used to create smart infrastructures such as smart buildings, transport systems, and information systems. These infrastructures are then used to deliver solutions and services to citizens (smart mobility, services, energy, and governance), thereby improving the quality of life and reducing the environmental footprint of the city. In the meantime, the project collects, saves, and communicates with data and information along with consolidating the existing procedures for future projects. It also mobilizes citizens, other actors, and stakeholders, modifying their knowledge and behaviors through stable engagement. Thus, it creates relations and competencies. Data, infrastructures, and relationships developed through stakeholder engagement coupled with new services and governance solutions create resilience in urban areas. Consequently, it leads to the development of a resilient smart city.

6 Conclusions

Smart and resilient cities appear as converging strategies that need to be consciously merged to produce the desired results. The current study investigates the evolutionary path from smart to resilient cities. It primarily examines the key levers which are necessary to achieve this objective.

R2Cities is a smart project with a strong focus on reducing the environmental footprint of the city. Pollution control is also one of the most relevant drivers of resilience, as it may reduce climatic shocks. Moreover, smart projects have the merit to direct the interest toward the high impact of large cities on environmental deterioration (Antrobus, 2011; Lazaroiu & Roscia, 2018; Elmqvist et al., 2019). In the city of Genoa, a large number of citizens and actors involved in smart projects have been sensitized to climate change.

One of the most important roles that R2Cities has played in paving the way for resilience regards governance capability (Meijer & Bolívar, 2016; Martikka et al., 2018; Argento et al., 2019; Aurigi & Odendaal, 2021) to foster cooperation between various stakeholders from both public and private sectors, including local government, citizens, researchers, and businesses.

The case of R2Cities shows that governing smart city programs and designing resilient strategies require dedicated teams and committees to experiment with living labs. It consequently enhances the balance between contrasting claims and perspectives (e.g., economic interests, social welfare, and environmental impact) (Hespanhol, 2017). A pivotal role in the R2Cities project was played by the collection, sharing, and discussion of data and information which created a virtuous circle among the three participating cities (Poncela et al., 2014). Simultaneously, these data helped in taking political decisions and assessing their impact on the citizens and the social and economic milieu.

The smart projects also create a durable intellectual capital composed of several components useful to move from a smart city to a *resilient* smart city. These projects also need to develop a comprehensive, integrated strategic plan mainly based on the city's existing resources and sharing of knowledge and resources through smart technologies (Dameri & Ricciardi, 2015; Matos et al., 2017).

The present paper highlights the link between smartness and resilience, providing evidence of the common elements and ways for cities to implement smart and resilient policies within administrative and urban governance (Moraci et al., 2018). The process of achieving a smart resilient city could produce common good and better quality of life for citizens while reducing the environmental footprint (Zhu et al., 2019). However, a shared vision is essential (Mora et al., 2019) that requires a well-conceived strategic plan along with the commitment of all stakeholders and significant involvement of citizens.

The research reports the findings from a single case study; therefore, further empirical investigations are required to endorse the results presented. However, the study offers a rare point of view derived from the long-term direct participation of one of the researchers who sheds the light on some of the levers that can be managed to steer a smart city toward a resilient one.

References

Argyris, C. (1970). *Intervention theory and method: A behavioural science view*. Addison-Wesley Publishing Company.

Alawadhi, S., et al. (2012). Building understanding of smart city initiatives. In H. J. Scholl, M. Janssen, M. A. Wimmer, C. E. Moe, & L. S. Flak (Eds.), *Electronic government* (EGOV 2012. Lecture notes in computer science) (Vol. 7443). Springer.

Anthopoulos, L. (2015). Understanding the smart city domain: A literature review. In M. Rodríguez-Bolívar (Ed.), *Transforming city governments for successful smart cities* (Public administration and information technology) (Vol. 8). Springer.

Antrobus, D. (2011). Smart green cities: From modernization to resilience? *Urban Research and Practice, 4*(2), 207–214.

Argento, D., Grossi, G., Jääskeläinen, A., Servalli, S., & Suomala, P. (2019). Governmentality and performance for the smart city. *Accounting, Auditing and Accountability Journal, 33*(1), 204–232.

Aurigi, A., & Odendaal, N. (2021). From "smart in the box" to "smart in the city": Rethinking the socially sustainable smart city in context. *Journal of Urban Technology, 28*(1–2), 55–70.

Baard, V. C., & Dumay, J. (2018). Interventionist research in accounting: Reflections on the good, the bad and the ugly. *Accounting and Finance*. https://doi.org/10.1111/acfi.12409.

Bracci, E. (2017). The practical relevance of public sector research: The potential contributions of the interventionist approach. *Revista de Contabilidade e Organizações, 11*(30), 4–13.

Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology, 18*(2), 65–82.

Dameri, R. P. (2014). Comparing smart and digital city: Initiatives and strategies in Amsterdam and Genoa. Are they digital and/or smart? In R. Dameri & C. Rosenthal-Sabroux (Eds.), *Smart City* (Progress in IS). Springer.

Dameri, R. P., & Benevolo, C. (2016). Governing smart cities: An empirical analysis. *Social Science Computer Review, 34*(6), 693–707.

Dameri, R. P., & Ricciardi, F. (2015). Smart city intellectual capital: An emerging view of territorial systems innovation management. *Journal of Intellectual Capital, 16*(4), 860–887.

Elmqvist, T., Andersson, E., Frantzeskaki, N., McPhearson, T., Olsson, P., Gaffney, O., et al. (2019). Sustainability and resilience for transformation in the urban century. *Nature Sustainability, 2*(4), 267–273.

European Parliament, Directorate General for Internal Policies, Policy Department A: Economic and Scientific Policy. (2014). *Mapping smart cities in the EU*. Strasbourg.

Fujinawa, Y., Kouda, R., & Noda, Y. (2015). The resilient smart city (an proposal). *Journal of Disaster Research, 10*(2), 319–325.

Hespanhol, L. (2017). More than smart, beyond resilient: Networking communities for antifragile cities. In *Proceedings of the 8th International Conference on Communities and Technologies* (pp. 105–114).

Israilidis, J., Odusanya, K., & Mazhar, M. U. (2019). Exploring knowledge management perspectives in smart city research: A review and future research agenda. *International Journal of Information Management, 56*, 101989. https://doi.org/10.1016/j.ijinfomgt.2019.07.015

Jo, J. H., Sharma, P. K., Sicato, S., Costa, J., & Park, J. H. (2019). Emerging technologies for sustainable smart city network security: Issues, challenges, and countermeasures. *Journal of Information Processing Systems, 15*(4), 765–784.

Jöonsson, S., & Lukka, K. (2007). There and back again: Doing interventionist research in management accounting. In C. S. Chapman, A. G. Hopwood, & M. S. Shields (Eds.), *Handbook of management accounting research* (Vol. 1, pp. 373–397). Elsevier.

Lazaroiu, C., & Roscia, M. (2018). *Smart resilient city and IoT towards sustainability of Africa*. In 7th International Conference on Renewable Energy Research and Applications (ICRERA) (pp. 1292–1298). IEEE.

Martikka, M., Salo, S., Siilin, K., Ruohomäki, T., Tuomaala, P., & Nykänen, E. (2018). Smart City Resilience with Active Citizen Engagement in Helsinki. In *International Conference on Intelligent Systems* (IS) (pp. 162–167). IEEE.

Matos, F., Vairinhos, V. M., Dameri, R. P., & Durst, S. (2017). Increasing smart city competitiveness and sustainability through managing structural capital. *Journal of Intellectual Capital, 18* (3), 693–707.

Meijer, A., & Bolívar, M. P. R. (2016). Governing the smart city: A review of the literature on smart urban governance. *International Review of Administrative Sciences, 82*(2), 392–408.

Mora, L., Deakin, M., & Reid, A. (2019). Strategic principles for smart city development: A multiple case study analysis of European best practices. *Technological Forecasting and Social Change, 142*, 70–97.

Moraci, F., Errigo, M. F., Fazia, C., Burgio, G., & Foresta, S. (2018). Making less vulnerable cities: Resilience as a new paradigm of smart planning. *Sustainability, 10*(3), 755.

Poncela, J., Vlacheas, P., Giaffreda, R., De, S., Vecchio, M., Nechifor, S., et al. (2014). Smart cities via data aggregation. *Wireless Personal Communications, 76*(2), 149–168.

Sharifi, A. (2020). A typology of smart city assessment tools and indicator sets. *Sustainable Cities and Society, 53*, 101936.

Uziene, L. (2013). City's intellectual capital framework: The performance measurement point of view. *Economics and Management, 18*(2), 198–208.

Vanolo, A. (2014). Smartmentality: The smart city as disciplinary strategy. *Urban Studies, 51*(5), 883–898.

Viitanen, J., & Kingston, R. (2014). Smart cities and green growth: Outsourcing democratic and environmental resilience to the global technology sector. *Environment and Planning A, 46*(4), 803–819.

Zhu, S., & Li, D. (2019). A comprehensive evaluation for disaster resilience of smart cities in China. In *ICCREM 2019: Innovative construction project management and construction industrialization* (pp. 733–740). American Society of Civil Engineers.

Zhu, S., Li, D., & Feng, H. (2019). Is smart city resilient? Evidence from China. *Sustainable Cities and Society, 50*, 101636.

Other Relevant Smart Technologies: From Advanced Manufacturing Solutions to Smart Factory

Silvia Testarmata and Mirella Ciaburri

1 Introduction

Businesses continuously strive for the betterment of human life by producing, exchanging, and distributing goods and services efficiently and effectively. The first three industrial revolutions were driven by steam engines and mechanization (Mid eighteenth–nineteenth century), electrification (1870 onward), and digitization (1970 onward), respectively. The demand for more efficient and automated processes, higher quality, and customized products are driving businesses toward the fourth industrial revolution, called "Industry 4.0" (I4.0), that is, the prime agenda of the *High-Tech Strategy 2020 Action Plan* taken by the government of Germany, the *Industrial Internet* initiative promoted by the USA, and *Internet* + from China (Sinha & Roy, 2020). Indeed, businesses need to go through a radical change toward smart production and resource utilization to tackle the grand challenge of sustainable development (United Nations, 2015).

Emerging smart technologies including cyber-physical systems (CPSs), Internet of Things (IoT), Internet of Services, wireless sensors for networked control systems, data mining, big data handling, cloud, fog, edge computing, smartphones, smart devices, high-performance computers, 5G/6G communication, high-speed Internet, artificial intelligence (AI) and machine learning (ML) technologies, multiagent system, advanced robotic technology, blockchain, additive

Although this chapter represents the results of a joint effort of the authors, the individual contributions are as follows: Sections 1, 2, 4, and 5 are written by Silvia Testarmata, whereas Sect. 3 and its subsections are written by Mirella Ciaburri.

S. Testarmata (✉) · M. Ciaburri
Niccolò Cusano University, Rome, Italy
e-mail: silvia.testarmata@unicusano.it; mirella.ciaburri@unicusano.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_16

manufacturing, virtual reality and augmented reality, digital twins, etc., are the key enabling technologies involved in I4.0.

All these technologies can have repercussions not only in the manufacturing sector, but also in everyday life by transforming traditional appliances into smart products to implement sophisticated smart home systems (Aheleroff et al., 2020). In addition, the advent of new technologies has led to the emergence of new business models, such as "multi-sided digital platforms", i.e., businesses capable of connecting two or more groups of users thanks to the support of a digital platform (Zheng et al., 2021), and, "digital business ecosystems," which refer to a new interpretation of what socioeconomic development catalyzed by ICTs means.

In this chapter we briefly examine, through a systematic literature review, the state of the art in the area of I4.0. Specifically, we investigate the scientific knowledge about some of these new smart technologies that are at the forefront of I4.0 development and could potentially have a huge impact on business activity, such as additive manufacturing, augmented reality, cloud computing, 5G communication, and chatbot. Then, we investigate the most promising application of smart technologies in the business environment, that is, the smart factory.

Therefore, the remainder of this chapter is structured as follows: Section 2 outlines the research method; Section 3 presents the results of the literature review about the state-of-the-art research on smart technologies in the business environment; Section 4 describes the research results regarding significant applications of smart technologies in business, such as smart factory; finally Sect. 5 provides a discussion of the research results for academia and practitioners and the conclusion of the study.

2 Research Method

In our study, we adopt a structured literature review (SLR) method to investigate the state of the art on new relevant smart technologies and their applications. The SLR, initially proposed by Massaro et al. (2016), is widely recognized as the best method to provide insights and critique that will help identify future research agenda for the issue under investigation. The approach followed to conduct the SLR can be summarized by the following stages:

1. Definition of the research protocol
2. Definition of the research questions
3. Literature search and analysis
4. Development of insights, critique, and future research paths

To develop our research, we adopt the SLR protocol proposed by Massaro et al. (2016). The research questions addressed with this study are as follows: What is the focus and critique of the literature on new relevant smart technologies? What are the main applications of smart technologies in business? And what is the future of research on smart technologies?

We performed a systematic literature search through the Scopus database during November and December 2020, with the criteria detailed further in this paragraph. The time period of the research is limited from January 2016 to the end of 2020. In addition, due to the current debate regarding smart technologies, the available preprints of 2021 are included in the analysis. Actually, at the first stage we performed a wider research, however, due to the huge number of articles on this issue that we found, we opted to restrict the research period to the most recent years, in which we discovered very significant publications consistent with the aims of this study. The Scopus search was done to retrieve articles whose titles, abstracts, and keywords contained either the words "additive manufactur*", or "augmented reality", "cloud" or "5G", or "chatbot", or "smart factor*". Further filters included searching in the Business, Management, and Accounting subset of the database, to ensure consistency with the subject area, and searching peer-reviewed English only journal articles.

This search retrieved an initial sample of 8748 documents, where 1626 articles regard additive manufacturing, 780 articles concern augmented reality, 3838 articles contained the word cloud, 538 articles regard 5G, 115 articles include the word chatbot, and 1851 articles regard smart factory. Then a filtering process was carried out that consisted of independent reading of abstracts by this chapter's authors. After this process, 8656 articles were excluded from the analysis either because they were out of the scope of the present study or because they addressed other research topics not (directly) related to the business and management field. The final set of 92 documents (26 for additive manufacturing, 24 for augmented reality, 7 for cloud computing, 16 for 5G, 8 for chatbot, and 11 for smart factory) was then used for the SLR.

As a result, this study identifies technical potential, business prospects, and industry applications of these new relevant smart technologies and provides distinct perspectives on smart technologies within the sphere of smart factories.

3 State of the Art on New Relevant Smart Technologies

This section shows the main results regarding the first research question on new relevant smart technologies.

3.1 Additive Manufacturing

Additive manufacturing, opposed to subtractive manufacture (i.e., lean manufacturing), can be defined as a "constructive process of solid tri-dimensional objects starting from layer deposition" (ASTM, 2012). Its main application is known as three-dimensional (3D) printing. The technology can make products with complicated interior structures by adding powder materials together by layering upon layering and has the potential to revolutionize the entire manufacturing or complement the traditional production process (D'Aveni, 2015). Originally, the technology was used only to produce prototypes, but thanks to its many benefits like the availability of a wide range of materials, the reliability, the repeatability, the simplification of supply chain, and the reduction of inventories, it is now applied also to fabricate final products. Moreover, policy makers consider it as an important tool to strengthen sustainability, as thanks to it, it is possible to eliminate waste, while lean manufacturing can only reduce it (Ghobadian et al., 2020).

However, there are evidences that a single company cannot reach all the abovementioned advantages alone because, to reach its full potential, additive manufacturing requires the involvement of several stakeholders in the supply chain (Oettmeier & Hofmann, 2017) and needs to achieve high-scale adoption. Moreover, the implementation of this technology requires the re-engineering of business logics and potentially of the whole firms' supply chains (Weller et al., 2015).

This rising technology has been largely used in recent years in different fields like aeronautical and aerospace industries (Metzger et al., 2013), automotive industry (Rahim & Maidin, 2014), and biomedical one (Stansbury & Idacavage, 2016).

3.2 Augmented Reality

Augmented reality is a technology that integrates virtual objects with real-world environments, enhancing the reality and allowing real-time interactions (Fan et al., 2020). Thanks to this technology, users perceive the real environment enriched with new virtual objects "as if" they are part of the environment and can also interact with them. Such a promising technology allows for an enhancement of customer experiences, an increase of consumer involvement in the shopping process and a reduction of uncertainty in product selection (Hoyer et al., 2020).

Thanks to augmented reality, the consumer is accompanied throughout his/her whole shopping experience: in the pre-purchase phase, where he/she can use augmented reality application to obtain contextual information; during the purchase phase, when he/she can improve his/her purchase experience; in the post-purchase phase, where he/she can obtain some additional services (Chylinski et al., 2020). Moreover, the technology is continuing to evolve at a rapid pace thanks to several tools like 5G and Apple glasses.

The emergence of augmented reality has provided a strong technological support to those manufacturing industries that are experiencing difficult challenges in creating innovative products at a lower price. Companies can use this technology for improving several phases leading to the final product, such as product design, value chain management, logistics, marketing, after-sales services, training, and workers safety, which will result in costs saving also because companies can eliminate the need to rework (Choudhry & Premchand, 2021). For this reason, not only companies in every industry (e.g., Amazon, Facebook, Ikea, General Electrics, and Wayfair) but also other kinds of organizations like universities and social enterprises are investing huge amounts in this technology (Porter & Heppelmann, 2017) as, realizing the perfect combination of real world and virtual world, it leads to decreasing errors, enhancing efficiency, and implementing productivity.

3.3 Cloud Computing

Cloud computing is a fast-advancing technology that can be defined as a set of services that can be accessed from anywhere using a mobile device and an Internet connection (Erdogmus, 2009). The term “cloud” perfectly describes this technology, because it shows how easy it is for users to access on demand and from anywhere the stored applications. It is considered a new paradigm shift, by which firms can share ubiquitous resources with their employees or trading partners and create their own private cloud database. Moreover, users do not have to care about maintenance, backup or upgrade, because these tasks are on the provider side, being a technology based on a pay-per-use model.

This technology offers several strategic and operative advantages to its users, such as the possibility to reduce errors and costs of services, increase efficiency, enhance productivity, allow flexibility, implement scalability, and it is also considered a potential value creator, becoming a fundamental part of firms’ business tactics (Pyke, 2009). Moreover, it allows firms to share and control information along several steps of their value chains, such as manufacturing, finance, distribution, sales, and customer service. However, cloud computing raises the issue related to data security, privacy, protection, and integrity. For this reason, its application must be economical, efficient, credible with effective security, and privacy (Radhika & Aruna, 2019).

Along with the potential aforementioned benefits of cloud, the major concerns about this technology relate to possible service interruptions due to server maintenance decided by the server provider and to the cost of the technology if the amount of stored data is huge. For these reasons, large companies have a higher probability of adopting this technology, given the more resources they have and their better capability to manage risks related to innovation adoptions.

3.4 5G Communication

The transformation process of firms into smart manufacturing grounds its basis on connectivity needs (Godor et al., 2020). Moreover, almost all the day-to-day companies’ business operations are dependent on Internet connectivity (Smith, 2017): email exchange process, cloud-based software access, and IoT applications. For this reason, an eventual and accidental poor Internet performance could bring a loss in terms of workers productivity, income, and company reputation (Park et al., 2021). To better understand the potentials of this technology in comparison to its previous versions (i.e., 1G/2G/3G/4G, where G stands for *generation*), we need to introduce its main features, such as high speed, expanded bandwidth, low latency, low energy consumption, more security (Pundziene et al., 2019; Lu & Ning, 2020). Speed is usually measured in megabits and refers to the velocity at which data are sent and received; bandwidth is also measured in megabits and refers to the amount of data that can be transferred in a specific unit of time; latency is measured in milliseconds and measures how fast data can travel in a given network; energy consumption is decreased in order to avoid resource waste; also security is improved in this version of the technology because it is based on an end-to-end pre-judgment. Compared to the previous generations, in the 5G technology these features are highly improved. Moreover, in contrast with earlier versions, the main target of 5G is to improve the communication between people and machines or between machines and not between people (Li et al., 2018).

The capability of this technology to represent a disruptive shift can be seen in different industries, even if in most of them it requires to rethink the conventional business models, the use of communication procedures and IT applications. In the healthcare sector, where real-time data are crucial to save lives, Internet of medical things, together with virtual and augmented reality are tools exploiting the capabilities of 5G (Proksch et al., 2019) that are becoming very common in high-level medical centers. Manufacturing industries using additive manufacturing, sensors and nanotechnologies, AI, robotics, drones, cloud, and big data analytics tools in their production processes have been impacted by the use of 5G because this technology can assure a timing and secure data exchange process and offer a unifying platform to interconnect all the aforementioned elements (Rao & Prasad, 2018).

3.5 Chatbot

Thanks to the advent of smart technologies, also the way customers interact with companies has changed and companies have to deal with smart technology when they manage to communicate with their clients. In this context, both big and small companies started to use chatbots to automatize the customer interaction. Chatbots are “online human-computer dialog system[s] with natural language” (Jia, 2003). They can be considered as an instant messaging account that, thanks to AI, is able to provide conversational services and problems solutions to its users. The most famous examples of chatbots include: Amazon’s Echo and Alexa, Apple’s Siri, and Microsoft’s Cortana (Weinberger, 2017). While from a customers’ point of view, the main goal is their satisfaction maximization, there are several advantages companies can experience when implementing chatbots. First of all, establishing long-term customer loyalty and increasing close customer relationships which are fundamental elements for companies’ survival (Lovelock et al., 2015); reducing the number of support calls, which results in saving resources for the company’s core activities; increasing customer satisfaction thanks to the 24/7 availability of the service; contributing to customer's experience during online shopping and providing tailored products (Kusber, 2017).

To reach these advantages, chatbot needs to respect some features (Johannsen et al., 2018): it has to understand the user, providing quality communication and adapting its language to the target user; react to unspecific or inappropriate user inputs; provide an avatar to be seen as a real communication interface, which is also the reason why they are usually given a name to enforce the trust of their users; support different languages and include a spell-checking function to minimize errors and misunderstandings; provide security to stored data, mainly for those companies working with sensitive information (i.e., financial services firms); be integrated into the website and easily identifiable by users.

This promising technology is becoming used also in small-sized enterprises, even if its implementation costs remain high and not always accessible for these firms due to their license and billing conditions and since more consumers prefer to approach firms using virtual channels, chatbot is used in several industries, from financial services to manufacturing industries.

4 Smart Factory as Application of Smart Technologies

This section shows the main results of the SLR regarding the second research question on the main applications of smart technologies in the business environment. Actually, there are many applications of smart technologies in business, such as smart factory, smart farm, smart grids, and smart home. We decided to focus our analysis on the most promising application of smart technologies in the business environment, namely the smart factory, that is, one of the key constructs of I4.0. Understanding the current view on the smart factory concept is vital to connect with the academic progress and future promising research streams in sub-areas of the smart factory and smart technologies.

Smart factory is envisioned as a future state of a fully connected manufacturing system, completely monitored, largely data optimized, with blockchain-based payment flows, and mainly steered by decentralized CPSs that generate many autonomous real-time decisions, where human beings from the core workforce as well as from the working cloud create the computerization infrastructure and provide for higher-order decisions, conflict solution, and meaning in terms of business model and value creation (Stein & Scholz, 2020).

Smart factory has been defined by academia and practitioners from multiple perspectives, however, a consistent and shared definition of smart factory does not exist (Shi et al., 2020). Many of the definitions are from the perspective of CPSs. For example, Wang et al. (2016) define smart factory as a hyperconnected network-based integrated manufacturing system that integrates physical objects and products with information systems, to implement flexible and agile production. According to Trappey et al. (2017), the smart factory connects infrastructure, physical objectives, human actors, machines, and processes across organizational boundaries, enabling the fusion between physical and virtual world, exploiting sensors, actuators, and computation power to transmit data in real time for decentralized decision-making processes. In other words, smart factory integrates physical technologies and cyber technologies and makes the involved technologies more complex and precise in order to improve performance, quality, controllability, management, and transparency of manufacturing processes (Shi et al., 2020). Accordingly, smart factory can extend the scope of interconnection beyond the factory and further strengthen the relationships with suppliers and customers. Finally, smart factory leads to sustainable production to cope with the global challenges of sustainable development (Wang et al., 2016).

It is important to highlight that smart factory lays its foundation on digital factory (also known as simulation). Digital factory is a key smart technology of I4.0, which simulates, optimizes, and evaluates the entire production process and even the entire product life cycle in a virtual environment. Digital factory provides advanced decision-making support in relation to product, process and system design, and real-world production planning and control, using innovative technologies such as virtual reality or augmented, simulation, optimization, and intelligent software. Specifically, digital factory can rationally plan and control the production process, reduce the impact of labor on the production line, and use IoT to strengthen information management (Shi et al., 2020).

In any case, the implementation of smart factory could be very convenient for manufacturers because it has many intelligent features that could increase process efficiency, product quality, sustainability, and safety and it offers various prospective benefits and business opportunities. On the other hand, companies that would implement smart factory have to face several technical and managerial challenges. The desired intelligent features, prospective benefits, and challenges of smart factories are summarized in Table 1.

It is worthy to note that smart factory does not mean a factory without human beings. Instead, the development trend of smart factory is human–machine cooperation. In doing so, human flexibility and machine repeatability can be well combined. In such a scenario, human beings still control decision-making in key aspects. Moreover, implementing smart factory will be complex because not only traditional fields (mechanical, electronic, automation), but also emerging technologies (e.g., virtual reality, big data, and AI) will be involved. Therefore, the implementation of a future smart factory demands the rise of a new type of intellectual workforce with different and diverse kinds of knowledge, skillsets, and creativity (Sinha & Roy, 2020). As the former CEO of the Siemens Industry Sector in North America, Helmuth Ludwig says "*this is nothing less than a paradigm shift in industry: the real manufacturing world is converging with the digital manufacturing world to enable organizations to digitally plan and project the entire lifecycle of products and production facilities.*"

Table 1 Desired features, prospective benefits, and challenges of smart factories

Desired features	Prospective benefits	Technical challenges	Managerial challenges
Interoperability	Optimal resource handling	Intelligent decision making and negotiation	Initial investment
Virtualization	Robust manufacturing Process	High-speed IWN protocol	Competitive market Scenario
Modularity	Minimum human intervention in manufacturing	Industrial big data Handling	Value creation
Distributed control	Smart customized Products	Malfunction restrains	Supply chain management
Flexibility	Better customer experience	Cyber–physical Interface and control mechanism	Unavailability of skilled Workers
Personalization		Security	
Real-time response			
Self-maintenance			

Source: Adapted from Sinha and Roy (2020)

5 Conclusion and Future Research Directions

The study has revealed some interesting insights regarding the future of research on smart technologies in the field of business and management.

First, the analysis highlights the advent of smart factory as a new manufacturing model in the digital age, which requires future research and includes many patterns of development. According to Osterrieder et al. (2020), eight thematic distinct perspectives can be identified in academia as research fields that can be developed in the future: decision-making, CPSs, data handling, IT infrastructure, digital transformation, human–machine interaction, IoT, and cloud manufacturing and services. Research in the decision-making field analyses and develops concepts for data-based decision-making situations in manufacturing using different technologies, such as AI, ML, visualization techniques, to increase the performance and automatization. Studies in the CPSs field are concerned with developing models for assistant systems for operators, self-steering manufacturing systems, and CPSs. Research on data handling analyses how to exploit the potential of data, including data generation, acquisition, mining, and analysis. Studies in the IT infrastructure field address questions around hardware and software of a factory to enable and foster a development toward a connected system. Research on digital transformation focuses on the transformation of industrial products and production systems to intelligent and connected systems. Studies in the human–machine interaction field concentrate on the human role in a connected production system. Research on IoT addresses questions around the IoT development for manufacturing, focusing on the connectivity of elements in the production and supply chain system. Studies in the cloud manufacturing and services field discuss the digitalization of knowledge and exploitation through new service and business models for on-demand manufacturing.

Second, the literature analysis suggests some promising research avenues that can be further investigated in the future. A first avenue of research lies in the investigation of data-based performance forecasting systems and further development of solving real-world decision problems. A second promising research avenue is the extension of simulation models in the sphere of CPSs and incorporation of multiple modules into AI-aided manufacturing tools. A third fruitful avenue of research lies in the study of the integration of multiple forms of data in manufacturing, the investigation of data-based software tools for the organization of knowledge in production systems, the analysis of data mining approaches, and data security issues within manufacturing. A fourth promising research avenue consists in enriching the knowledge on the use of smart technologies and digital applications throughout the smart factory. Another fruitful avenue of research lies in the study of different perspectives on the adoption of IoT applications in manufacturing, including behavioral, economic, and managerial aspects. Finally, another research avenue relates to the investigation of application strategies for key smart technologies within manufacturing, the analysis of future cloud applications and business models, and the study of the operational impacts and benefits of cloud computing.

Third, regarding the applications of smart technologies in the business environment future research could enrich the knowledge on emerging issues such as smart grids, smart homes, smart farms and smart agriculture, and investigate the use of smart technologies and digital applications throughout these value chains.

In conclusion, we argue that the research on smart technologies in the business and management field is in an early stage of development and scholars need to make an effort to provide new theoretical models and frameworks to better explain the paradigm shift in business practices caused by the adoption of smart technologies.

References

Aheleroff, S., Xun, X., Yuqian, L., Aristizabal, M., Velasquez, J. P., Joa, B., & Valencia, Y. (2020). IoT-enabled smart appliances under Industry 4.0: A case study. *Advanced Engineering Informatics, 43*(1), 101043.

American Society for Testing and Materials (ASTM). (2012). *ASTM F2792–10: Standard terminology for additive manufacturing technologies*, West Conshohocken.

Choudhry, A., & Premchand, A. (2021). Digital transformation using immersive technologies in manufacturing and utilities. In M. Favorskaya, S. Mekhilef, R. Pandey, & N. Singh (Eds.), *Innovations in electrical and electronic engineering. Lecture notes in electrical engineering* (Vol. 661). Springer.

Chylinski, M., Heller, J., Hilken, T., Keeling, D. I., Mahr, D., & de Ruyter, K. (2020). Augmented reality marketing: A technology-enabled approach to situated customer experience. *Australasian Marketing Journal, 28*(4), 374–384.

D'Aveni, R. A. (2015). The 3-D revolution. *Harvard Business Review, 93*(5), 40–48.

Erdogmus, H. (2009). Cloud computing: Does Nirvana hide behind the Nebula? *IEEE Software, 26*, 4–6.

Fan, X., Chai, Z., Deng, N., & Dong, X. (2020). Adoption of augmented reality in online retailing and consumers' product attitude: A cognitive perspective. *Journal of Retailing Consumer Services, 53*, 101986.

Ghobadian, A., Talavera, I., Bhattacharya, A., Kumar, V., Garza-Reyes, J. A., & O'regan, N. (2020). Examining legitimatisation of additive manufacturing in the interplay between innovation, lean manufacturing and sustainability. *International Journal of Production Economics, 219*, 457–468.

Godor, I., Luvisotto, M., Ruffini, S., Wang, K., Patel, D., Sachs, J., Dobrijevic, O., Venmani, D. P., Le Moult, O., Costa-Requena, J., Poutanen, A., Marshall, C., & Farkas, J. (2020). A look inside 5G standards to support time synchronization for smart manufacturing. *IEEE Communications Standards Magazine, 4*(3), 14–21.

Hoyer, W. D., Kroschke, M., Schmitt, B., Kraume, K., & Shankar, V. (2020). Transforming the customer experience through new technologies. *Journal of Interactive Marketing, 51*(3), 57–71.

Jia, J. (2003). *The study of the application of a keywords-based chatbot system on the teaching of foreign languages*. ArXiv preprint cs/0310018. Retrieved from https://arxiv.org/abs/cs/0310018

Johannsen, F., Leist, S., Konadl, D., & Basche, M. (2018). *Comparison of commercial chatbot solutions for supporting customer interaction*. Research papers 158. Retrieved from https://aisel.aisnet.org/ecis2018_rp/158

Kusber, R. (2017). Chatbots—Conversational UX platforms. In R. Smolinski, M. Gerdes, M. Siejka, & M. C. Bodek (Eds.), *Innovationen und Innovationsmanagement in der Finanzbranche* (pp. 231–244). Springer International.

Li, S., Xu, L., & Zhao, S. (2018). 5G internet of things: A survey. *Journal of Industrial Information Integration, 10*, 1–9.

Lovelock, C., Patterson, P. G., & Wirtz, J. (2015). *Services marketing*. Pearson.

Lu, Y., & Ning, X. (2020). A vision of 6G-5G's successor. *Journal of Management Analytics, 7*(3), 301–320.

Massaro, M., Dumay, J., & Guthrie, J. (2016). On the shoulders of giants: Undertaking a structured literature review in accounting. *Accounting Auditing and Accountability Journal, 29*(5), 767–801.

Metzger, P., Muscatello, A., Mueller, R. P., & Mantovani, J. (2013). Affordable, rapid bootstrapping of the space industry and solar system civilization. *Journal of Aerospace Engineering, 26*(2), 18–29. https://doi.org/10.1061/(ASCE)AS.1943-5525.0000236.

Oettmeier, K., & Hofmann, E. (2017). Additive manufacturing technology adoption: An empirical analysis of general and supply chain-related determinants. *Journal of Business Economics, 87*(1), 97–124.

Osterrieder, P., Budde, L., & Friedli, T. (2020). The smart factory as a key construct of Industry 4.0: A systematic literature review. *International Journal of Production Economics, 221*, 107476.

Park, A., Jabagi, N., & Kietzmann, J. (2021). The truth about 5G: It's not (only) about downloading movies faster! *Business Horizons, 64*(1), 19–28.

Porter, M. E., & Heppelmann, J. E. (2017). Why every organization needs an augmented reality strategy. *Harvard Business Review, 95*(6), 46–57.

Proksch, D., Busch-Casler, J., Haberstroh, M. M., & Pinkwart, A. (2019). National health innovation systems: Clustering the OECD countries by innovative output in healthcare using a multi-indicator approach. *Research Policy, 48*, 169–179.

Pundziene, A., Heaton, S., & Teece, D. J. (2019). *5G, dynamic capabilities and business models innovation in healthcare industry*. 2019 IEEE International Symposium on Innovation and Entrepreneurship (TEMS-ISIE).

Pyke, J. (2009). *Now is the time to take the cloud seriously*. White Paper. Retrieved from www.cordys.com/cordyscms_sites/objects/bb1a0bd7f47b1c91ddf36ba7db88241d/time_to_take_the_cloud_seroiusly_online_1_pdf

Radhika, D., & Aruna, K. D. (2019). The smart triad: Big data analytics, cloud computing and internet of things to shape the smart home, smart city, smart business and smart country. *International Journal Recent Technology and Engineering, 8*(2), 3594–3600.

Rahim, S. L., & Maidin, S. (2014). Feasibility study of additive manufacturing technology implementation in Malaysian automotive industry using analytic hierarchy process. *Advanced Materials Research, 903*, 450–454.

Rao, S. K., & Prasad, R. (2018). Impact of 5G technologies on Industry 4.0. *Wireless Personal Communications, 100*(1), 145–159.

Shi, Z., Xie, Y., Xue, W., Chen, Y., Fu, L., & Xu, X. (2020). Smart factory in Industry 4.0. *Systems Research and Behavioral Science, 37*, 607–617.

Sinha, D., & Roy, R. (2020). Reviewing cyber-physical system as a part of smart factory in Industry 4.0. *IEEE Engineering Management Review, 48*(2), 103–117.

Smith, G. (2017). Emergency business management and internet connectivity. *Business Horizons, 60*(3), 353–361.

Stansbury, J. W., & Idacavage, M. J. (2016). 3D printing with polymers: Challenges among expanding options and opportunities. *Dental Materials, 32*(1), 54–64.

Stein, V., & Scholz, T. M. (2020). Manufacturing revolution boosts people issues: The evolutionary need for 'human-automation resource management' in smart factories. *European Management Review, 17*, 391–406.

Trappey, A. J. C., Trappey, C. V., Govindarajan, U. H., Chuang, A. C., & Sun, J. J. (2017). A review of essential standards and patent landscapes for the internet of things: A key enabler for Industry 4.0. *Advanced Engineering Informatics, 33*, 208–229.

United Nations. (2015). Sustainable development goals. In Department of Economic and Social Affairs (Ed.), *Transforming our world: The 2030 agenda for sustainable development*. United Nations. Retrieved from https://sustainabledevelopment.un.org/sdgs.

Wang, S., Wan, J., Li, D., & Zhang, C. (2016). Implementing smart factory of Industrie 4.0: An outlook. *International Journal of Distributed Sensor Networks, 4*, 1–10.

Weinberger, M. (2017). *Why Amazon's Echo is totally dominating—And what Google, Microsoft, and Apple have to do to catch up*. Retrieved from http://www.businessinsider.com/amazon-echo-google-home-microsoft-cortana-apple-siri-2017-1

Weller, C., Kleer, R., & Piller, F. T. (2015). Economic implications of 3D printing: Market structure models in light of additive manufacturing revisited. *International Journal of Production Economics, 164*(6), 43–56.

Zheng, T., Ardolino, M., Bacchetti, A., & Perona, M. (2021). The applications of industry 4.0 technologies in manufacturing context: A systematic literature review. *International Journal of Production Research, 59*(6), 1922–1954.

Digital Platforms and Collaborative Ecosystems: Best Practices and Emerging Issues

Paola De Bernardi and Sara Moggi

1 Introduction

The significant rise in relevance in "digital transformation" is drastically evolving the business environment and presenting a multitude of diverse organizational and sectoral challenges. Indeed, the emergence of a multifaced set of innovative and powerful digital technologies as well as the growing attention to sustainability issues are pushing companies to rethink their business models with broad organizational and policy implications (Yoo et al., 2010; Nambisan, 2017). The phenomenon of digitization is radically encouraging organizations to create new products, services, and disrupt their way of doing business that relies on multi-stakeholder and openness-based collaborations among individuals, organizations, ecosystems, and society (Adner, 2017; Russo et al., 2013; Nambisan et al., 2019a, 2019b). The inherent network capacity that the internet provides is leading companies to abandon closed models to rely on collaborations with different partners (De Bernardi et al., 2020). In this vein, digital collaborative platforms have become relevant due to their capacity to facilitate connections among people, organizations, and resources to enhance valuable interactions between different stakeholders (Gawer & Cusumano, 2014). It emerged the phenomenon of platformization, namely a shift from individual products/services to platforms as intermediaries for transactions and organizing value creation processes (Parker & Van Alstyne, 2018; Nambisan et al., 2019a, 2019b; Bogers et al., 2018). The raising digital platform business model is shaped by

P. De Bernardi (✉)
Department of Management, University of Turin, Turin, Italy
e-mail: paola.debernardi@unito.it

S. Moggi
Department of Business Administration, University of Verona, Verona, Italy
e-mail: sara.moggi@univr.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_17

four interrelated common drivers: the co-creation of value, the strong interdependency and complementarity of participants, the synergy force, and the evolutionary growth (Smedlund et al., 2018). Moreover, platform business models could be considered as ecosystems in which the owner normally acts as a focal point or as an orchestrator (McIntyre & Srinivasan, 2016), who may manage the platform in a goal-directedness or serendipity ways (Thomas et al., 2014). The communities orchestrated by platform providers, along with outside complementors and consumers, could be defined as platform ecosystems based on strong and continuous interactions between suppliers, lead producers, competitors, and other stakeholders (Gawer & Cusumano, 2014; Inoue, 2019; European Commission, 2020).

Despite some common features, an unambiguous definition of digital platforms is still missing due to the intertwinement of institutions, actors, and digital technologies, which characterized platform-based models (Sedera et al., 2016; Klein et al., 2020). There is, in fact, a huge amount of platform types, whose definition depends in part on the field under which they are studied (Koskinen et al., 2019). Platforms can be defined as transactional, innovation, and integrated platforms (Koskinen et al., 2019; de Reuver et al., 2018). Collaborative platforms can also be defined according to the nature of the stakeholders involved. In this case, the most common models are the Business-to-Customer (B2C), the Business-to-Business (B2B), and the Customer-to-Customer (C2C) models (D'Andrea et al., 2019).

Despite the increasingly prominent role that collaborative platforms are playing in economies (Accenture, 2018), there is still a paucity of studies that analyze their business models, especially when these platforms leverage modern digital technologies. To acquire knowledge on the business models of digital collaborative platforms, this work employs a multiple case study on two emergent collaborative platforms from the food sector, which are built around a B2B and a B2C model, respectively.

The remainder of the present work is structured as follows. Section 2 summarizes the literature on digital-based platform ecosystems and B2C and B2B collaboration. Section 3 presents the methodology and the background of the cases. Section 4 discusses the main findings, while Sect. 5 provides some final remarks on some key novel knowledge acquired through the analysis of the cases.

2 Literature Review

2.1 Digital-Based Platform Ecosystems

On the wave of the recent studies on digital transformation, emerges different sets that enhance digital technologies, digital platforms, and digital infrastructures in which entrepreneurship is steered by innovation both at the organizational and societal levels (Nambisan et al., 2019a, 2019b; Nambisan, 2017; Yoo et al., 2010). In this context, knowledge is transferred by digital rather than physical means and the digital platforms become the media for enhancing this exchange (Helfat &

Raubitschek, 2018). Teece (2018) underlines that these platforms for supporting the sharing of knowledge should be rooted in the same ecosystem and involved two or more groups of stakeholders on different "sides" of the platform. The pivotal role of digital platforms in their related ecosystems is driving important implications at an entrepreneurial level such as the development of new services and products together with a new managerial perspective to manage them (Nambisan et al., 2019a, 2019b). According to Nambisan and Baron (2013, p. 1), the digital platform ecosystems "allow for smaller entrepreneurial firms to develop products and services that complement those of the platform owner." and, for new firms, to access established markets and enhanced their reputation. This implies the rethink and redesign of the company's business model embedding digital technologies as a core means for value creation inside the boundaries of the hosting ecosystems (Nambisan et al., 2019a, 2019b).

Since the large improvement and wide diffusion of technologies, digital platforms are becoming one of the managerial tools to manage by the firms. Digital platforms are based on the Internet or private intranet that are developed for the common use of a standard for integrating services and productions of companies but also another kind of organizations that increasingly are involved in the digital-platform ecosystem (Teece, 2018; Gawer, 2014). According to Teece (2018, p.19), a digital platform "provides a hub around which companies and users can, jointly or separately, innovate and attract users far more productively than if they were to try to achieve the same goals in the absence of the platform." Owning or managing a popular platform can provide a leader position upon which other firms base their business model on the common ecosystem that combine multiple business models from B2B and B2C businesses.

2.2 B2B Collaborative Models

Previous literature on B2B collaboration has prevalently focused on digital platforms as marketplaces that enable transactions between companies. However, digital platforms can also enhance collaboration for innovation and entrepreneurship among firms. Organizational processes which were traditionally been developed by single organizations alone, such as research and development, the manufacture of key components, or the assembly of final products, are nowadays increasingly accomplished through the means of partnerships or other contractual agreements between organizations (Chesbrough, 2003). This change of paradigm relies on new forms of relationships among organizations to foster the exchange of information and resources to identify, explore, and exploit opportunities for innovation (Gassmann, 2006; Dahlander & Gann, 2010). An effective joint innovation implies advantages for both start-ups and incumbents. On the one side, a start-up can develop a strategic alliance to get access to larger companies' resources and knowledge base and be legitimated in the market (O'Connor, 2006; Chesbrough, 2019; de Groote & Backmann, 2020). On the other side, incumbents may exploit new technologies and spur their innovation activities by leveraging start-ups' agility and ability to think outside the box (Hogenhuis et al., 2016; Usman & Vanhaverbeke, 2017). In the new paradigm, innovative business models emerge with the architecture of digital platform-based ecosystems (Teece, 2018) orchestrated by platform leaders who bear primary responsibility for continually innovate and redesign and altering those architectures as a consequence of the pace of change and the pressure of competition (Helfat & Raubitschek, 2018). As a confirmation of this, a recent report from Accenture has shown a significant correlation between collaboration, innovation, and growth of start-ups and large companies in G20 countries (Usman & Vanhaverbeke, 2017).

2.3 B2C Collaborative Models

The term B2C has traditionally been intended as a broad term that refers to the approach of selling goods, products, and services to consumers. This model has undergone significant evolutions with the new digitalization wave, which has favored online transactions and has overcome some limits related to physical channels (Yeow et al., 2018). B2C is recently evolving toward multiple collaborative models oriented to co-create value. The main aim of digital B2C platforms is, in fact, to open up to customers to enable mutually beneficial transactions through an infrastructure that should facilitate these interactions and create value to their distinct users while appropriating value for themselves (Nambisan et al., 2019a, 2019b). Co-creation with customers or users can be divided into two fields. The first one has its foundation in Vargo and Lusch (2008), who, according to service-dominant logic, point out that consumers always co-create when interacting with products (services). The second one is more practical and focuses on the joint commitment of consumers and companies to develop solutions (Prahalad & Ramaswamy, 2004). The increasing attention to the environment and society has pushed consumers to become agents that contribute to developing sustainable and responsible behaviors which in turn are reflected in the companies which come into contact with them (De Bernardi et al., 2019a, 2019b; Moggi et al., 2018). This is, for example, the case of Food Assembly, an emergent food digital platform that is based on the concept of the short food supply chain is the Food Assembly that facilitates direct exchanges between local producers and consumer communities, creating small temporary local markets. Farmers sell directly to Food Assembly's members and pay a 20% tax-free fee. There are no intermediaries: it is a direct sale. In this vein, the spread of digital platforms represents a powerful tool to engage customers and to increase the flow of information and knowledge about sustainable practices (De Bernardi et al., 2019a, 2019b).

3 Methodology

3.1 Multiple Case Study

This study, qualitative in its nature (Eisenhardt, 1989), aims to investigate in-depth two case studies of digital platforms from the food sector. This sector, traditionally defined as slow-growing, is evolving faster and faster through the development of collaborative models and innovation ecosystems that allow different stakeholders to jointly create value (De Bernardi et al., 2020). Following Siggelkow (2007), the authors focus on two specific organizations, analyzing them in their specific context. Both Forward Fooding and Too Good To Go were chosen as they represent exemplar cases where digital platforms and platform-based markets have enhanced collaborations among different stakeholders in the same ecosystem.

Data were collected through semi-structured interviews carried between September 2018 and February 2019. Three interviews were carried out face to face. Each of them was conducted by one co-author, while a second one was in charge of taking field notes and scrutinized the behavior and the approach of the interviewee in answering questions (Patton, 2002). The other three interviews were conducted via Skype due to proximity issues. All the key informants were selected following a purposive sampling technique and according to their knowledge and availability. More specifically, the interviews involved Founders and CEOs of Forward Fooding and the Business Developer of Too Good To Go in Italy who has been interviewed twice to provide new detailed information after a discussion with the Top Management at the Copenhagen branch. The interviews have been recorded, transcribed, and coded, generating open, axial, and selective codes (Patton, 2002). Data from the interviews were triangulated with online document analysis to integrate the findings and increase their reliability (Patton, 2002).

3.2 Cases Background

Forward Fooding, founded by Alessio D'Antino in San Francisco in 2014 and headquartered in London, is active on a global level. It represents the first collaborative platform enhancing collaboration among entrepreneurs and large companies of food and beverage sectors. Spurring entrepreneurs to share data with other actors of the network, Forward Fooding aims to provide both start-ups and corporate services. Forward Fooding offers alternative sales channels for start-ups to tap into and unlock collaboration opportunities with established food organizations and help business leaders redefine their innovation agenda by enabling collaborations with entrepreneurs, through partnership, and investment opportunities. Their business model is based on collective data intelligence activities which will be discussed in the article.

Too Good To Go is an APP that aims to reduce food waste. It was launched in Copenhagen in 2015, and it rapidly spread to other European Countries, overcoming 14 million users. Too Good To Go acts as a marketplace that connects businesses (e.g., restaurants, bakeries, hotels, supermarkets, cafes) with surplus food to regular consumers who can buy this food for a discounted price. Via the APP, which acts as a digital platform, the customers can buy a so-called "magic box," which is named magic since the customer does not know what he/she will find inside the box. The purchase process is quick and user-friendly since customers have to simply choose the store they want to pick the product up, place the order, pay, and then go to the assigned collection window and show their in-app receipt to the staff of the business which is selling the surplus food. These mechanisms allow the local entrepreneur to be supported and to acquire new customers while, at the same time, the percentage of food waste is reduced.

4 Results

4.1 The Case Forward Fooding

Forward Fooding is a platform whose mission is to spur food innovation through meaningful collaborations. According to the Founder and CEO of Forward Fooding Alessio D'Antino "*Collaboration between corporates and start-ups can make a difference in solving some of the biggest issues that are affecting our food system and bring more innovation to consumers*." Indeed, the Forward Fooding collaborative platform offers a valuable contribution to fulfill both start-ups and corporates' needs. On the one side, Forward Fooding supports start-ups by opening alternative channels and connecting them with corporates. On the other side, it helps corporates to innovate by nurturing collaborations with innovative companies via food-tech data intelligence. Data intelligence plays a pivotal role in Forward Fooding's business model and helps the company to differentiate itself from traditional business consulting models. This makes the process of partner selection faster and less susceptible to errors. The FoodTech Data Navigator provides access to Forward Fooding directory of 4.5 K+ start-up companies, institutional investors, and accelerators of the agri-foodtech sector and develops data-rich insights on the global ecosystem. FoodTech Data Navigator tool provides accurate information to the agri-foodtech ecosystem and helps experts to conduct research, uncover trends, develop forward-looking insights, and discover the latest companies and investors entering and exiting this dynamic new landscape.

The automatization of this process allowed Forward Fooding's team to focus their effort to manage the collaboration phase instead of the scouting phase. As stated by the CEO "*At the beginning we concentrated more on the scouting phase, now instead the platform offers greater empowerment to our customers and stimulates the understanding of what is happening at the ecosystem level, while we can focus more on the next phase, which is that of managing the collaborations*." Indeed, after the scouting phase in which corporates can identify the most relevant businesses and investment opportunities based on their innovation agenda, Forward Fooding will engage with its customers and deploy a 12-week methodology to facilitate the relationships for both parties from arranging meetings and signing a non-disclosure agreement to finalizing commercial partnerships and/or investment arrangements. The 12-week methodology, which is the essential phase to launch an effective partnership between the start-up and the corporate has been described deeply by the founder of Forward Fooding: "*Our methodology consists in a series of 12 structured meetings, one a week, where we go from the exploratory phase of understanding what is the ground for the commercial partnership to an executable proof of concept within a 12 weeks-time window. So that, it is to help entrepreneurs not to spend too much time on a corporate deal, or really to get some focused meetings where they can see also if the conversation is advancing in the right direction. But also, vice versa, we aim to force the corporate to make decisions and not being too afraid of taking*."

Another initiative realized by Forward Fooding is the so-called FoodTech 500. Inspired by the Fortune 500, Forward Fooding has created a definitive list of global entrepreneurial talent at the intersection between food, technology, and sustainability. The three aspects considered to list the ranking are business size score, digital footprint score, and sustainability score. Concerning the last aspect, which is gaining increasing importance, Forward Fooding looked at a range of factors such as (1) carbon footprint of the manufacturing process, (2) presence of third-party sustainable certification, and (3) presence of a dedicated sustainability team.

Finally, Forward Fooding uses data not only to stimulate open innovation but also to create a community through its recurrently organized meetings, the Food Meetup Series. These meetings are organized frequently to gather "*entrepreneurs, techies, and foodies*," empowering each entrepreneur to connect, share their ideas, and collaborate to build new ventures at the intersection of food and technology. These meetups include among the main activities start-up pitches, keynotes with entrepreneurs and industry leaders, panel discussions, and fireside chats. Figure 1 sums up the main pillars of this innovative collaborative platform.

4.2 The Case Too Good to Go

Too Good To Go represents a unique case following a win-win-win logic. This APP connects through a digital platform retailers and consumers to reduce food waste. Although the amount of food waste in traditional supply chains is generated at every step, previous literature has already individuated the late stages of the food supply chain, including the consumption stage, as the most critical generators of food waste (Moggi et al., 2018). Too Good To Go has set itself the ambitious target of reducing the food waste by incentivizing the communication between those retailers who have spare food (e.g., supermarkets, restaurants, bakeries, coffees) with consumers who would be willing to purchase it for a discount price.

Fig. 1 The three pillars of Forward Fooding. Source: Authors own elaboration from sources provided by the Forward Fooding's founder

The transaction is made possible by an APP that acts as a digital platform able to intermediate between retailers and consumers and to keep them constantly updated. In win-win logic, Too Good To Go represent a viable solution that has a positive impact on retailers, consumers, and the whole planet, alike.

Too Good To Go offers *retailers* the opportunity to sell food that is near to its expiration date or fresh food that remains unsold at the end of the day at a discounted price to consumers. According to Jamie Crummie, one of the founders of Too Good To Go, through his company not only retailers increase their earnings but they are also able to reduce their costs associated to waste management: "*We're placing a value on something which businesses have traditionally had to spend a lot of money to get rid of—by that I mean their waste and waste disposal costs—we're shifting an established approach*."[1] However, the advantage is not only economic. Food suppliers can improve their brand images and reputation and leverage their corporate social responsibility by joining the Too Good To Go community, embracing this sustainability-oriented paradigm.

The second group of stakeholders that gain advantages from the Too Good To Go ecosystem are *consumers* that by the easy interface which characterize the APP can purchase the "magic box" quickly, with the opportunity to select the time they want to pick the product up. Too Good To Go will enable consumers to buy discounted food and save money. As for the retailers, however, the advantages are not limited to the economic sphere. Too Good To Go is a strong community where people can identify themselves as sustainability-oriented purchasers and share their vision, making their purchasing behavior a hedonistic choice. There is also another social element related to consumers. Since this APP increases the sensitivity toward food

[1]Jamie Crummie article, release at Too Good To Go. Speciality Food Magazine release in May 2019. Available at the following link https://www.specialityfoodmagazine.com/assets/images/free-issue/sf-may19.pdf

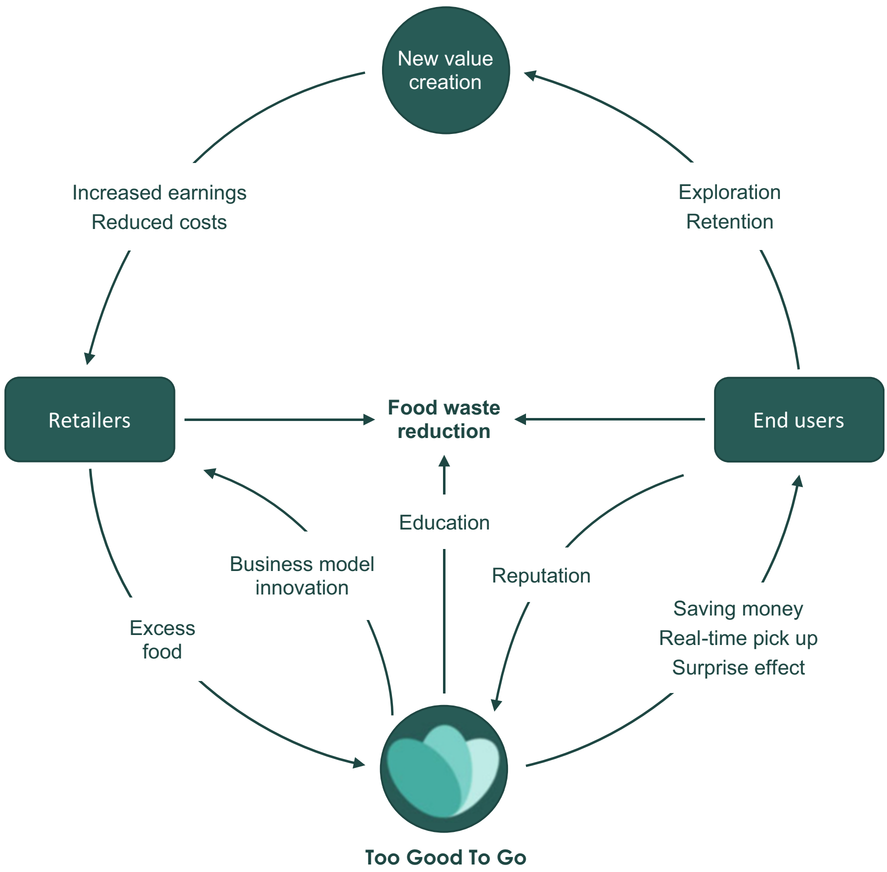


Fig. 2 The circular model of Too Good To Go's. Source: Authors own elaboration

waste issues, consumers are aware of not discarding the food they have purchases and they usually prefer to share it with homeless people or acquaintances such as friends or relatives. This is a relevant indirect social element that arises from Too Good To Go model.

Finally, the third invisible actor which is involved in this virtuous mechanism is the *planet*. First of all, Too Good To Go empowers a sustainability paradigm that leads consumers and retailers to co-create value. Looking at the statistics related to the environmental impact of this Too Good To Go, the website has registered in 2019 that the APP had sold 27,081,177 magic boxes, saving approximately 68,000 tons of $CO2$. Figure 2 summarizes the circular view of the business model enabled by Too Good To Go and emerged by the cases analysis.

According to the Business Developer of Too Good To Go who is operating in Italy, although the consumers which join the community are sensitive toward sustainability-related issues, it is important that Too Good To Go engages in educational programs. Indeed, the company has developed a whole section of its website for describing its efforts in this direction. So, it can be observed how it is financing educational programs in schools, pushing toward political changes in the countries where it is operative, and sensitizing and involving other actors of the food supply chain in joining its cause. Moreover, the company is planning to launch a new MOOC (massive online open course) for promoting food circularity and sustainable practices. More exactly, the willingness to engage and sensitize the broader public as possible is so intimately rooted in Too Good To Go's vision that is structuring this course in the form of an open-access.

5 Final Remarks

Despite the increasingly prominent role that digital platforms are playing in economic ecosystems, there is still a lack of studies that analyze their business models built on collaborations through digital technologies. For increasing the understanding of this phenomenon, the present research analyzed two innovative collaborative platforms of the food sector: Forward Fooding and Too Good To Go. More specifically, these two organizations lay their foundations in the B2B and B2C platform models, respectively, enhancing the richness of this study. In particular, the Forward Fooding case underlined how data have become a priority element which, thanks to machine learning and artificial intelligence mechanisms combined with human work, allows to create an innovation community and to stimulate collaboration between start-ups and corporates to spur innovation and entrepreneurship around the world. The analysis of the case Too Good To Go, instead, highlighted how a digital platform can enable interactions between retailers and consumers to reduce food waste, with positive consequences at economic, environmental, and societal levels.

In both cases, the presence of a digital platform acts as a media that enable transactions and collaborations, providing data in a flexible and updated way. However, in both cases, the digital instrument is integrated with the physical one. In fact, in the Forward Fooding case, the match between start-up and corporate is enabled by a period of 12 weeks where the two potential partners engage in periodic meetings that allow increasing trust, mutual knowledge, and align corporate strategies. In the case of Too Good To Go, instead, the product is physically withdrawn by consumers, reducing the barriers that could characterize such an online transaction, where producers do not know in advance what the food "magic box" contains.

Since this study has collected data from interviewing companies' owners and managers, further steps should enlarge the data collection to the industry side as in the case of Forward Fooding and the consumer side as in the case of Too Good To Go. Other case studies from other sectors should be leveraged to gain deeper knowledge about this emerging topic, such as to understand how trust and commitment are generated through digital platforms and how they are integrated by physical interactions.

References

Accenture. (2018). *Digital platforms will define the winners and losers in the new economy*. Retrieved on 08/03/2020 from https://www.accenture.com/_acnmedia/pdf-85/accenture-digital-platforms-pov.pdf

Adner, R. (2017). Ecosystem as structure: An actionable construct for strategy. *Journal of Management, 43*(1), 39–58.

Bogers, M., Chesbrough, H., & Moedas, C. (2018). Open innovation: Research, practices, and policies. *California Management Review, 60*(2), 5–16.

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business Press.

Chesbrough, H. (2019). *Open innovation results: Going beyond the hype and getting down to business*. Oxford University Press.

D'Andrea, F. A. M. C., Rigon, F., de Almeida, A. C. L., da Silveira, F. B., & Slongo, L. A. (2019). Co-creation: A B2C and B2B comparative analysis. *Marketing Intelligence and Planning, 37*(6), 674–688.

Dahlander, L., & Gann, D. M. (2010). How open is innovation? *Research Policy, 39*(6), 699–709.

De Bernardi, P., Bertello, A., & Venuti, F. (2019a). Online and on-site interactions within alternative food networks: Sustainability impact of knowledge-sharing practices. *Sustainability, 11*(5), 1457.

De Bernardi, P., Bertello, A., Venuti, F., & Zardini, A. (2019b). Knowledge transfer driving community-based business models towards sustainable food-related behaviours: A commons perspective. *Knowledge Management Research and Practice*, 1–8.

De Bernardi, P., Azucar, D. A. C., Forliano, C., & Bertello, A. (2020). Innovation and entrepreneurial ecosystems: Structure, boundaries, and dynamics. In P. De Bernardi & D. A. C. Azucar (Eds.), *Innovation in food ecosystem: Entrepreneurship for a sustainable future 189:221* (pp. 73–104). Springer.

de Groote, J. K., & Backmann, J. (2020). Initiating open innovation collaborations between incumbents and startups: How can David and Goliath get along? *International Journal of Innovation Management, 24*(2), 2050011. https://doi.org/10.1142/S1363919620500115.

de Reuver, M., Sørensen, C., & Basole, R. C. (2018). The digital platform: A research agenda. *Journal of Information Technology, 33*(2), 124–135.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review, 14*(4), 532–550.

European Commission. (2020). *Shaping Europe's digital future*. Retrieved on 08/03/2020 from https://ec.europa.eu/info/sites/info/files/communication-shaping-europes-digital-future-feb2020_en_4.pdf

Gassmann, O. (2006). Opening up the innovation process: Towards an agenda. *R&D Management, 36*(3), 223–228.

Gawer, A. (2014). Bridging differing perspectives on technological platforms: Toward an integrative framework. *Research Policy, 43*(7), 1239–1249.

Gawer, A., & Cusumano, M. A. (2014). Industry platforms and ecosystem innovation. *Journal of Product Innovation Management, 31*(3), 417–433.

Helfat, C. E., & Raubitschek, R. S. (2018). Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems. *Research Policy, 47*, 1391–1399.

Hogenhuis, B. N., van den Hende, E. A., & Hultink, E. J. (2016). When should large firms collaborate with young ventures? Understanding young firms' strengths can help firms make the right decisions around asymmetric collaborations. *Research-Technology Management, 59*(1), 39–47.

Inoue, Y. (2019). Winner-takes-all or co-evolution among platform ecosystems: A look at the competitive and symbiotic actions of Complementors. *Sustainability, 11*, 726.

Klein, A., Sørensen, C., de Freitas, A. S., Pedron, C. D., & Elaluf-Calderwood, S. (2020). Understanding controversies in digital platform innovation processes: The Google glass case. *Technological Forecasting and Social Change, 152*, 119883.

Koskinen, K., Bonina, C., & Eaton, B. (2019). Digital platforms in the global south: Foundations and research agenda. In P. Nielsen & H. C. Kimaro (Eds.), *International conference on social implications of computers in developing countries* (pp. 319–330). Springer.

McIntyre, D. P., & Srinivasan, A. (2016). Networks, platforms, and strategy: Emerging views and next steps. *Strategic Management Journal, 38*(1), 141–160.

Moggi, S., Bonomi, S., & Ricciardi, F. (2018). Against food waste: CSR for the social and environmental impact through a network-based organizational model. *Sustainability, 10*(10), 3515.

Nambisan, S., & Baron, R.A. (2013). Entrepreneurship in innovation ecosystems: Entrepreneur's self-regulatory processes and their implications for new venture success. *Entrepreneurship Theory and Practice, 37*(5), 1071–1097.

Nambisan, S. (2017). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. *Entrepreneurship Theory and Practice, 41*(6), 1029–1055.

Nambisan, S., Zahra, S. A., & Luo, Y. (2019a). Global platforms and ecosystems: Implications for international business theories. *Journal of International Business Studies, 50*(9), 1464–1486.

Nambisan, S., Wright, M., & Feldman, M. (2019b). The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes. *Research Policy, 48*(8), 103773.

O'Connor, G. C. (2006). Open, radical innovation: Toward an integrated model in large established firms. In H. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *Open innovation: Researching a new paradigm* (pp. 62–81). Oxford University Press.

Parker, G., & Van Alstyne, M. (2018). Innovation, openness, and platform control. *Management Science, 64*(7), 3015–3032.

Patton, M. Q. (2002). Two decades of developments in qualitative inquiry: A personal, experiential perspective. *Qualitative Social Work, 1*(3), 261–283.

Prahalad, C. K., & Ramaswamy, V. (2004). Co-creation experiences: The next practice in value creation. *Journal of Interactive Marketing, 18*(3), 5–14.

Russo, G., Lombardi, R., & Mangiagli, S. (2013). The tourist model in the collaborative economy: A modern approach. *International Journal of Business and Management, 8*(7), 1.

Sedera, D., Lokuge, S., Grover, V., Sarker, S., & Sarker, S. (2016). Innovating with enterprise systems and digital platforms: A contingent resource-based theory view. *Information and Management, 53*(3), 366–379.

Siggelkow, N. (2007). Persuasion with case studies. *Academy of management journal, 50*(1), 20–24.

Smedlund, A., Faghankhani, H., Ikävalko, H., & Turkama, P. (2018). Platform ecosystem orchestration for efficiency, development, and innovation. In A. Smedlund et al. (Eds.), *Collaborative value co-creation in the platform*. Springer Nature.

Teece, D. J. (2018). Profiting from innovation in the digital economy: Standards, complementary assets, and business models in the wireless world. *Resource Policy, 47*(8), 1367–1387.

Thomas, L. D. W., Autio, E., & Gann, D. M. (2014). Architectural leverage: Putting platforms in context. *Academy of Management Perspectives, 28*, 198–219.

Usman, M., & Vanhaverbeke, W. (2017). How start-ups successfully organize and manage open innovation with large companies. *European Journal of Innovation Management, 2016*, 1.

Vargo, S. L., & Lusch, R. F. (2008). Service-dominant logic: Continuing the evolution. *Journal of the Academy of Marketing Science, 36*(1), 1–10.

Yeow, A., Soh, C., & Hansen, R. (2018). Aligning with new digital strategy: A dynamic capabilities approach. *The Journal of Strategic Information Systems, 27*(1), 43–58.

Yoo, Y., Henfridsson, O., & Lyytinen, K. (2010). The new organizing logic of digital innovation: An agenda for information systems research. *Information Systems Research, 21*(4), 724–735.

Museums' Digital Communication: The Role of the Pandemic in Accelerating the Digital Revolution in Italian Museums

Nadia Cipullo

1 Introduction

The museum is a complex system, with a material and immaterial heritage consisting respectively of its own collections and the knowledge of its scientific staff who—as the definition of the ICOM states—acts to serve the community development through knowledge creation, conservation, and dissemination activities. The implementation of emergent technologies is crucial for the relationship with stakeholders to create and to co-design new tailored-made experiences. With the advent of the so-called "Web 2.0" and the birth of social media, the individual has assumed a central role in the process of creating and spreading knowledge, in a context of widespread socialization of knowledge. In particular, the topic of social media adoption should be more discussed and analyzed in-depth, as museums have started to rethink their business models in order to become more community oriented. In this new and evolving context, knowledge remains the main commodity offered by museums and Knowledge Management helps them to widely spread their resources in the globe for access, navigation, and contribution while sharing knowledge among museum professionals and communities. Moreover, as participatory institutions, museums should work to develop human, structural and relational capital in order to promote Intellectual Capital.

During the lockdown, many museums have started or increased their presence on social media and on online tools, by engaging the audience with old and new ways of communication of their cultural heritage. Through a quantitative content analysis based on 167 questionnaires collected during the first lockdown in Italy, the chapter aims to give an answer to the following three main research questions:

N. Cipullo (✉)
Link Campus University, Rome, Italy
e-mail: n.cipullo@unilink.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_18

1. Which communication and digital engagement initiatives were adopted by Italian museums during the lockdown?
2. Has the number of visitors increased?
3. What are the future challenges that museums will face and what are the strategies they will put in place to actively engage visitors?

In the following three paragraphs, after a review of the main literature concerning technology and museums, the ongoing changes and future prospects regarding the involvement of users through digital technologies for a sample of Italian Museums generated by the COVID-19 pandemic will be analyzed and discussed. The last paragraph will propose some conclusions.

2 Technology and Museums: A New Digital Revolution for Cultural Institutions

Museums are institutions at the service of society and as such, they make their cultural heritage available to the public. They acquire, store, research, communicate and exhibit, for purposes of study, education, and entertainment (Anderson, 1999; Addis, 2005). Museums collect, re-elaborate, and provide information, carrying out an operation of interpretation of their collections for visitors. As institutions of memory and repositories of knowledge (Freedman, 2000), museums should pay close attention to information management in order to create and share new knowledge (Schweibenz, 2011). In fact, they contribute to providing cultural knowledge (Russo & Watkins, 2007). As a community, museums contribute to sharing knowledge of cultural heritage within cultural ecosystems (Davies et al., 2013; Borin & Donato, 2015) and should strengthen human, structural and relational capital to develop Intellectual Capital (IC). According to Dumay (2016) the IC is the sum of everything that gives the organization a competitive advantage. IC is the knowledge that transforms raw materials and makes them more valuable (Stewart, 1997). IC should include:

- Human capital in terms of skills, competences, and abilities of individuals and groups
- Structural capital related to intellectual property, patents, copyrights, processes, documents and other artifacts of knowledge, computer networks and software
- Relational capital, relating to relations with suppliers and customers (Stewart & Ruckdeschel, 1998)

As participatory institutions, museums should work to develop human, structural and relational capital in order to promote IC.

Indeed, museums are increasingly developing interaction with the public, increasing the flow of communication and guiding users of cultural resources to act as learners but also as producers of new information for the creation of cultural value (Capriotti & Kuklinski, 2012; Bonacini, 2012).

Museums are rediscovering the public as an active participant in defining cultural heritage content also to co-construct the service experience (Prahalad & Ramaswamy, 2004).

Technology is proving to be indispensable in this process of communicating and opening up to the public its cultural heritage. Thanks to new technologies, therefore, the public becomes global (Roussou, 2002; Bautista, 2014) and museums can involve users in the development of active and long-lasting collaborations (Hazan, 2007; Marty, 2011). Technology, therefore, supports the co-creation of value. It allows users to participate in the definition of cultural heritage contents through co-creative and interactive experiences (Russo, 2011; Russo et al., 2008). Virtual reality, networked objects, and information visualization help drive innovation within museums (Freeman et al., 2016). Museums are therefore building virtual and collaborative environments for information and knowledge management (Eklund et al., 2009; Limp et al., 2011), ensuring the public use of cultural heritage (Stone & Ojika, 2000; Addison, 2000).

Museums, therefore, are transforming into public-led organizations (Gilmore & Rentschler, 2002), information-based and knowledge-oriented (MacDonald & Alsford, 1991; Freedman, 2000). Bi-directional digital communication, virtual environments, and data-driven innovation support intellectual capital (IC) and foster the co-creation of value (Dumay, 2016; Dumay & Garanina, 2013).

Furthermore, technology strengthens the role of the public and visitors and consolidates the skills of museum professionals who satisfy the needs of users (Bonacini, 2012; Marty, 2011).

Technology supports museums in developing service innovation, bringing the public to take part in the production of cultural service through co-creative, interactive, and learning experiences. User-driven innovation (Russo, 2011; Russo et al., 2008) and cultural co-creation are therefore favored by the use of technology. In the context of an emerging digital culture (Herdin & Egger, 2018) and digital humanities, the role of digital technologies is crucial in attracting new visitors (Bakhshi & Throsby, 2012), providing interactivity, immersive experience, and creative engagement (Cerquetti, 2016).

The museum's communicative projection, encouraging significant public participation in the definition of cultural content and promoting the co-creation of knowledge, learning, and educational opportunities, stimulates the definition of ad-hoc communication strategies that develop IC. As public-led institutions, museums use interactive technologies to improve their communication with their internal and external stakeholders in order to develop the creation and sharing of knowledge about their collections. The public becomes a co-producer of cultural heritage content. Museums are therefore transforming themselves into virtual meeting places and social spaces for sharing knowledge and spreading innovation.

In the last decade, in particular, digital technologies and social media are creating spaces for interaction and sharing between the various cultural stakeholders, including museums, producing a constructivist approach to communication and learning (Hooper-Greenhill, 1999; Lazzeretti et al., 2015). They are helping to reshape the role and mission of museums as producers and distributors of cultural value and their high diffusion is transforming many aspects of the cultural offer. New audiences are also being generated, often unable to go to the museum in person. The widespread use of social media is therefore becoming a key strategic trend and is favoring innovative business models within which physical and digital boundaries are increasingly tenuous and visitors are transformed into "prosumers" (Bertacchini & Morando, 2013; Pulh & Mencarelli, 2015). Museums are starting to review their activities, orienting themselves more and more toward the community, guided by more communicative and inclusive strategies (Cerquetti, 2016; Solima, 2016). Digital technologies, in fact, represent very useful tools to improve the visit experience and to make it even more immersive, guaranteeing the creation of effective communication strategies (Pallud & Straub, 2014). Millions of users can be reached through multiple channels: videos, podcasts, social media, websites, email campaigns, blogs, apps, audio guides, gaming, which are just some of the tools that can be used.

Web and social media, in particular, allow museums to redesign traditional products and foster new cultural experiences by involving a worldwide network of potential visitors, who can take part in the co-production of the cultural service, both before and after the visits (Marty, 2007; Romolini et al., 2020).

Social media can help museums communicate their activities and exhibitions, create digital communities and reach a wider audience of potential visitors (Srinivasan et al., 2009). In recent years, museum organizations have also used social media to build and strengthen their relationships with users in order to transform this process into "real" stakeholder engagement, a strategy to increase the interaction of visitors with the institution (Chang et al., 2014).

The unexpected COVID-19 pandemic has forced Governments in Italy and many other countries to enforce the total closure of all nonessential facilities and activities, including Museums. Institutions that have not been able to open their doors to an audience have had to choose the only alternative to spread culture and knowledge through online tools, including social media and websites. This caused an acceleration in digital transformation processes (Agostino et al., 2020).

Museums have reached a wider online audience, posting virtual tours, videos, podcasts, interviews with their directors and descriptions of works of art, as well as organizing quizzes and conducting treasure hunts for the little ones. These initiatives have transformed social media from communication channels to tools for the dissemination of cultural and educational material.

Cultural participation has recently attracted renewed attention from scholars and practitioners (Gross & Wilson, 2020; Stevenson et al., 2017). The participatory revolution (Knudsen, 2016; Noy, 2017; Hetland & Schrøder, 2020) sees museums called to change their model of interaction with the public and, more generally, with stakeholders. This trend has been further increased by digital technologies, in particular the Internet and social media, thanks to which access to museum communication and therefore to culture becomes "mass." Any user with an Internet connection has the ability to interact with the museum institution and with millions of other users.

Social media are leading to a true democratization of communication, transforming the wider context of public and community participation, enhancing and encouraging self-organization (Arnaboldi & Coget, 2016; Black, 2018).

3 Digital Communication of Italian Museums During the First Lockdown: A Survey

Through a quantitative content analysis based on 167 questionnaires collected by Museum Professionals during the first lockdown and first closures of Museums in Italy (April–May 2020), the survey aims to give an answer to the following three main research questions:

1. Which communication and digital engagement initiatives were adopted by Italian Museums during the first lockdown?
2. Has the number of visitors increased?
3. What are the future challenges that museums will face and what are the strategies they will put in place to actively engage visitors?

3.1 Methodology

The data collected through the survey has been analyzed with a quantitative method. In particular, for the open-ended questions with textual answers, a manual content analysis has been used in order to quantify the frequency of specific keywords identified after a first analysis and reading of the answers. As a matter of fact, content analysis can be used to quantify the occurrence of certain words, phrases, subjects, or concepts in a set of historical or contemporary texts. It is a research method—used either as a quantitative or a qualitative one—that has been utilized increasingly in social research, to identify patterns in recorded communication. The objective of content analysis is to convert recorded "raw" phenomena into data, which can be treated in essentially a scientific manner so that a body of knowledge may be built up. Over the years, it expanded from being an objective quantitative description of manifest content to a subjective interpretation of text data dealing with theory generation and the exploration of underlying meaning. Krippendorff (1980) defined content analysis as a research technique for making replicable and valid inferences from data to their context.

Like any other research method, content analysis conforms to three basic principles of the scientific method, that is objectivity, systematicity, generalizability.

3.2 The Survey

The survey was composed of ten closed-ended questions and four open-ended questions. The list of questions and the answers are reported below.

1. *Museum Category* (*closed*)

Art	52	31.1%
Archeology/Archeological Park	45	27%
Science	12	7.2%
History/Natural History	11	6.5%
Ethnography	10	6%
Other	37	22.2%

2. *In which area of the country is the Museum located?* (*closed*)

Northern Italy	79	47.3%
Central Italy	41	24.6%
Southern Italy	35	21%
Islands	12	7.2%

3. *Average annual number of visitors* (*closed*)

<20,000	85	50.9%
<50,000	38	22.8%
<100,000	18	10.8%
<300,000	14	8.4%
<500,000	4	2.4%
<1 million	5	3%
>1 million	3	1.8%

4. *Has the Museum a website?* (*closed*)

Yes	142	85%
No	25	15%

5. *What social media have you used so far?* (*closed*)

Facebook	166	99.4%
Twitter	91	54.5%
Instagram	133	79.6%
YouTube	90	53.9%
LinkedIn	20	12%
Other	15	9%

6. *If you have activated new digital communication channels in the face of the health emergency generated by COVID-19, can you please indicate which ones?* (*open*)

No one/existing/No	22
YouTube	14
Instagram	4
Educational channels	4
Twitter	3
Website	3
App	3
LinkedIn	2
Facebook	2
Newsletter	2
WhatsApp	1
Spotify	1
Radio	1
Spreaker (podcast)	1
TikTok	1
Social media (general)	1
Mibact channel	1

7. *Since the closing date, has the Museum increased its presence on social media?* (*closed*)

Yes	144	86.2%
No	23	13.8%

8. *What communication and digital engagement initiatives does the Museum adopt?* (*open*)*—Keywords and their frequency*

Collections/archive	52
Video	44
Post	35
Gaming/quiz	31
Children	28
Education	27
Photos/images	25
Virtual tour	24
Sections	23
Mibact/ICOM	22
Events	15
Virtual lab	13

(continued)

Contest	13
Streaming	12
Short videos/pills	12
Newsletter/emails	12
Community/followers	11
Podcast	10
Storytelling	9
Engagement	9
Traditions/anecdotes	8
Exhibitions	8
Tales/stories	7
Territory	6
Interactivity	5

9. *How have museum's digital communication initiatives changed compared to the past?* (*closed*)

Increasing	133	79.6%
As before	21	12.6%
Just started	5	3%
We are considering starting them	7	4.2%
Not adopted	1	0.6%

10. *Have you noticed an increase in online visits since the museum closed?* (*closed*)

Yes	117	70.1%
No	50	29.9%

11. *If the answer to the previous question is yes, what is the average percentage increase of online visitors per week that has been registered?* (*open*)

<10%	9	8.91%
Between 10 and 20%	14	13.86%
Between 20 and 30%	25	24.75%
Between 30 and 50%	24	23.76%
Between 50 and 100%	9	8.92%
>100%	2	1.98%
No calculation/qualitative answer	15	14.85%
Number of followers	3	2.97%

12. *How satisfied are you with the digital initiatives put in place by the Museum in terms of active public engagement?* (*closed*)

1—Not very satisfied	5	3%
2	15	9%
3	68	40.7%
4	61	36.5%
5—Very satisfied	18	10.8%

13. *Do you think that the museum will have to hire additional professionals in the future for the management of social media?* (*closed*)

Yes	108	64.7%
No	59	35.3%

14. *What do you think are future challenges that the museum will face and what are the strategies it will put in place to actively engage visitors?* (*open*)—*Keywords and their frequency*

Social Media/Web	82
Digitization	51
New visit offers/tools	43
People/visitors	40
Schools/universities/education	29
Spaces	24
Communication formats	20
Territory	17
Professionals	16
Quality	14
Tourism	14
Sustainability	14
Community	13
Interactivity	12
Participation	12
Networks/partnerships	12
Security	11
Curiosity	11
Storytelling	7
Innovation	6
Children/young people	6
Visit experience	3
Fundraising	3

4 Discussion

Analyzing the responses received (167), it can be seen that about one-third of the responding museums (31.1%) belong to the "Art" category and almost half (53.9%) are located in Northern and Central Italy. The dimensional data is also relevant, identified in the average annual number of visitors: half of the museums are small if not very small, registering less than 20,000 visits per year. This data is indicative of the characteristics of Italian museums: most of them are represented by territorial micro institutions, often public or private with the nature of third sector bodies, civic and ethnographic museums. Eighty-five percent of respondents already have a website, indicating that the digital transition was already underway before the pandemic. The use of social media also records a good figure: almost all the responding museums already used Facebook (99.4%) and about 80% used Instagram. Only a little more than half (54.5%) used Twitter, perhaps interpreted as an excessively professional channel and underestimating its potential.

The analysis of the demand relating to the new digital communication channels adopted in the face of the emergency generated by Covid-19 is interesting. Twenty-two museums did not make use of new equipment (13%), but 14 opened a YouTube page (8.3%) and four activated channels for educational purposes. A respondent stated that they had started using TikTok, a social network that has been showing growth in recent months also in the museum field as evidenced by the case of the Uffizi in Florence, the Prado in Madrid, and the Palace of Versailles. 86.2% of the museums declared that they had increased their presence on social media since the closing date, demonstrating the usefulness of digital channels to involve users even in the case of impossibility to physically visit the museum.

Question number 8 is essential to understand the initiatives adopted by the Italian museums during the first period of closure. The keyword most frequently is "Collections," indicating that most museums have resorted to digitizing their collections and archives to make them accessible online as well. Also important is the use of videos, museum "pills" (this data can be associated with the interest shown in YouTube channels) and periodic posts on social media. This is followed by the gaming initiatives and quizzes offered, aimed at a young audience but not disdained by adults as well. Initiatives with educational purposes, in a period of closed schools, proved to be important (frequency: 27) and is still ongoing. Less frequent, but no less relevant, were the periodic contests, podcasts, and direct streaming from the museum spaces. The traditional newsletter continued to be used, albeit less frequently.

Storytelling, tales, stories, and anecdotes have also begun to make room in places of culture, demonstrating the need to make increasing use of innovative and engaging communication techniques, such as the transmission of content in the form of a story. A trend that is proving to be constantly growing.

Ultimately, about 80% of respondents said they had increased online communication initiatives during the lockdown and 70% noted an average increase in virtual visitors per week between 20 and 50% for about half of the Museums. Forty percent of respondents are on average satisfied with the initiatives implemented in terms of active public engagement. About 65%, moreover, believe that in the future specific professional figures will have to be hired for the management of digital channels, demonstrating the undersizing of museum staff and the need to foster new professionals with skills that at the moment are often lacking if at all absent.

The last question represents the future perspectives and new challenges that museum professionals expect. Certainly, digital communication and the increase in the active and strategic use of social media and the web will represent the greatest commitment that will affect most museums, both in Italy and beyond. The challenge of digitizing collections is also very significant, highlighting that so far only a few virtuous institutions had made their collections available online as well. Then, the centrality of the visitor emerges, who will become more and more active user in managing the visit, real or virtual. The participation and active involvement of local communities is another aspect that emerged, valid for all museums but above all for museums spread across the territory, ethnographic ones, and EcoMuseums. The contents must be increasingly educational, innovative and engaging, in order to guarantee a unique and personalized visit experience. Even the quality of the same will prove to be successful: it is not enough to publish thousands of posts but to publish a few but "good" ones. One of the further challenges that emerged from the survey is represented by sustainability: museums, in fact, will be increasingly committed to contributing to the achievement of the SDGs, in terms of preservation of cultural and natural heritage, contribution to education, inclusiveness, gender equality, the climate crisis, and the environment.

5 Conclusions

The study contributes to the analysis of Social Media and Digital Communication as a powerful engagement instrument for the Knowledge Management of museums in times of crisis and for the creation of Intellectual Capital. It also points out as changes in socio-technical systems will make Museum staff and visitors more and more connected. The survey shows also the necessity for Museums to hire new professionals and to devote an increased attention to economic, social, and environmental sustainability. The study has the final goal to underline how "museum social media audience" will play a crucial role in the survival of many cultural institutions. As a matter of fact, the pandemic will most likely lead to a change in the consumption habits of cultural tourists. They will use the digital tools and methods of interaction offered by museums not only in the pre-visit phase, in order to retrieve relevant information about their future visit, but also as a way to interact with exhibition material and collections while remaining at home and in their countries.

References

Addis, M. (2005). New technologies and cultural consumption—Edutainment is born! *European Journal of Marketing, 39*(7/8), 729–736.

Addison, A. (2000). Emerging trends in virtual heritage. *IEEE Multimedia, 7*(2), 22–25.

Agostino, D., Arnaboldi, M., & Lampis, A. (2020). Italian state museums during the COVID-19 crisis: From onsite closure to online openness. *Museum Management and Curatorship*. https://doi.org/10.1080/09647775.2020.1790029.

Anderson, M. L. (1999). Museums of the future: The impact of technology on museum practices. *Daedalus, 128*(3), 129–162.

Arnaboldi, M., & Coget, J. F. (2016). Social media and business. We've been asking the wrong question. *Organizational Dynamics, 45*(1), 47–54.

Bakhshi, H., & Throsby, D. (2012). New technologies in cultural institution: Theory, evidence and policy implications. *International Journal Cultural Policy, 18*(2), 205–222.

Bautista, S. S. (2014). *Museums in the digital age. Changing meanings of place, community, and culture*. AltaMira Press.

Bertacchini, E., & Morando, F. (2013). The future of museums in the digital age: New models of access and use of digital collections. *International Journal of Arts Management, 15*(2), 60–72.

Black, G. (2018). Meeting the audience challenge in the 'age of participation'. *Museum Management and Curatorship, 33*(4), 302–319.

Bonacini, E. (2012). Il museo partecipativo sul web: forme di partecipazione dell'utente alla produzione culturale e alla creazione di valore culturale. *Il Capitale Culturale: Studies on the Value of Cultural Heritage, 5*, 93–125.

Borin, E., & Donato, F. (2015). Unlocking the potential of IC in Italian cultural ecosystems. *Journal of Intellectual Capital, 16*(2), 285–304.

Capriotti, P., & Kuklinski, H. P. (2012). Assessing dialogic communication through the internet in Spanish museums. *Public Relations Review, 38*(4), 619–626.

Cerquetti, M. (2016). More is better! Current issues and challenges for museum audience development: A literature review. *ENCATC Journal of Cultural Management and Policy, 6*(1), 30–43.

Chang, T. L., Marcketti, S., & Fiore, A. M. (2014). Use of social networking services for marketing art museums. *Museum Management and Curatorship, 29*(2), 1–18.

Davies, S. M., Paton, R., & O'Sullivan, T. J. (2013). The museum values framework: A framework for undertanding organisational culture in museums. *Museum Management and Curatorship, 28*(4), 345–361.

Dumay, J. (2016). A critical reflection on the future of intellectual capital: From reporting to disclosure. *Journal of Intellectual Capital, 17*(1), 168–184.

Dumay, J., & Garanina, T. (2013). Intellectual capital research: A critical examination of the third stage. *Journal of Intellectual Capital, 14*(1), 10–25.

Eklund, P., Goodall, P., Wray, T., Bunt, B., Lawson, A., Christidis, L., Daniel, V., & Van Olffen, M. (2009). *Designing the digital ecosystem of the virtual museum of the pacific*. 3rd IEEE International Conference on Digital Ecosystems and Technologies, 2009. DEST'09, IEEE, pp. 377–383.

Freedman, G. (2000). The changing nature of museums. *Curator: The Museum Journal, 43*(4), 295–306.

Freeman, A., Adams Becker, S., Cummins, M., McKelroy, E., Giesinger, C., & Yuhnke, B. (2016). *NMC horizon report: 2016 Museum edition*. The New Media Consortium.

Gilmore, A., & Rentschler, R. (2002). Changes in museum management: A custodial or marketing emphasis. *Journal of Management Development, 21*(10), 745–760.

Gross, J., & Wilson, N. (2020). Cultural democracy: An ecological and capabilities approach. *International Journal of Cultural Policy, 26*(3), 328–343.

Hazan, S. (2007). A crisis of authority: New lamps for old. In F. Cameron & S. Kenderline (Eds.), *Theorizing digital cultural heritage. A critical discourse* (pp. 133–147). MIT Press.

Herdin, T., & Egger, R. (2018). Beyond the digital divide: Tourism, ICTs and culture—A highly promising alliance. *International Journal of Digital Culture and Electronic Tourism, 2*(4), 322–336.

Hetland, P., & Schrøder, K. C. (2020). The participatory turn: Users, publics, and audiences. In P. Hetland, P. Pierroux, & L. Esborg (Eds.), *A history of participation in museums and archives* (pp. 168–185). Routledge, Taylor & Francis Group.

Hooper-Greenhill, E. (1999). *The educational role of the museum*. Routledge.

Knudsen, L. V. (2016). Participation at work in the museum. *Museum Management and Curatorship, 31*(2), 193–211.

Krippendorff, K. (1980). *Content analysis: An introduction to its methodology*. Sage.

Lazzeretti, L., Sartori, A., & Innocenti, N. (2015). Museums and social media: The case of the Museum of Natural History of Florence. *International Review on Public and Nonprofit Marketing, 12*, 267–283.

Limp, F., Payne, A., Simon, K., Winters, S., & Cothren, J. (2011). Developing a 3-D digital heritage ecosystem: From object to representation and the role of a virtual museum in the 21st century. *Internet Archaeology, 30*, 1–38.

MacDonald, G. F., & Alsford, S. (1991). The museum as information utility. *Museum Management and Curatorship, 10*(3), 305–311.

Marty, P. F. (2007). Museum websites and museum visitors: Before and after the museum visit. *Museum Management and Curatorship, 22*(4), 337–360.

Marty, P. F. (2011). My lost museum: User expectations and motivations for creating personal digital collections on museum websites. *Library and Information Science Research, 33*(3), 211–219.

Noy, C. (2017). "Participatory media and discourse in heritage museums: Co-constructing the public sphere?" communication. *Culture and Critique, 10*(2), 280–301.

Pallud, J., & Straub, D. W. (2014). Effective website design for experience-influenced environments: The case of high culture museums. *Information Management, 51*, 359–373.

Prahalad, C. K., & Ramaswamy, V. (2004). Co-creation experiences: The next practice in value creation. *Journal of Interactive Marketing, 18*(3), 5–14.

Pulh, M., & Mencarelli, R. (2015). Web 2.0: Is the museum visitor relationship being redefined? *International Journal of Arts Management, 18*(1), 43–51.

Romolini, A., Fissi, S., & Gori, E. (2020). Visitors engagement and social media in museums: Evidence from Italy. *International Journal of Digital Culture and Electronic Tourism, 3*(2), 36–53.

Roussou, M. (2002). Virtual heritage: From the research lab to the broad public. *Bar International Series, 1075*, 93–100.

Russo, A. (2011). Transformation in cultural communication: Social media, cultural exchange, and creative connections. *Curator: The Museum Journal, 54*(3), 327–346.

Russo, A., & Watkins, J. (2007). Digital cultural communication: Audience and remediation. In F. Cameron & S. Kenderline (Eds.), *Theorizing digital cultural heritage. A critical discourse* (pp. 149–164). MIT Press.

Russo, A., Watkins, J., Kelly, L., & Chan, S. (2008). Participatory communication with social media. *Curator: The Museum Journal, 51*(1), 21–31.

Schweibenz, W. (2011). Museums and web 2.0: Some thoughts about authority, communication, participation and trust. In G. Styliaras, D. Koukopoulos, & F. Lazarinis (Eds.), *Handbook of research on technologies and cultural heritage: Applications and environments* (pp. 1–15). IGI global.

Solima, L. (2016). Smart Museums. Sul prossimo avvento della Internet of Things e del dialogo tra gli oggetti nei luoghi della cultura. *Sinergie Italian Journal of Management, 34*, 263–283.

Srinivasan, R., Boast, R., Furner, J., & Becvar, K. (2009). Perspective: Digital museums and diverse cultural knowledge: Moving past the traditional catalog. *The Information Society, 25*(4), 265–278.

Stevenson, D., Balling, G., & Kann-Rasmussen, N. (2017). Cultural participation in Europe: Shared problem or shared Problematisation? *International Journal of Cultural Policy, 23*(1), 89–106.
Stewart, T. (1997). *Intellectual capital: The new wealth of organizations*. Doubleday.
Stewart, T., & Ruckdeschel, C. (1998). Intellectual capital: The new wealth of nations. *Performance Improvement, 37*(7), 56–59.
Stone, R., & Ojika, T. (2000). Virtual heritage: What next? *IEEE Multimedia, 7*(2), 73–74.

The Impact of Digitalization on the Company Value: A Nonperforming Loan Management Business Application

Maria Teresa Bianchi and Antonietta Cosentino

1 Introduction

Nonperforming loans are exposures to subjects who, due to worsening of their economic and financial situations, cannot fulfill their contractual obligations in whole or in part. The management of nonperforming loans (NPLs) has given rise to a large number of specialized companies. Over the years, these have increasingly focused on building a computerized operating machine, capable of managing the incoming and outgoing information flows. The management of non-performing credit is increasingly based on knowledge and information assets (Sole et al., 2010; Adams, 2008; Carlucci & Schiuma, 2007; Grant, 1996).

Companies that manage these loans have embarked on an important digitalization path. Today, this becomes an important element to boost their market value. Thus, nonperforming loan management companies have a value substantially equal to that of the "operating machine," which constitutes their fundamental intangible asset (Daum, 2002; Kaplan & Norton, 2004; Lev & Daum, 2004).

Literature on NPLs is wide but, as far as we know, no studies demonstrate the market value impact of information technology (IT) and, precisely, advanced data management systems based on artificial intelligence, on companies that manage NPLs. On one hand, the prevailing literature investigated NPLs' determinants to measure the "quality" of loan portfolios from the macroeconomic point of view (Beck et al., 2015; Klein, 2013; Irina & Angela, 2016; Mohaddes et al., 2017). On the other hand, it investigated NPLs' effects on the financial market (Accornero et al., 2017). Some authors analyze the regulatory and risk management methods for

M. T. Bianchi (✉) · A. Cosentino
Department of Law and Economics of Productive Activities, University of Rome "La Sapienza", Rome, Italy
e-mail: mariateresa.bianchi@uniroma1.it; antonietta.cosentino@uniroma1.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_19

reducing NPLs (Erdinç & Gurov, 2016) while others underline the effect of a country's fiscal policy on NPLs (Barbagallo, 2017; Panetta, 2017; Siakoulis, 2017).

This study bridges the literature gap by focusing on the digitalization and artificial intelligence's impact on intangible assets and businesses' value. Based on this goal, we can formulate our research question:

What impact does IT have on the value of companies managing NPLs?

The response will be based on research methodology using the case study. Thus, a merger carried out in 2019 between two companies operating in the NPLs management sector will be analyzed to evaluate the economic capital of a company operating in the NPLs market acquired by another sector operator, to then achieve a merger between the two.

Up to now, not many acquisitions and mergers have been carried out in the Italian market in this sector and this transaction represents an interesting benchmark for subsequent operations.

The results show that the value of artificial intelligence systems does not only influence the value of companies that manage NPLs but that it substantially coincides with it.

The study is structured as follows. Section 2 analyzes the relevant literature on the topic; Section 3 describes the research methodology; Section 4 shows the evaluation process followed in an evaluation case, which took place in the merger between two Italian market operators. Finally, the research conclusions are presented.

2 The Digitalization Impact on the Business Value

The progressive digitalization of business processes allows us to understand a series of phenomena influencing business strategies such as the development of innovation projects, emergence of new business models, and dissemination and use of new technologies (Istat, 2020). Digitalization is a complex and multidimensional phenomenon. There is no complete definition of what exactly is meant by digitalization.

Digitalization can be defined as "the integration of the analogue and digital worlds with new technologies that enhance customer interaction, data availability and business processes" (Eling & Lehmann, 2018, p. 363).

The integration of new technologies into the analog and digital worlds has already profoundly transformed many sectors (Caputo et al., 2020; Simon, 2020; Öberg, 2021; Moreau, 2013). The transformation process in some of them, such as insurance, has come rather late and has not yet fully exploited digital technologies' potential (Catlin et al., 2015).

Some studies have highlighted the needs, requirements, and use of big data by public and private organizations in decision-making processes, business processes, and emerging business models (Oliveira & Martins, 2011; Oliveira et al., 2014). In specific sectors, exploitation of big data can have an economic value and an impact on the social value dimensions (Morris & Shin, 2002; Viscusi et al., 2014). In many cases, the empirical evidence shows a low rate of use of the collected data, a lack of adequate tools and skills, and a low rate of companies' digital transformation (Kitchin & McArdle, 2016; Viscusi & Batini, 2014; Rossi et al., 2019).

The consensus is that information technology (IT) has significant effects on companies' productivity (Oliveira & Martins, 2011). It follows that, since the 1980s, literature has paid great attention to the determinants of IT adoption (Davis et al., 1989; Ajzen, 1991; Rogers, 1995; Venkatesh et al., 2003; Hsu et al., 2006; Oliveira & Martins, 2011). Both individual characteristics and the internal (centralization, complexity, formalization, interconnectedness, organizational slack) and external (system openness) characteristics of the organizational structure are found to be important antecedents of organizational innovation (Rogers, 1995; Hsu et al., 2006; Bradford & Florin, 2003). Equally important are the aspects relating to the context in which companies operate (technological, organizational, and environmental context) (Tornatzky et al., 1990; Kuan & Chau, 2001).

There are fewer studies on the impact of technological innovations on company value.

Existing studies mainly deal with the enhancement of individual assets (e.g., volume and variety of data, monetization of data) (Chen et al., 2012; Chowdary & Muthineni, 2012; Hanafizadeh & Nik, 2020), while other studies have analyzed digitalization's strategic implications (Maas & Bühler, 2015; Johansson & Vogelgesang, 2015; Berger et al., 2016). Ahituv (1980) examines various approaches to the evaluation of the information system by classifying them into pragmatic (e.g. cost/benefit analysis), theoretical, based on decision theory, and underpinned on attempts to formulate a utility function for defined information problems.

Technological innovations' impact on the firm's value is less observed (Eling & Lehmann, 2018; Zeleti & Ojo, 2017; Zeleti et al., 2016).

This research aims to bridge the literature gap on NPLs and artificial intelligence's impact on the creation of company value through an analysis of a case study.

3 Research Methodology

To achieve the research objectives, we used a qualitative research methodology based on a case study analysis (Yin, 2014). We analyzed a merger of two companies operating in the NPLs management sector to study the impact artificial intelligence produces on companies' market value.

Not many acquisitions and mergers have been carried out in the Italian market in this sector, and this transaction represents an interesting benchmark for subsequent operations. The case study presented evaluates the economic capital of subject A, which will then be merged with subject B.

A and B are two companies that operate in the direct and indirect management of NPLs. Therefore, they have the same business, and the company merger has the task of bringing out any synergies.

4 Results Discussion

Company A's value is represented by the operating machine that it has created. This consists of software that allow automation of information flows to improve NPL management and make it more efficient. The operating machine's value lies in its digitalization.

The first step is to provide the advisors with the documentary basis for determining the value attributed to the platform.

The information request checklist to evaluate the platform value is presented in Table 1.

To determine the platform value, we started from the need to build an economic Business Plan that would allow determining the goodwill value, understood as the ability of subject A)'s operating machine to generate income.

Company A) does not realize revenues from services, but only positive components related to portfolio management. Therefore, first of all, the value of portfolio management service revenues deriving from the realization of company A)'s Business Plan can be estimated from the following fee (Table 2) by applying a hypothetical grid of market fees.

Structural costs were correlated to this with the aim of determining an EBITDA and a forecast profit similar to that of a "market" platform active in the business of managing impaired loans. To do this, some assumptions were established, such as:

- No new portfolio acquired by A (run-off scenario)
- Gradual insourcing of the portfolio managed by external servicers to optimize the cost structure
- External servicer costs as per contracts signed with progressive reduction in the insourcing of PTFs
- Gradual shift of staff personnel and asset management, correlated with the decrease in assets managed
- Reduction of IT and ASA costs in relation to residual masses (GBV)
- These same assumptions are used in parallel to determine the value of synergies resulting from economies of scale achievable with the inclusion of subject B).

Obviously, some highly impacting choices on final values, such as considering A's run-off portfolio as the basis of the income statement, had important effects in determining the price. This was, to a certain extent, also conditioned by some ranges that the shareholder and counterpart considered acceptable.

Using an IRR of 7.5% and discounting the economic results as constructed with the illustrated simulation subsequently determined one of the two components used to establish the value attributed to the "A" platform (the other is represented by the Synergies component). However, other valuation methods are also used in market transactions. Table 3 shows the prospective income statement that generates the discounted flows for the evaluation of the platform.

Table 1 Information request to evaluate platform value

N°	Scope	Information request
1	Corporate	Company shareholders and composition of the share capital to the date...
2	Corporate	Documentation required for definition of the operation (accounting, legal, tax)
3	Operational/business model	Organizational chart
4	Operational/business model	Function chart/internal regulations
5	Operational/business model	Details relating to personnel (position, activity carried out, contract type, RAL, age)
6	Operational/business model	Indications of credit manager by type (large corporate manager, small business manager) and number of cases processed for each one
7	Operational/business model	Outsourcing services and related contracts
8	Operational/business model	Servicing contracts in place
9	Operational/business model	Description of third-party commercial agreements for product/service supply
10	Operational/business model	IT systems maps and descriptive documentation
11	Operational/business model	Description of territorial offices with real estate evidence if owned or leased
12	Operational/business model	Indication of personnel employed and role by territorial office and activities performed
13	Operational/business model	Information relating to branch perimeter (resources, activities, liabilities)
14	Internal regulations	Credit assessment regulations/procedures
15	Internal regulations	Internal control rules/regulations
16	Credit portfolio	Indication of credit portfolio management model with indication of the portfolio managed in house or outsourced
17	Credit portfolio	Detail of portfolio by servicer with indication of gross exposure and number of NDGs
18	Credit portfolio	Indications of servicers' historical recovery performance
19	Credit portfolio	Detail of prospective recovery forecasts
20	Credit portfolio	Loan data tape of the loan portfolio at .... and breakdown also by loan status (bad loans, UTP, PD) debtor type (corporate, individual) secured/unsecured
21	Financial	Financial statements as of.... and ....
22	Financial	Economic and equity projections and industrial evolution drivers (last available)
23	Financial	Evolution of receipts from .... to ....
24	Financial	IT costs and license contracts/application management/facility management)
25	Financial	Breakdown of the ASA
26	Financial	Possible dividend policy in the plan

Table 2 Commission based on expected receipts as prospected by Business Plan

Management fee	0.20%
Performance fee	
o/w secured	3.0%
o/w unsecured	5.5%

Table 3 Prospective profit component

Evaluation		1E	2E	3E	4E	5E	6E	7E
Revenues		28.6	25.4	22.5	15.3	9.0	6.1	1.7
Total costs		(23.3)	(21.9)	(20.5)	(13.1)	(7.5)	(5.1)	(4.6)
- Personal		(5.1)	(3.2)	(2.6)	(2.5)	(2.4)	(1.4)	(1.1)
- Cost overstaffing		–	(2.4)	(0.6)	–	(0.1)	(1.3)	(1.3)
- Servicing		(14.2)	(12.7)	(14.1)	(7.5)	(2.1)	–	–
ASA		(4.0)	(3.6)	(3.3)	(3.0)	(2.8)	(2.4)	(2.2)
EBITDA		5.4	3.5	2.0	2.2	1.6	0.9	(3.0)
Tax rate	33%	(1.8)	(1.1)	(0.6)	(0.7)	(0.5)	(0.3)	–
Net income		3.6	2.3	1.3	1.5	1.0	0.6	(3.0)
Ke	7.5%	3.3	2.0	1.1	1.1	0.7	0.4	(1.8)
Updating of platform flows	6.9							

Table 4 Industrial synergies component

Synergies		1E	2E	3E	4E	5E	6E	7E	
Synergy area									
Corporate area		0.9	0.9	0.9	0.9	0.9	0.9	0.9	6.3
Organizational model		0.4	0.6	1.1	0.7	1.0	1.0	1.0	5.8
Operative model—insourcing top loans		2.9	5.2	5.7	3.4	0.4	–	–	17.6
Special servicing/master servicing		0.3	0.4	0.5	0.5	0.3	0.2	0.1	2.3
IT model		0.5	0.5	0.5	0.5	0.5	0.5	0.5	3.5
ASA area		1.2	0.9	0.7	0.5	0.3	0.3	0.2	4.1
Total synergies		6.2	8.6	9.4	6.5	3.5	2.9	2.8	39.9
Total synergies (*net cost failure to buy-out*)		5.8	8.0	8.3	5.9	2.5	1.9	1.8	34.2
Synergies at partner A	50%	2.9	4.0	4.2	2.9	1.3	1.0	0.9	17.2
Synergies at partner B	50%	2.9	4.0	4.2	2.9	1.3	1.0	0.9	17.2

Table 5 Platform value

Platform flow updating	6.90
Attribution of synergies	17.10
Platform value	**€24.00/MLN**

The synergies were valued for each area. Once their total value was determined, it was attributed equally between the two parties involved in the operation, forming the second component of the price construction (Table 4).

The value attributable to the platform was therefore determined as follows (Table 5).

The main element of the lower costs and higher revenues resulting from the two companies' integration is due to the IT branch synergies.

In fact, while company A has built an important IT branch, company B, despite being dimensionally larger, has not invested in this area and is totally dependent on external software and consultancy.

5 Conclusion

The proposed study demonstrates how to create value for the company in an extremely effervescent market through investment in IT and creation of an operational machine capable of monitoring the information flows made up of repayment plans, judicial auctions, and judging phases. More precisely, the value of artificial intelligence systems does not only influence the value of companies that manage NPLs but substantially coincides with it.

The research's originality is that in a market where transactions on these types of companies are still few, we hypothesized an alternative valuation scenario based, as mentioned, on the hypothesis that the acquired company cannot have further portfolios. In fact, in the hypothesis of continuity, the criterion of EBITDA multiples could have been used, simplifying the methodology and reaching an even greater value.

The originality of this evaluation lies precisely in the runoff scenario, which highlights the importance of IT investment in this sector as well.

Our study contributes to enriching the literature on NPLs by focusing on the assets that determine companies' value in the sector. At the same time, it fills the literature gap on the impact of IT on businesses by offering an original scenario in which artificial intelligence is not only an important asset, but it is the most important. Thus, in our study, we show that the merged companies' value coincides with the software value rather than with that of the NPLs portfolio.

The limit of this research is that it is based on a single case, and only within the Italian market. Further research steps may include other merger operations in Italy and abroad and compare the results to achieve a general conclusion.

References

Accornero, M., Alessandri, P., Carpinelli, L., & Sorrentino, A. M. (2017). *Non-performing loans and the supply of bank credit: Evidence from Italy*. Bank of Italy Occasional Paper (374).

Adams, M. (2008). Management 2.0: Managing the growing intangible side of your business. *Business Strategy Series, 9*(4), 190–200.

Ahituv, N. (1980). A systematic approach toward assessing the value of an information system. *MIS Quarterly: Management Information Systems, 4*(4), 61–75.

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior & Human Decision Processes, 50*, 179–211.

Barbagallo, C. (2017). *I crediti deteriorati delle banche italiane: Problematiche e tendenze recenti*. Bankitalia, 6 giugno 2017.

Beck, R., Jakubik, P., & Piloiu, A. (2015). Key determinants of non-performing loans: New evidence from a global sample. *Open Economies Review, 26*(3), 525–550.

Berger, D., Broer, P., & Pankoke, D. (2016). Digitization in life insurance: A prerequisite for success in spite of low interest rates. I. *VW HSG Trendmonitor, 1*, 15–19.

Bradford, M., & Florin, J. (2003). Examining the role of innovation diffusion factors on the implementation success of enterprise resource planning systems. *International Journal of Accounting Information Systems, 4*(3), 205–225.

Caputo, A., Pizzi, S., Pellegrini, M. M., & Dabić, M. (2020). Digitalization and business models: Where are we going? A science map of the field. *Journal of Business Research, 123*, 489–501.

Carlucci, D., & Schiuma, G. (2007). Knowledge assets value creation map: Assessing knowledge assets value drivers using AHP. *Expert Systems with Applications, 32*(3), 814–821.

Catlin, T., Scanlan, J., & Willmott, P. (2015). Raising your Digital Quotient. *McKinsey Quarterly, 3*, 30–43.

Chen, H., Chiang, R. H. L., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. *MIS Quarterly: Management Information Systems, 36*(4), 1165–1188.

Chowdary, B. V., & Muthineni, S. (2012). Selection of a flexible machining Centre through a knowledge based expert system. *Global Journal of Flexible Systems Management, 13*(1), 3–10.

Daum, J. (2002). *Intangible assets and value creation*. Wiley.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science, 35*(8), 982–1002.

Eling, M., & Lehmann, M. (2018). The impact of digitalization on the insurance value chain and the insurability of risks. *The Geneva Papers on Risk and Insurance-Issues and Practice, 43*(3), 359–396.

Erdinç, D., & Gurov, A. (2016). The effect of regulatory and risk management advancement on non-performing loans in European banking, 2000–2011. *International Advances in Economic Research, 22*(3), 249–262.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*(Suppl. Winter), 109–122.

Hanafizadeh, P., & Nik, M. R. H. (2020). Configuration of data monetization: A review of literature with thematic analysis. *Global Journal of Flexible Systems Management, 21*(1), 17–34.

Hsu, P. F., Kraemer, K. L., & Dunkle, D. (2006). Determinants of e-business use in US firms. *International Journal of Electronic Commerce, 10*(4), 9–45.

Irina, B., & Angela, R. (2016). Effects of macroeconomic factors on bank loans quality: Evidence from Central and Eastern European countries. In *Entrepreneurship, business and economics* (Vol. 2, pp. 571–584). Springer.

Istat (2020). Digitalizzazione e tecnologia nelle imprese italiane, Censimenti permanenti imprese (translation: Digitization and technology in Italian companies, Permanent business censuses), August 2020 available at https://www.istat.it/it/files//2020/08/REPORT_DIGITALIZZAZIONE_CENSIMPRESE_PC.pdf

Johansson, S., & Vogelgesang, U. (2015). *Insurance on the threshold of digitization implications for the life and P&C workforce*. McKinsey & Company.

Kaplan, R., & Norton, D. (2004). *Strategy maps—Converting intangible assets into tangible outcomes*. Harvard Business School Press.

Kitchin, R., & McArdle, G. (2016). What makes big data, big data? Exploring the ontological characteristics of 26 datasets. *Big Data and Society, 3*(1), 1–10.

Klein, N. (2013). *Non-performing loans in CESEE: Determinants and impact on macroeconomic performance* (No. 13–72). International Monetary Fund.

Kuan, K. K., & Chau, P. Y. (2001). A perception-based model for EDI adoption in small businesses using a technology–organization–environment framework. *Information & Management, 38*(8), 507–521.

Lev, B., & Daum, J. H. (2004). The dominance of intangible assets: Consequences for enterprise management and corporate reporting. *Measuring Business Excellence, 8*(1), 6–17.

Maas, P., & Bühler, P. (2015). I-society: How multi-optionality is pushing individualisation in the digital age. *St. Gallen Business Review, 2*(2015), 6–11.

Mohaddes, K., Raissi, M., & Weber, A. (2017). Can Italy grow out of its NPL overhang? A panel threshold analysis. *Economics Letters, 159*, 185–189.

Moreau, F. (2013). The disruptive nature of digitization: The case of the recorded music industry. *International Journal of Arts Management, 15*(2), 18–31.

Morris, S., & Shin, H. S. (2002). Social value of public information. *American Economic Review, 92*(5), 1521–1534.

Öberg, C. (2021). Disruptive and paradoxical roles in the sharing economies. *International Journal of Innovation Management, 25*(04), 2150045.

Oliveira, T., & Martins, M. F. (2011). Literature review of information technology adoption models at firm level. *The Electronic Journal Information Systems Evaluation, 14*(1), 110–121.

Oliveira, T., Thomas, M., & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors. *Information and Management, 51*(5), 497–510.

Panetta, F. (2017). *Seminario istituzionale sulle tematiche legate ai non performing loans*, 15 maggio 2017.

Rogers, E. M. (1995). Diffusion of innovations: Modifications of a model for telecommunications. In *Die diffusion von innovationen in der telekommunikation* (pp. 25–38). Springer.

Rossi, E., Rubattino, C., & Viscusi, G. (2019). For what it's worth: A multi-industry survey on current and expected use of big data technologies. *Lecture Notes in Business Information Processing, 341*, 72–79.

Siakoulis, V. (2017). *Fiscal policy effects on non-performing loan formation*. Working Papers 224, Bank of Greece.

Simon, J. P. (2020). The global internet market(s): A reconstruction of the views of the industry. *Digital Policy, Regulation and Governance, 22*(2), 109–133.

Sole, F., Carlucci, D., & Schiuma, G. (2010). Understanding organisational knowledge-based value creation dynamics: A systems thinking approach. In *Business performance measurement and management* (pp. 327–341). Springer.

Tornatzky, L. G., Fleischer, M., & Chakrabarti, A. K. (1990). *Processes of technological innovation*. Lexington Books.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *Management Information System quarterly*, 425–478.

Viscusi, G., & Batini, C. (2014). Digital information asset evaluation: Characteristics and dimensions. *Lecture Notes in Information Systems and Organisation, 7*, 77–86.

Viscusi, G., Castelli, M., & Batini, C. (2014). Assessing social value in open data initiatives: A framework. *Future Internet, 6*, 498–517.

Yin, R. K. (2014). *Case study research: Design and methods*. Sage.

Zeleti, F. A., & Ojo, A. (2017). The 6-values open data business model framework. In *Government 3.0—Next generation government technology infrastructure and services* (pp. 219–239). Springer.

Zeleti, F. A., Ojo, A., & Curry, E. (2016). Exploring the economic value of open government data. *Government Information Quarterly, 33*(3), 535–551.

The Theory of New Business Models Innovation and Sustainability: Toward New Investigations of Smart Technologies

Daniela Coluccia, Rosa Lombardi, Paola Paoloni, and Silvia Solimene

1 Preliminary Issues

In recent years, the Business Model (BM) has been widely investigated by academic literature as an opportunity for innovation and competitive advantage supporting organizations (Amit & Zott, 2012; Bocken et al., 2014; Hossain, 2017; Wirtz et al., 2016). It is widely considered as the source of sustainable value for organizations, through its innovations and features. In this scenario, BM innovation is widely discussed by literature especially in recent years (Bashir et al., 2020; Zott et al., 2011).

Searching the term "business model" in the Scopus database, more than 33,000 results are retrieved among which more than 11,000 results belonging to the business, management, and accounting subject (www.scopus.com). Additionally, BM innovation represents the hottest topic numbering more than 1600 documents with major interest for the same subject area.

The aim of this chapter is to define the theory of BM providing an updated overview of new business models in the academic community focusing on BM innovation and sustainability toward the investigation of smart technologies (Lombardi, 2019; Lombardi et al., 2020a, 2020b). In this direction, we adopted a qualitative methodology using a document analysis of the relevant literature. Additionally, we include a very primary research on emerging topics using the content and bibliometric analysis (Van Eck & Waltman, 2014) investigating the years 2018–2020.

D. Coluccia (✉) · R. Lombardi · P. Paoloni · S. Solimene
Department of Law and Economics of Productive Activities, Sapienza University of Rome, Rome, Italy
e-mail: daniela.coluccia@uniroma1.it; rosa.lombardi@uniroma1.it; paola.paoloni@uniroma1.it; silvia.solimene@uniroma1.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_20

Our results are directed to contribute to the new theory of business models in organizations, enriching existing studies with a primary set of relevant keywords and streams directed to support BM innovation, sustainability, and smart technologies. Our contribution is original in the research landscape drafting keywords by BM innovation and sustainability as the first step in the path of investigation of BM and smart technologies. Among relevant keywords, smart technologies represent a thrilling endeavor for future studies and we propose the thematic analysis based on IT EU firms in order to collect empirical evidence.

This chapter is organized as follows. After this introduction, we present the theoretical background in Sect. 2. Section 3 presents the methodology. Section 4 shows the primary results by the content and bibliometric analysis. Section 5 presents insights, implications, and future research.

2 Theoretical Background

Following main literature in BM (Amit & Zott, 2012; Bocken et al., 2014; Hossain, 2017), the dynamic aspects of BMs are helpful to understand the strategic orientation of organizations and to obtain a competitive advantage in the market, as BMs link strategies with business processes (Osterwalder & Pigneur, 2003). The study of the BM, therefore, is part of the expression of the proposal aimed at improving the strategy on customers and the general environment and, consequently, the financial performance (Chesbrough, 2007; Zott & Amit, 2008).

From Wirtz's perspective, indeed, BM is the representation of the relevant activities by each organization, representing a profitable combination of its elements qualifying the business value proposition, as a mixed result of several elements: the value creation, the value capturing, and value delivery. This proposition involves both internal and external resources to companies (Chesbrough & Rosenbloom, 2002; Magretta, 2002; Teece, 2010; Zott & Amit, 2010).

Additionally, the combination of BM and technological development made it easier to analyze the companies' innovation processes (Calia et al., 2007; Wei et al., 2014) and the consequent differentiation of BM. For this reason, BM innovation is the way through which an organization guarantees the Smithian concept of "value" (corporate value and value for society). The dynamic capability of BM to innovate allows establishing different corporate strategies to survive, namely to maintain in the long run the "sustainable" profitability and to persist to complex scenarios and to crises (Chesbrough & Rosenbloom, 2002).

In this context, research has shown that companies must focus on innovation and the reinvention of their BM to obtain a competitive advantage (Voelpel et al., 2004). In literature, therefore, the concept of "Business Model Innovation" (BMI) spreads and finds its formulation in the study by Sorescu (2017) and Khanagha et al. (2014). BMI ranges from incremental changes in existing BMs, up to a breakthrough of BMs, which may replace the existing model with a fundamentally new one, due to technological development (Calia et al., 2007; Wei et al., 2014).

In this context, technological development has made it possible to better analyze company innovation processes and to formulate the strategic perspective of the BM (Chesbrough & Rosenbloom, 2002). According to BMI theories, technological progress may lead to the need to modify and renew the existing BM into a new one (Calia et al., 2007; Wei et al., 2014).

BMI has also been studied as a *trade union* between the concept of BM and sustainability (Bocken et al., 2014; Stubbs & Cocklin, 2008). BMI includes the elements to identify the company's innovative process aimed at pursuing the going concern and economic sustainability. In this sense, BM becomes a crucial element for improving performance and capturing sustainable value (Chesbrough, 2007; Lozano, 2018; Zott & Amit, 2008).

Organizations attempt to get sustainable dimensions aimed at achieving sustainable business models (Lozano, 2018; Lozano & Huisingh, 2011; Schrippe & Duarte Ribeiro, 2019). Sustainability generates a competitive advantage for organizations thanks to market appreciation and risk reduction and is a driving force for system innovation (Allais et al., 2017).

Several elements of BM architecture are relevant in defining the value creation and capturing the process of firms, to pursue the Going Concern Principle and economic sustainability. For instance, external and internal factors can affect BM toward the stakeholder plethora. Among internal resources, strategy, human resource (knowledge, capabilities, and competencies of human resource within the organization), and leadership capabilities are the most important organizational competencies (Chesbrough, 2010).

Several existing studies have focused their attention on companies belonging to innovative sectors, which require BMI to ensure sustainability and business growth and increase value (Morris et al., 2005; Wiklund et al., 2009). Unfortunately, no attempt was made to empirically test which variables identify a framework for BM and whether they allow firms to gain financial performance and competitive advantages, leading to BMI. Further, while it is generally acknowledged that a business model is the way firms reach competitive advantage ad create value for its stakeholder (Wirtz et al., 2016), agreement on both the theoretical and empirical aspects is still lacking. Although several efforts existing, actually the core constructs of BMs are not defined adequately (Foss & Saebi, 2018; Paoloni et al., 2019), which also makes it difficult to conduct empirical testing.

A first systematic conceptualization of BM has been provided by Lazonick (2006) who identified the existence of a BM in the US high tech listed companies. The Lazonick (2006) study identifies the common features defining the New Economy Business Model. The successful New Economy companies and smart and new technologies depict, nowadays, different profiles of companies compared to the past. This seminal work by Lazonick (2006) has theoretically described the BM of companies engaged in the typical sectors of the so-called New Economy. Looking at the US experience, Lazonick has verified the existence of a consolidated (NEBM), since the introduction of the semiconductor technology (in the 1950s). The NEBM differs from the traditional model of business (the so-called Old Economy Business Models—OEBM) as per strategy, finance, and organization dimensions. As for strategy, NEBMs focus on vertical integration over horizontal diversification. As regards organization, in NEBM the “organizational man” becomes “highly-mobile man,” who prefers to move from a company to another and to change his role, rather than be stable in the same firm and in the same role. As for finance, in NEBM reinvestment rates reach high levels. Among the different financial methods, self-financing resources are the financial channel that NE firms prefer to use to support the long-term growth and to finance the indispensable investments, achieving the going concern principle. Accordingly, they prefer to limit both financial debts—making less use of financial leverage—and dividends to be distributed to shareholders. They generally choose to increase the reinvestment rates to get enough resources to finance indispensable investments as R&D activities.

3 Method

We adopted a qualitative methodology using a document analysis of the relevant literature. Additionally, we include very primary research on emerging topics using the content and bibliometric analysis adopting VOSviewer software (Van Eck & Waltman, 2014). Thus, we consulted the Scopus database searching the term “business model innovation” in the area of business, management, and accounting. The investigation has been done in the last 3 years 2018–2020 as relevant horizon timing.

We initially found 416 documents, including all kinds of researches (i.e., articles, reviews, conference papers). We also added in the search query the word “sustainability” as investigated in the theoretical background to refine this research. Our last result was based on 207 documents. We discussed the results of this analysis among authors and we decided to adopt a grey analysis (Kraus et al., 2020). Our analysis is directed to support the future investigation of smart technologies in the field of BM innovation and sustainability. The following section presents the primary results of the content and bibliometric application even if a more extensive investigation could be completed on this emerging topic for academic and practical communities.

4 The Content and Bibliographic Analysis

Applying the content and bibliographic analysis through the utilization of VOSviewer software, we conducted our research in the recent 3 years (2018–2020), discovering interesting keywords and an increasing trend of publications in the field. Figure 1 shows nine clusters of keywords of several relevance identified by different colors.

The most relevant cluster (red color) is based on 27 keywords among which we retrieve the following keywords:

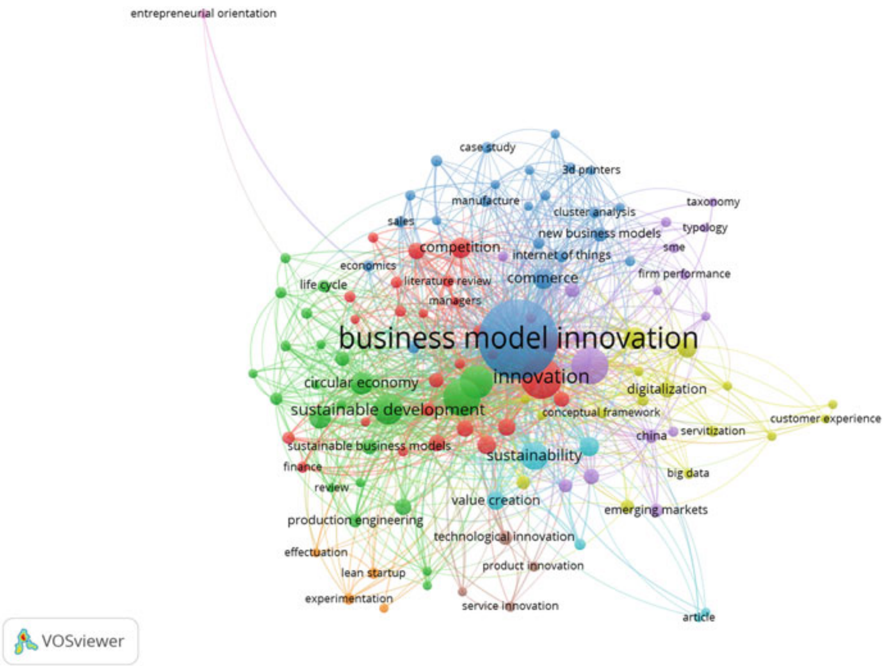


Fig. 1 Clusters of keywords by BM innovation

- Business
- Business development
- Competition
- Competitive advantage
- Decision-making
- Dynamic capabilities
- Ecosystems
- Enterprises resource management
- Enterprise resource planning
- Entrepreneur
- Entrepreneurship
- Finance
- Industrial management
- Innovation
- Innovation management
- Managers
- Product-service systems
- Strategic approach
- Strategy
- Supply chains

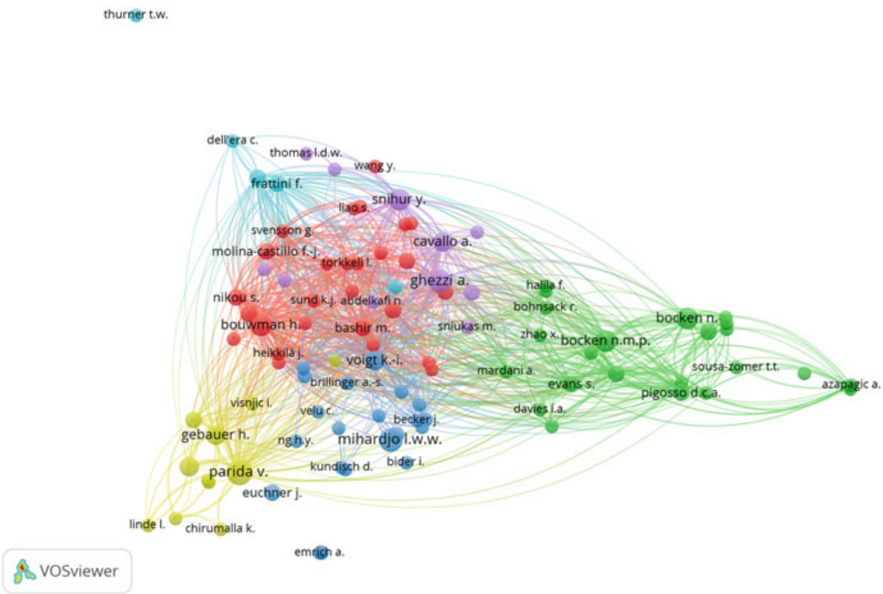


Fig. 2 The most influential authors are represented in figure 2

Analyzing all clusters by Fig. 1, we also retrieve a strong connection of BM innovation and the following keywords:

(i) circular economy and circular business model
(ii) sustainable business models and sustainable values
(iii) smart technologies (i.e., blockchain, 3d printers, internet of things)
(iv) digitalization, sharing economy and transformational economy
(v) disruptive innovation and social enterprise
(vi) sustainability and value creation
(vii) internationalization and lean start-up
(viii) product and technological innovation
(ix) entrepreneurial orientation (Fig. 2)

Figure 3 shows the five clusters of keywords refining the research with the BM innovation and sustainability. The most relevant cluster of keywords by BM innovation and sustainability is in red color having 17 keywords among which the following:

– business
– business model innovation
– competition
– competitive advantage
– digital transformation
– digitization
– dynamic capabilities

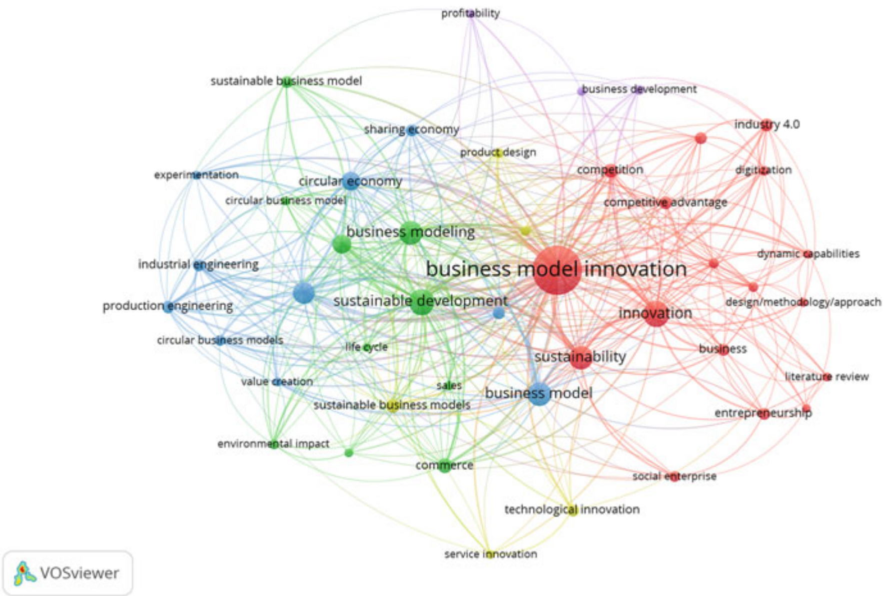


Fig. 3 Cluster of keywords by BM innovation and Sustainability

– ecosystems
– entrepreneurship
– industry 4.0
– innovation
– social enterprises
– strategy
– sustainability

Also, in this refined analysis, we retrieved a strong connection of BM innovation and sustainability and the following keywords:

(i) circular economy and circular business model
(ii) sustainable business models
(iii) sharing economy and value creation
(iv) disruptive innovation and social enterprise
(v) product and technological innovation

5 Insights, Implications, and Future Research

Our research is posed as the primary springboard to investigate BM innovation and sustainability. Following the emerging keywords identified in Sect. 4, we decide to focus on smart technologies in future research. Thus, we are directed to further investigate companies involved in such research area and smart technologies. We intend to draft the main characteristics of BM assuming companies engaged in high-knowledge intensive businesses in Europe. The future purpose of the project is to study whether BM is persistent over time to claim BMs sustainability in the long run (Bocken et al., 2014) assuring corporate sustainability and defining a new business modeling. Our explorative project will be the first step toward the Lazonick (2006) approach as theoretical background to investigate a sample of legally operating EU high-tech and knowledge-intensive listed companies and related to smart and new-advent technologies.

According to European Commission, smart technologies refer to processes and products that make decisions and carry out work to improve people's lives. Smart technologies comprise smart automation and devices that work automatically, without human help. They also include smart devices by joining innovative software with traditional products from existing industrial firms. This "Era" is a powerful driver of innovation, in which the real-time capability, the flexibility of strategy, the horizontal and vertical integration of production systems through ICT systems, are considered the unique response to complex environment, to new way of competition among organizations, to the high volatility of market demands, to make firms "stay tuned."

The wider definition of smart technologies encompasses several business sectors (Lombardi, 2019; Lombardi et al., 2020a, 2020b): smart technologies' manufacturers and smart technologies' users. In this sense, smart technologies companies could be innovative firms operating in new smart business industries and traditional organizations operating in traditional sectors. According to Ho et al. (2011), the connection between smart technologies and business model is an under-investigated field, yet.

Thus, "smart technologies" involve in several business industries. Indeed, smart technologies allow realizing a new and smart product/service, or they enable to change and improve traditional product/service. In both cases, smart technologies bring about an innovation. Thus, BM is forced to adapt and to change due to innovation.

Even if our project represents a first step to transpose BM approach from a theoretical perspective into an empirical dimension, we provide a theoretical and practical contribution to the existing literature on corporate sustainability (Lozano, 2018; Lozano & Huisingh, 2011; Schrippe & Duarte Ribeiro, 2019; Pedersen et al., 2018) and dynamic business modeling (Bocken and Short, 2016; Bocken et al. 2013; Evans et al., 2017). Even if this research has several limitations (i.e., primary research, theoretical concepts, selection of keywords, absence of empirical analysis), we believe that this stream of studies could propose interesting results to academic, practical communities and policymakers, stimulating several reflections and efforts to measure and define sustainable BMs in the context of corporate sustainability drafting a new business modeling.

References

Allais, R., Roucoules, L., & Reyes, T. (2017). Governance maturity grid: A transition method for integrating sustainability into companies? *Journal of Cleaner Production, 140*, 213–226.

Amit, R., & Zott, C. (2012). Creating value through business model innovation. *MIT Sloan Management Review, 53*, 41–49.

Bashir, M., Nasqshbandi, N. M., & Farooq, R. (2020). Business model innovation: A systematic review and future research directions. *International Journal of Innovation Science, 12*(4), 457–476.

Bocken, N. M. P., & Short, S.W. (2016). Towards a sufficiency-driven business model: Experiences and opportunities. *Environmental Innovation and Societal Transitions, 18*, 41–61.

Bocken, N. M. P., Short, S. W., & Evans, R. S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production, 65*, 42–56.

Bocken, N.M.P., Short, S.W., Rana, P., & Evans, S. (2013). A value mapping tool for sustainable business modelling. *Corporate Governance, 13*(5), 482–497.

Calia, R. C., Guerrini, F. M., & Moura, G. L. (2007). Innovation networks: From technological development to business model reconfiguration. *Technovation, 27*(8), 426–432.

Chesbrough, H. (2007). Business model innovation: It's not just about technology anymore. *Strategy and Leadership, 35*(6), 12–17.

Chesbrough, H. (2010). Business model innovation: Opportunities and barriers. *Long Range Planning, 43*(2–3), 354–366.

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change, 11*(3), 529–555.

Evans, S., Vladimirova, D., Holgado, M., Van Fossen, K., Yang, M., Silva, E. A., & Barlow, C. Y. (2017). Business model innovation for sustainability: Towards a unified perspective for creation of sustainable business models. *Business Strategy and the Environment, 26*(5), 597–608.

Foss, N. J., & Seabi, T. (2018). Business models and business model innovation: Between wicked and paradigmatic problems. *Long Range Planning, 51*, 9–21.

Ho, Y. C., Fang, H. C., & Hsieh, M. J. (2011). The Relationship between Business-model Innovation and Firm Value: A Dynamic Perspective. *International Journal of Mechanical and Industrial Engineering, 5*(5), 599–607.

Hossain (2017). Business model innovation: past research, current debates, and future directions. *Journal of Strategy and Management, 10*(3), 1–19.

Khanagha, S., Volberda, H., & Oshr, I. (2014). Business model renewal and ambidexterity: structural alteration and strategy formation process during transition to a Cloud business model. *R&D Management, 44*(3), 322–340.

Kraus, S., Breier, M., & Dasí-Rodríguez, S. (2020). The art of crafting a systematic literature review in entrepreneurship research. *International Entrepreneurship and Management Journal, 16*, 1–20.

Lazonick, W. (2006). Evolution of the new economy business model. In E. Brousseau & N. Curien (Eds.), *Internet and digital economics* (pp. 59–113). Cambridge University Press.

Lombardi, R. (2019). Knowledge transfer and organizational performance and business process: Past, present and future researches. *Business Process Management Journal, 25*(1), 2–9.

Lombardi, R., Chiucchi, M. S., & Mancini, D. (2020a). *Smart Technologies, Digitalizzazione e Capitale intellettuale. Sinergie e opportunità*. FrancoAngeli.

Lombardi, R., Paoloni, P., Belyaeva, Z., & Shams, S. M. R. (2020b). Guest editorial: Smart technologies for sustainable business model: Adaptation challenges and prospects in economic and cultural drift. *Management Decision, 58*(8), 1517–1524.

Lozano, R. (2018). Sustainable business models: Providing a more holistic perspective. *Business Strategy and the Environment, 27*(8), 1159–1166.

Lozano, R., & Huisingh, D. (2011). Inter-linking issues and dimensions in sustainability reporting. *Journal of Cleaner Production, 19*, 99–107.

Magretta, J. (2002). Why business model matter. *Harvard Business Review, 80*, 3–8.
Morris, M., Schindehutte, M., & Allen, J. (2005). The entrepreneur's business model: Toward a unified perspective. *Journal of Business Research, 58*(6), 726–735.
Osterwalder, A., & Pigneur, Y. (2003). Modeling Value Propositions in e-Business, Fifth International Conference on Electronic Commerce (ICEC), Pittsburgh,USA.
Paoloni, P., Solimene, S., Coluccia, D., & Fontana, S. (2019). Business Model and Sustainability: the state of the Art, 14. *International Forum on Knowledge Asset Dynamics*, IFKAD, Matera, 5–7. https://www.ifkad.org/event/ifkad-2019/
Pedersen, E. R. G., Gwozdz, W., & Hvass, K. K. (2018). Exploring the relationship between business model innovation, corporate sustainability, and organisational values within the fashion industry. *Journal of Business Ethics, 149*(2), 267–284.
Schrippe, P., & Duarte Ribeiro, J. L. (2019). Preponderant criteria for the definition of corporate sustainability based on Brazilian sustainable companies. *Journal of Cleaner Production, 209*, 10–19.
Sorescu, A. (2017). Data-driven business model innovation. *Product Development and Management Association, 34*(5), 691–696.
Stubbs, W., & Cocklin, C. (2008). Conceptualizing a Sustainability. *Organization & Environment, 21*(2), 103–127.
Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning, 43* (2/3), 172–194.
Van Eck, N. J., & Waltman, L. (2014). Visualizing bibliometric networks. In *Measuring scholarly impact* (pp. 285–320). Springer.
Voelpel, S. C., Leibold, M., & Tekie, E. B. (2004). The wheel of business model reinvention: How to reshape your business model to leapfrog competitors. *Journal of Change Management, 4*(3), 259–276.
Wei, Z., Yang, D., Sun, B., & Gu, M. (2014). The fit between technological innovation and business model design for firm growth: Evidence from China. *R&D Management, 44*(3), 288–305.
Wiklund, J., Patzelt, H. & Shepherd, D.A. (2009). Building an integrative model of small business growth. *Small Business Economics, 32*, 351–374.
Wirtz, B. W., Pistoia, A., Ullrich, S., & Gottel, V. (2016). Business models: Origin, development and future research. *Long Range Planning, 49*(1), 36–54.
Zott, C., & Amit, R. (2008). The fit between product market strategy and business model: Implications for firm performance. *Strategic Management Journal, 29*(1), 1–26.
Zott, C., & Amit, R. (2010). Designing your future business model: An activity system perspective. *Long Range Planning, 43*(2–3), 216–226.
Zott, C., Amit, R., & Massa, L. (2011). The business model: Recent developments and future research. *Journal of Management, 37*(4), 1019–1042.

Smart Technologies and New Business Models: Insights from Artificial Intelligence and Blockchain

Francesca Dal Mas, Carlo Bagnoli, Maurizio Massaro, and Stefano Biazzo

1 Introduction

Among the several smart technologies, Artificial Intelligence (AI) and Blockchain are considered among the most disruptive ones that have appeared in recent decades (Sousa et al., 2021; Sousa & de Bem Machado, 2020). More in details, AI is the technology that is supposed to lead the most significant changes in the business world with a potential contribution of $15 trillion to the world economy by 2030 (Panetta, 2018). Fifty-nine percent of companies have not yet formulated real AI strategies, but the remaining ones are already advanced in experimenting and adopting this technology in several business fields (Panetta, 2018). AI thus stands as a crucial factor for the transformation and reconfiguration of companies' operational and organizational models, but also, above all, of their business models (Campos de Mendonça & Valente de Andrade, 2018). AI will trigger the digital disruption of all sectors, making algorithmic business models dominate. Transformations of a similar impact are considered to be those conveyed by the Blockchain. According to a survey conducted by the World Economic Forum, by 2027 10% of global GDP will be developed on (or "10% of global monetary exchanges will be managed by") Blockchain platforms (Carson et al., 2018). However, this technology

F. Dal Mas (✉)
Lincoln International Business School, University of Lincoln, Lincoln, UK
e-mail: fdalmas@lincoln.ac.uk

C. Bagnoli · M. Massaro
Dipartimento di Management, Università Ca' Foscari, Venice, Italy
e-mail: bagnoli@unive.it; maurizio.massaro@unive.it

S. Biazzo
Dipartimento di Tecnica e Gestione dei Sistemi Industriali, Università degli Studi di Padova, Padua, Italy
e-mail: stefano.biazzo@unipd.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_21

will not only allow less costly transactions with the same security but is considered to revolutionize business strategies, like AI (Ruzza et al., 2020). Cryptocurrencies are the best-known example, but through the Blockchain, it is possible to certify, for example, even the first recording of a song, to distinguish the original from the copies. The main challenges for companies in adopting AI and Blockchain are, therefore, above all of a strategic nature. The paradigm shift necessary to effectively apply these new mantras is such that it no longer requires the simple adaptation of corporate strategies but their total redefinition from the foundations in a digital-first perspective. The technological innovation of processes and products enabled by AI and the Blockchain must, therefore, be accompanied by a whole strategic innovation of the business model. The organizations that will be the first ones to adopt these technologies by integrating them into their business strategies will create a competitive gap that will be difficult to bridge from the others (Bagnoli et al., 2018b, 2019).

Starting from this premise, the aim of the chapter is to understand how such digital technologies can impact or foster new business models, conducting a structured literature review (SLR) on the works published on the topic.

2 Methodology

The research has been conducted on the structured review of the scientific literature according to the framework of Massaro et al. (2016) on the possible impacts of AI and Blockchain on business strategies. To this end, we selected all the scientific articles listed on the scientific database Scopus characterized by the keywords "Artificial Intelligence," "Blockchain," "strateg*". The search was limited to the period between 2008 and 2018, to the subject area "Business, Management and Accounting" and to the ISSN of the levels 3, 4, and 4* scientific journals selected from the United Kingdom based list "ABS Journal Ranking 2018," as done in previous studies (Dal Mas et al., 2019).

To the 123 scientific articles found, we added further professional contributions, considered relevant to the analysis, such as the reports produced by the various national authorities and by leading consulting firms. This preliminary phase of the research led to the selection of a total of 182 documents, divided as follows: 82% scientific articles, 13% consultancy reports, 5% other reports; and by focus: 85% AI, 13% Blockchain, 2% other topics. All the documents were studied and analyzed by two independent researchers using Nvivo. Table 1 shows the structure of the nodes used for the analysis of materials through the software. The information collected varies from merely identifying the documents analyzed (A–E) and the themes and research methodologies adopted (F–J), to those relating to their contents (K–M). In particular, the potential impacts of AI and Blockchain on the individual building blocks of the business models (L) were then aggregated to identify a list of operational benefits recognized in the literature.

The framework of the analysis, according to the canvas of Biloslavo et al. (2018), recalls the concept of business model. According to the literature, the business model

Table 1 Nodes, sources, and references

Nodes	Sources	References
A_Author	182	334
B_Year	182	192
C_Source type	182	191
C 01_Journal article	149	156
C 02_Consultancy report	24	26
C 03_Institutional report	4	4
C 04_Other	5	5
D_Journal	182	192
E_Institution	182	262
F_Research focus-topic	182	246
F 01_Artificial intelligence	157	217
F 02_Blockchain	24	26
F 03_Other	3	3
G_Research methods	182	276
G 01_Case study	55	69
G 02_Literature review	33	36
G 03_Survey	15	18
G 04_Interview	15	16
G 05_Simulation	20	28
G 06_Other qualitative methods	14	20
G 07_Other quantitative methods	26	32
G 08_Not specified	41	41
H_Research questions and hypothesis	182	250
H 01_Research questions	96	142
H 02_Research hypothesis	18	25
H 03_Not specified	69	71
I_Research framework	182	464
I 01_Theoretical framework	129	404
I 02_Not specified	49	49
J_Frameworks and models	182	261
J 01_New framework-model proposed	71	126
J 02_Previous framework-model adopted	39	51
J 03_Not specified	83	84
K_Kind of industry-sector	182	424
K_01 Enterprise AI	3	4
K_02 Non-AI	181	420
A_Agriculture, forestry, and fishing	8	14
B_Health care	28	66
C_Manufacturing	31	46
D_Energy	13	24
E_Transportation and logistics	10	15
F_Technology, media and telecom	13	17

(continued)

Table 1 (continued)

Nodes	Sources	References
G_Education	9	25
H_Finance	23	46
I_HoReCa and tourism	6	6
J_Retail and consumer	27	33
K_Automotive	14	27
L_Public sector	8	13
M_Chemical industry	2	2
N_Construction industry	2	2
O_Entertainment	4	4
P_Insurance	2	3
Q_Other	12	13
R_Not specified	61	63
L_Business model	182	958
L 01_Resources	51	140
L 02_Suppliers	15	21
L 03_Procurement channels	21	45
L 04_Internal processes	60	122
L 05_Distribution and communication channels	21	46
L 06_Customers	27	58
L 07_External processes	13	18
L 08_Products	25	46
L 09_Society	30	64
L 10_Value system	8	11
L 11_Value proposition	14	17
L 12_Cost structure	41	83
L 13_Revenue stream	29	52
L 14_Examples	35	147
L 15_Not specified	55	56
M_Findings	182	1094
M 01_Research findings	182	526
M 02_Management implications	182	354
M 03_Policy implications	182	214

represents the logic through which an organization creates value for itself and its stakeholders, also with the exploitation of new technology (Bagnoli et al., 2018a, 2018b; Nielsen et al., 2018; Osterwalder & Pigneur, 2012). It can be described and analyzed through the following building blocks and the relationships among them:

(a) *Suppliers*: They are represented by subjects with whom the organization establishes relationships for the procurement of resources that are not directly available.
(b) *Resources*: They are the tangible and intangible economic assets that are necessary to feed the processes.

(c) *Processes*: They are represented by the system of activities that the organization develops to transform inputs (resources) into outputs (products).
(d) *Products*: They are the visible offer with which the organization approaches the markets to meet the explicit, latent, or non-existent needs of the target customers.
(e) *Customers*: They are the recipients of the products, and certify the validity of the company's value proposition.
(f) *Society*: It is represented by the set of corporate stakeholders (employees, citizens, researchers, etc.) whose opinions, decisions, and behaviors can favor or hinder the organization.
(g) *Value Proposition*: It represents the value to be delivered, communicated, and acknowledged by the customers, explaining why a client should choose that organization over its competitors.

3 Findings: Insights from Artificial Intelligence and New Business Models

3.1 Artificial Intelligence: What It Is and How It Works?

In general terms, AI can be defined as a set of technologies that allow sensor systems, algorithms, and machines to perform activities that usually require human intelligence. AI is able to perceive the outside world, collecting structured and unstructured data from it, such as texts, sounds, images, and videos. AI is also able to understand, that is, process data by transforming it into information, knowledge, and even decisions. It should be highlighted how AI is inspired by human intelligence. Still, it does not necessarily have to simulate it, thus generating decision-making algorithms that humans may not fully understand and control, but which nevertheless prove to be correct in their judgment. For example, thanks to AI, it is possible to predict the malfunction of a device by putting together data from different sources that would have no particular meaning if read individually by an expert. In medicine, AI can be able to identify imperceptible signal variations within diagnostic images that would not be interpretable by a surgeon.

Trying to understand the main themes related to AI, we analyzed the terminologies used in the literature and their aggregations. We started from the definitions found in the scientific articles dealing with AI, employing Leximancer. This text mining software aggregates concepts into themes, and analyzes the relationships among them, deepening their syntactic proximity. In particular, by analyzing the co-occurrences of the words used by scholars, it clearly emerges how AI is strongly connected to the development of applications for machine learning aimed at solving tasks independently in a defined environment and space. Figure 1 summarizes the results of the analysis.

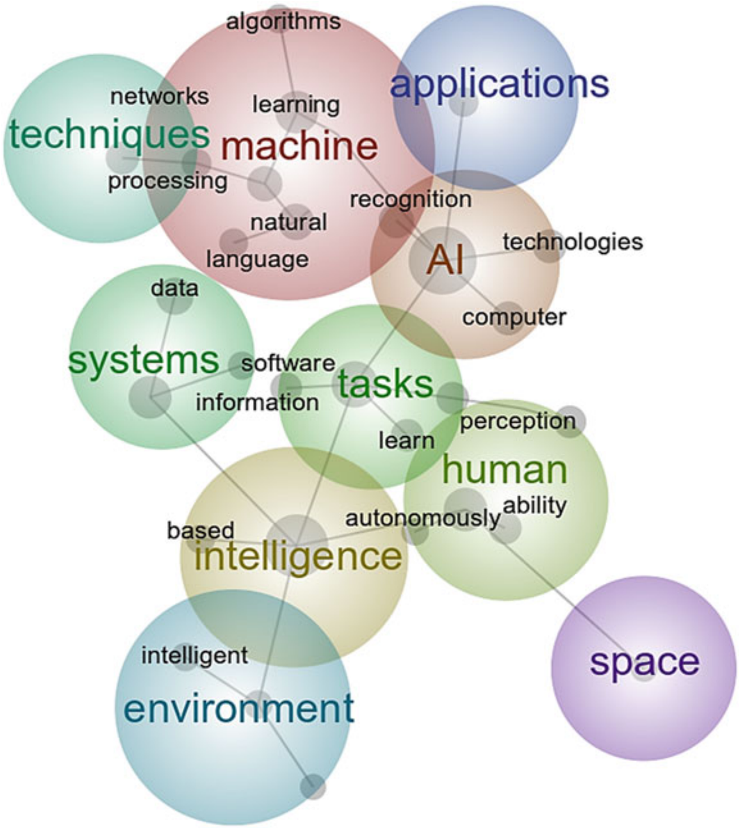


Fig. 1 AI, topics, and themes

3.2 The Potential Impact of Artificial Intelligence on the Business Model's Building Blocks

This section reports the potential impacts of AI on the single business model's building blocks, as gathered from the analysis of the literature.

Suppliers

Twelve percent of the sources analyzed highlighted how the introduction of AI along the supply chain opens up to significant changes in the management of relationships. For example, the use of intelligent decision support systems makes it possible to increase efficiency in supplier selection, improve the accuracy of forecasts by optimizing and automating the negotiation phases (Kannan, 2018). AI also enables to increase visibility and speed up communications throughout the supply chain, allowing the decentralization of logistics networks and thus reducing transport costs (Bogataj et al., 2017). AI permits to collect data and deliver information throughout the supply network to create "intelligent" knowledge bases for jointly solving problems along the supply chain (Min, 2010).

Resources

According to 23% of the sources, AI has a significant impact on resources, especially human ones. Extensive automation of physical tasks and production processes are literally putting technologies "to work." The creation of "augmented" jobs will be the direct consequence of the progressive replacement of human operators by intelligent machines. At the operational level, the intensification of the synergic combination of human intelligence (human skills) and AI (intelligent machines) can lead to the reduction of human errors and accidents at work, increasing productivity (Huang & Rust, 2018; Jarrahi, 2018). Men, therefore, are called to perform tasks that cannot be acquired by a machine: intuition, empathy, imagination, abstraction, aspiration for knowledge, and flexibility in putting it into practice. Human–machine interaction leads to an increase in analytical skills, enables the transfer of knowledge between people and robots. The use of AI techniques allows facilitating the analysis and classification of data, increasing the accuracy, accessibility, and availability of the information (Suominen et al., 2017).

Processes

According to 24% of the analyzed source, AI will strongly impact the internal processes, leading to benefits in terms of efficiency of production systems, for example, by increasing the efficiency in assigning tasks to machinery thanks to the prediction of production and assembly parameters (Yang & Lu, 2010). In product design processes, AI can reduce the time required to solve design problems using machine learning and reduce waste by minimizing product testing. In more traditional production processes, the efficiency in warehouse management will increase, reducing waste and unnecessary stocks, improving the times of order collection and diagnostics. Production processes will become faster and safer, reducing downtime. Alongside the automation of production processes, the introduction of AI in business models will significantly affect decision-making processes with the use of decision support systems and their incidence in operational and strategic choices (Bekker & Lotz, 2009; Duan et al., 2019).

Considering external processes, 11% of the sources confirm that AI has been contributing to the transformation of product and service distribution channels, communication with customers, and marketing activities. In market analysis, AI allows examining demand and supply data in real time, anticipating sales trends, and increasing efficiency in controlling the purchase and sale phases and reducing time to market (Baryannis et al., 2019). AI techniques can be used to increase the effectiveness of marketing strategies by, for instance, creating programs capable of learning from every interaction with users optimizing advertising communication, creating personalized content (predictive marketing) (Cui et al., 2012).

Products

According to 9% of the sources analyzed, products and services are becoming increasingly smart, providing new opportunities for use. AI increases the performance of products by improving their characteristics and functions (Davenport & Ronanki, 2018). The use of AI techniques in the collection, classification, and analysis of customer data also allows the creation of increasingly personalized products, thanks, for example, to the automatic and real-time integration of user feedback into the product design processes, with a view to the co-design approach. AI allows the services to be adjusted in real time, customizing them according to their requests, thus adapting to the specific needs of each user, increasing the ability to respond to human emotions and consequently, increasing loyalty at low cost.

Clients

Eleven percent of the sources underline how AI offers new ways of analyzing, interpreting, and using customer data with significant implications for the development of loyalty and the creation of a more competitive value proposition. The entire consumer experience, offline and online, is revolutionized thanks to the implementation of hyper-connected intelligent systems and forecasting algorithms that allow companies to design demand accurately and reach target customers through new forms of personalized communication (Grewal et al., 2017). The first examples of AI applications for customer engagement include virtual assistants and chatbots, capable of providing personalized advice and guide the purchasing decision-making process.

Society

Considering the relational capital of the organization, AI allows the development of new approaches to capture value in the ecosystem beyond company boundaries, providing a unique research context for sustainability and stakeholder engagement. For example, swarm intelligence algorithms can detect information and patterns of behavior in online community platforms, facilitating the extraction of knowledge and understanding the impact of the company's business on society (Martinez-Torres & Olmedilla, 2016), enhancing corporate social responsibility. AI techniques can also be used to improve environmental sustainability, for example, by increasing the accuracy of the forecast on energy consumption and consequently limiting waste and the environmental impact generated by the business. In the area of public services, AI can increase accessibility to public services and enhance public safety thanks to data analysis, facilitating the responsiveness of public interventions by creating policies to encourage the development of cities.

Value Proposition

The analysis led to the recognition of 97 potential impacts of AI on the individual building blocks of the business model, influencing the overall value proposition. Eleven critical success factors can be identified: “Price”; “Availability, accessibility and speed”; “Reliability;” “Material quality”; “Intangible qualities” “Performance”; “Announcements”; “Wide range and customization”; “Goods, services and complementary experiences”; “Involvement and sharing”; “Life (work) style”; “attributable to four different”; “generic”; competitive strategies (Treacy & Wiersema, 1994): Operational Excellence; Product Leadership; Customer Intimacy; and Ecosystem Leadership.

4 Findings: Insights from Blockchain and New Business Models

4.1 Blockchain: What It Is and How It Works

The Blockchain is a secure, distributed, and immutable data storage system shared between a network of actors (Dal Mas et al., 2020b; Enisa, 2020; EU, 2020). The data is stored in “blocks,” connected to each other in a chain via a hash, which is a function that converts alphanumeric characters into a new encrypted sequence of a predetermined length. These blocks have a “head,” which includes metadata, and a body, which instead concerns the details of the actual data. Since each block is connected to the previous and the next and distributed among all the participants, as the number of actors in the network increases, it becomes exponentially more complex to modify any information. There are different types of Blockchains categorized according to the separate access permission. In other words, some Blockchains can be made freely accessible (“public” vs. “private”) and the ability to write to the register unlimited or controlled (“permissionless” vs. “permissioned”), but there are also more hybrid models (such as the Blockchain consortium). These aspects appear particularly evident if we analyze the main definitions found in the scientific papers with the Leximancer text mining software. By studying the co-occurrences of the words used by the scholars of the topic, it clearly emerges that the Blockchain is a database distributed in a network that can be public or private, with different participants. The role of some key aspects such as the hash function and the block organization of the register to store data or transactions appears quite evident. Figure 2 reports the result of the analysis.

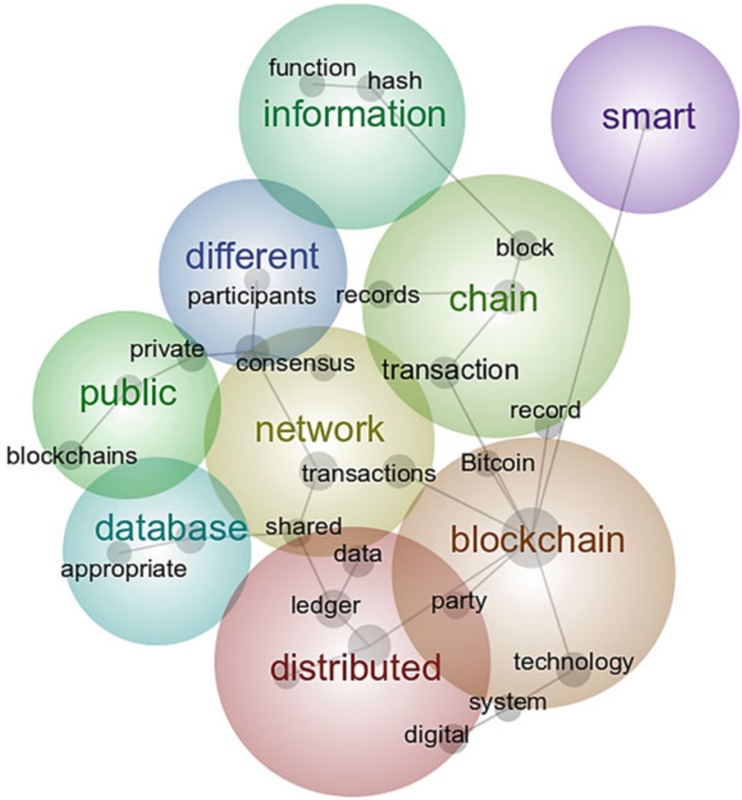


Fig. 2 Blockchain, topics, and themes

4.2 The Potential Impact of Blockchain on the Business Model's Building Blocks

This section reports the potential impacts of the Blockchain on the single business model's building blocks, as gathered from the analysis of the literature.

Suppliers

According to 18% of the sources, the Blockchain impacts on suppliers by increasing the transparency of transactions and exchange processes, allowing to reduce the risk of corruption, tracing the origin of assets, and enabling secure access to data on them, making the interactions transparent and verifiable at every moment of the life cycle of the resource. The Blockchain facilitates peer-to-peer partnerships between companies, strengthening, and expanding supply chains.

Resources

Following 13% of the sources analyzed, the Blockchain allows the creation of cryptographic markets, in which easily replicable resources, such as data, become scarce. Thus was born the "internet of value" where limited digital assets such as rights and other digital assets can be traded on unregulated markets. The birth of decentralized digital markets also makes it possible to increase the efficiency in the use of local resources, while increasing their availability and value (Dinh & Thai, 2018).

Processes

Twenty-one percent of the sources highlight the impact of the Blockchain on internal processes. Thanks to the standardization of data, information exchange among departments and divisions is faster and more efficient (Du et al., 2019). The integration with technologies like the Internet of Things increases the availability of information on the current state of machinery (Treiblmaier, 2018). The Blockchain allows expanding the security, reliability, and compliance with the regulations of automated decisions taken by AI systems (Dinh & Thai, 2018). Moreover, it reduces the risks of manual manipulation of data, protecting digital identities, sensitive data, and privacy.

Seventeen percent of the sources focus on external processes, stressing the ability to increase reliability in the delivery processes thanks to the tracking of certifications in real time. The use of smart contracts empowers fully traceable transactions, which can be verified by the ecosystem partners, preserving, at the same time, the user's privacy. Payment security increases, as well as security and privacy in data exchange. In general terms, middlemen can be eliminated, and the costs of transactions are reduced (Dal Mas et al., 2020a, 2020b; Massaro et al., 2020).

Products

Nine percent of the sources underline the positive impact of the Blockchain on products, by intervening in the authentication of both tangible and intangible traded goods (Nowiński & Kozma, 2017). The use of the Blockchain makes it possible to increase the traceability of products and services, consequently improving their security, reliability, and quality. The use in the agri-food and pharma sectors allows, for example, to know and track the history of products, from their production to the final consumer, limiting the risk of counterfeiting (Dal Mas et al., 2020b).

Clients

Nine percent of the sources highlight the impact on customers, as the distributed nature, the cooperative model that prevents the retroactive modification of the data contained in the blocks and the cryptographic process make the data management process robust and reliable, without the intervention of intermediaries. These features increase the perceived value, reducing the risk of fraud and enhancing security, allowing organizations to access new customer segments.

Society

Thirteen percent of the sources focus on the impacts on society. Acting as a decentralized peer-to-peer network, the Blockchain seeks reliability in achieving peer consensus, removing intermediaries and the need to trust a centralized entity. These features revolutionize the very foundations of the relationships of trust between producers, consumers, and stakeholders, enhancing social sustainability through the access to secure and cheaper products and services (Dal Mas et al., 2020a).

Value Proposition

The analysis led to 40 potential impacts of the Blockchain on the individual building blocks of the business model and the overall value proposition. These seem to allow the improvement of the critical success factor "Product reliability" (45% of cases), "Price" (20% of cases), "Availability, accessibility and speed" (18%), "Customer involvement and sharing" (8%), and lastly, "Performance," "Range of product range and customization," and "Characteristics of the complementary goods, services and experiences" (5% or less).

Results emphasize the impacts on "operational excellence" (meaning to "do the same things, but better"), rather than on those of "product leadership" or "Customer intimacy," that is, to "do different things, or the same things in a different way" (Treacy & Wiersema, 1994), enhancing Ecosystem Leadership.

5 Discussions and Conclusions

Our study started with a literature review conducted on the latest academic and professional sources to understand the impacts of smart technologies in the development of new business models. To better focus our research, we decided to concentrate on the two technologies which are widely considered as the most disruptive ones, AI and Blockchain. In collecting and analyzing our findings, we used the framework by Biloslavo et al. (2018), matching the results of the literature within the single building blocks of business model. The analysis highlights the potential impacts of the technologies on business models. More in detail, while AI influences on 97 various ways, the Blockchain has 40 potential impacts. Such effects are widely distributed among all the building blocks, allowing organizations to benefit from them as they think it is more appropriate or beneficial considering the company's business, its markets, clients, vision, and mission.

Given the real-life implications of the topic, there is a call to practical studies that can bring real-world implications for the industry and the global society (Bai et al., 2020; Saberi et al., 2018), contributing to bridging the gap between academia and practice (Massaro et al., 2018). Future research avenues may investigate such an aspect, maybe enlarging the sample to new sources like blogs (Massaro et al., 2017, 2018).

Policy implications may arise from the contributions of AI and the Blockchain to the society, in enhancing social and environmental sustainability.

Like all pieces of research, our study has some limitations. First, we focused only on peer-reviewed works listed on Scopus and published in high-end journals of the ABS list, adding professional reports and other sources from national as international institutions. Still, other meaningful sources may be missing, like books, book chapters or pioneering conference proceedings, or documents in languages different than English. Moreover, the validity of our findings can only be granted at the time of the study, also considering the growing academic and professional interest toward AI and Blockchain, and their evolving technological innovation. Future contributions and technological advancement may indeed change the validity of our outcome. Readers should acknowledge that SLRs are not a panacea offering ultimate answers. Still, they have the ambition to detect research gaps and opportunities for further studies and developments.

References

Bagnoli, C., Bravin, A., Massaro, M., & Vignotto, A. (2018a). *Business model 4.0*. Edizioni Ca' Foscari.

Bagnoli, C., Massaro, M., Dal Mas, F., & Demartini, M. (2018b). Defining the concept of business model. A literature review. *International Journal of Knowledge and Systems Science, 9*, 48–64.

Bagnoli, C., Dal Mas, F., & Massaro, M. (2019). The 4th industrial revolution and its features. Possible business models and evidence from the field. *International Journal of E-Services and Mobile Applications, 11*(3), 34–47.

Bai, C. A., Cordeiro, J., & Sarkis, J. (2020). Blockchain technology: Business, strategy, the environment, and sustainability. *Business Strategy and the Environment, 29*(1), 321–322.

Baryannis, G., Validi, S., Dani, S., & Antoniou, G. (2019). Supply chain risk management and artificial intelligence: State of the art and future research directions. *International Journal of Production Rese, 57*(7), 2179–2202.

Bekker, J., & Lotz, W. (2009). Planning formula one race strategies using discrete-event simulation. *Journal of the Operational Research Society, 60*(7), 952–961.

Biloslavo, R., Bagnoli, C., & Edgar, D. (2018). An eco-critical perspective on business models: The value triangle as an approach to closing the sustainability gap. *Journal of Cleaner Production, 174*, 746–762.

Bogataj, D., Bogataj, M., & Hudoklin, D. (2017). Mitigating risks of perishable products in the cyber-physical systems based on the extended MRP model. *International Journal of Production Economics, 193*, 51–62.

Campos de Mendonça, C. M., & Valente de Andrade, A. M. (2018). Dynamic capabilities and their relations with elements of digital transformation in Portugal. *Journal of Information Systems Engineering and Management, 3*(3) 1–8.

Carson, B., Romanelli, G., Walsh, P., & Zhumaev, A. (2018). Blockchain beyond the hype: What is the strategic business value? *McKinsey Digital*. Retrieved August 19, 2020, from https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/blockchain-beyond-the-hype-what-is-the-strategic-business-value#

Cui, G., Wong, M. L., & Wan, X. (2012). Cost-sensitive learning via priority sampling to improve the return on marketing and CRM investment. *Journal of Management Information Systems, 29* (1), 341–374.

Dal Mas, F., Massaro, M., Lombardi, R., & Garlatti, A. (2019). From output to outcome measures in the public sector. A structured literature review. *International Journal of Organizational Analysis, 27*(5), 1631–1656.

Dal Mas, F., Dicuonzo, G., Massaro, M., & Dell'Atti, V. (2020a). Smart contracts to enable sustainable business models. A case study. *Management Decision, 58*(8), 1601–1619.

Dal Mas, F., Massaro, M., Verde, J. M., & Cobianchi, L. (2020b). Can the blockchain lead to new sustainable business models? *Journal of Business Models, 8*(2), 31–38.

Davenport, T. H., & Ronanki, R. (2018). Artificial intelligence for the real world: Don't start with moon shots. *Harvard Business Review, 96*(1), 108–116.

Dinh, T. N., & Thai, M. T. (2018). AI and blockchain: A disruptive integration. *Computer, 51*(9), 48–53.

Du, W. D., Pan, S. L., Leidner, D. E., & Ying, W. (2019). Affordances, experimentation and actualization of FinTech: A blockchain implementation study. *The Journal of Strategic Information Systems, 28*(1), 50–65.

Duan, Y., Edwards, J. S., & Dwivedi, Y. K. (2019). Artificial intelligence for decision making in the era of Big Data—Evolution, challenges and research agenda. *International Journal of Information Management, 48*, 63–71.

Enisa. (2020). *Csirts in Europe, glossary*. Blockchain. Retrieved May 25, 2020, from https://www.enisa.europa.eu/topics/csirts-in-europe/glossary/blockchain

EU. (2020). *Shaping Europe's digital future*. Blockchain Technologies. Retrieved May 25, 2020, from https://ec.europa.eu/digital-single-market/en/blockchain-technologies

Grewal, D., Roggeveen, A. L., & Nordfält, J. (2017). The future of retailing. *Journal of Retailing, 93*(1), 1–6.

Huang, M. H., & Rust, R. (2018). Artificial intelligence in service. *Journal of Service Research, 21* (2), 155–172.

Jarrahi, M. H. (2018). Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. *Business Horizons, 61*(4), 577–586.

Kannan, D. (2018). Role of multiple stakeholders and the critical success factor theory for the sustainable supplier selection process. *International Journal of Production Economics, 195*, 391–418.

Martinez-Torres, R., & Olmedilla, M. (2016). Identification of innovation solvers in open innovation communities using swarm intelligence. *Technological Forecasting and Social Change, 109*, 15–24.

Massaro, M., Dumay, J. C., & Guthrie, J. (2016). On the shoulders of giants: Undertaking a structured literature review in accounting. *Accounting, Auditing and Accountability Journal, 29*(5), 767–901.

Massaro, M., Dumay, J., & Bagnoli, C. (2017). When the investors speak. Intellectual capital disclosure and the web 2.0. *Management Decision, 55*(9), 1888–1904.

Massaro, M., Dumay, J., Garlatti, A., & Dal Mas, F. (2018). Practitioners' views on intellectual capital and sustainability: From a performance-based to a worth-based perspective. *Journal of Intellectual Capital, 19*(2), 367–386.

Massaro, M., Dal Mas, F., Chiappetta Jabbour, C. J., & Bagnoli, C. (2020). Crypto-economy and new sustainable business models: Reflections and projections using a case study analysis. *Corporate Social Responsibility and Environmental Management, 27*(5), 2150–2160.

Min, H. (2010). Artificial intelligence in supply chain management: Theory and applications. *International Journal of Logistics Research and Applications, 13*(1), 13–39.

Nielsen, C., Lund, M., Montemari, M., Paolone, F., Massaro, M., & Dumay, J. (2018). *Business models: A research overview*. Routledge.

Nowiński, W., & Kozma, M. (2017). How can blockchain technology disrupt the existing business models? *Entrepreneurial Business and Economics Review, 5*(3), 173–188.

Osterwalder, P., & Pigneur, Y. (2012). *Business model generator: A handbook for visionaries, game changes, and challengers*. Wiley.

Panetta, K. (2018). *5 trends emerge in the Gartner Hype Cycle for emerging technologies, 2018—smarter with Gartner*. Gartner.

Ruzza, D., Dal Mas, F., Massaro, M., & Bagnoli, C. (2020). The role of blockchain for intellectual capital enhancement and business model innovation. In P. Ordonez De Pablos & L. Evinsson (Eds.), *Intellectual capital in the digital economy* (pp. 256–265). Routledge.

Saberi, S., Kouhizadeh, M., & Sarkis, J. (2018). Blockchain technology: Apanacea or pariah for resources conservation and recycling? *Resources, Conservation and Recycling, 130*, 80–81.

Sousa, M. J., & de Bem Machado, A. (2020). Blockchain technology reshaping education contributions for policy. In R. C. Sharma, H. Yildirim, & G. Kurubacak (Eds.), *Blockchain technology applications in education* (pp. 113–125). IGI Global.

Sousa, M. J., Dal Mas, F., Pesqueira, A., Lemos, C., Verde, J. M., & Cobianchi, L. (2021). The potential of AI in health higher education to increase the students' learning outcomes. *TEM Journal, 2*, 488–497.

Suominen, A., Toivanen, H., & Seppänen, M. (2017). Firms' knowledge profiles: Mapping patent data with unsupervised learning. *Technology Analysis and Strategic Management, 115*, 131–142.

Treacy, M., & Wiersema, F. (1994). Customer intimacy and other value disciplines. *Harvard Business Review, 71*(1), 84–93.

Treiblmaier, H. (2018). The impact of the blockchain on the supply chain: a theory-based research framework and a call for action. *Supply Chain Management, 23*(6), 545–559.https://doi.org/10.1108/SCM-01-2018-0029

Yang, T., & Lu, J. C. (2010). A hybrid dynamic pre-emptive and competitive neural-network approach in solving the multi-objective dispatching problem for TFT-LCD manufacturing. *International Journal of Production Research, 48*(16), 4807–4828.

The Application of Artificial Intelligence to Business Models: A Systematic Literature Review

Simona Ranaldo, Vittorio Dell'Atti, and Mario Turco

1 Introduction

The uncertainty and increasing competitiveness of markets, also linked to the progressive spread of digital technologies, make it necessary to implement flexible business management policies that can ensure business continuity (Marques & Ferreira, 2009). The digital age has led to the spread of different technologies (Schwab, 2016) that have changed the habits of consumers and companies (Jovanović et al., 2018; Kaartemo & Helkkula, 2018). Industry 4.0, Artificial Intelligence (AI), Big Data, Internet of Things, cloud databases, social networks, blockchain and fintech applications are considered the engine of the fourth industrial revolution (Schwab, 2016). Among these, Artificial intelligence is considered one of the most promising digital technologies, having already brought important benefits in different business sectors (Serafini & Garcez, 2016). AI represents a complex of "intelligent" systems "*created to use data, analysis and observations to perform certain tasks without the need to be programmed to do so*" (Antonescu, 2018).

Author's Contribution:
Simona Ranaldo: 2. Research Method; 3. The Application of Artificial Intelligence to Business Models
Vittorio Dell'Atti: 4. Conclusion
Mario Turco: 1. Introduction

S. Ranaldo (✉) · V. Dell'Atti
Department of Economics, Management and Business Law, University of Bari Aldo Moro, Bari, Italy
e-mail: simona.ranaldo@uniba.it; vittorio.dellatti@uniba.it

M. Turco
Department of Economic Sciences, University of Salento, Lecce, Italy
e-mail: mario.turco@unisalento.it

M. S. Chiucchi et al. (eds.), *Intellectual Capital, Smart Technologies and Digitalization*, SIDREA Series in Accounting and Business Administration,
https://doi.org/10.1007/978-3-030-80737-5_22

Indeed, the definitions of AI are multiple, having also been defined as "*an activity dedicated to making machines intelligent. Intelligence is that quality that allows an entity to function appropriately and with foresight in its environment*" (Nilsson, 2010). In fact, the origins of the concept of "artificial intelligence" date back to 1956 when John McCarthy, together with a research group, assumed that every aspect of learning and, more generally, of intelligence, could be replicated by a machine. The goal was therefore to create a machine capable of thinking and acting like a human being (McCorduck, 2009). AI deals with the "*study of mental faculties through the use of computational models*" (Charniak & McDermott, 1985) and "*calculation processes that make it possible to perceive, reason and act*" (Salin & Winston, 1992). AI has also been defined as the set of scientific studies aimed at investigating the ways in which computers can think, do, interact and act in many fields just like humans (Rich, 1985). For example, among the first AI applications we find the intelligent assistant developed by Apple Inc., "Siri," which performs a series of functions and commands through the recognition of the human voice (Dirican, 2015). Learning, adaptation, generalization, inductive and deductive reasoning and human-like communication in a natural language configure the characteristic features of this technology (Kasabov, 2018). What has led to an ever-increasing attention to AI technology is "machine learning," a branch of AI that uses algorithms to analyze the flows of data and information available to companies, also known as Big Data, in order to use them to build a valuable competitive advantage (Pappas et al., 2018).

Another approach distinct from machine learning is represented by deep learning (DP) which has the ability to identify the desired information, process it through learning by creating new information useful for making future predictions, for example with reference to what the user will need, thus creating a new business model (Lee & Park, 2018).

To this end, the business model must be built around digital technologies and AI is one of the tools available to companies to implement innovative business models (Parida et al., 2019).

The choice of many companies to adopt new digital technologies is justified by the advantages linked to their implementation, for example in terms of process automation, optimization of production times and reduction of costs, errors and risks (Grubic & Jennions, 2018), promoting the use of resources and more efficient business models (Neligan, 2018).

In order to achieve the above, it is necessary to first implement changes in the objectives of business management, formulating a digital business strategy (Bharadwaj et al., 2013). Subsequently, it is necessary to innovate the entire business model, making a high initial investment (Lundvall et al., 2002) to support structural, organizational and cultural changes (Ruessmann et al., 2015; Parida et al., 2019).

Given the importance of digital technologies in promoting and developing more efficient and sustainable business models, this work intends to focus on artificial intelligence, considered one of the most promising technologies (Serafini & Garcez, 2016) to examine the state of the art on the topic, answering the following research question:

RQ: What are the issues that animate the scientific debate on the application of artificial intelligence to corporate business models?

To achieve this goal we intend to conduct a systematic literature review so as to provide evidence of the ways in which AI is able to make changes in corporate business models.

In particular, we aim to explore the main issues that have animated the debate in the literature between artificial intelligence and business models. The results show that researchers have mainly focused on the following three strands of research: (1) the benefits related to the application of artificial intelligence to business models; (2) the steps leading to the successful application of AI; (3) how the sector influences the application of AI.

The work is structured as follows: Sect. 2 describes the research method; Sect. 3 illustrates the results of the literature review related to the study of AI applied to business models; Sect. 4 contains the conclusions of the work.

2 Research Method

This section illustrates the research method used to answer the research question. An analysis of the literature was conducted with reference to the scientific contributions published in the last decade (2010–2020), using the Scopus database. The approach followed for the analysis of the literature is systematic (Parris & Peachey, 2012).

Systematic review has been defined as: "*a scientific process governed by a set of explicit and demanding rules oriented towards demonstrating comprehensiveness, immunity from bias, and transparency and accountability of technique and execution*" (Dixon-Woods, 2011, p. 332).

This analysis differs from that of the narrative type precisely because of its systematic nature, since it is an objective, replicable analysis, similar to an empirical research. In particular, the systematic analysis is characterized by a selection of articles based on clearly defined, non-random criteria; for the clarity of the criteria adopted for the inclusion/exclusion of articles, in order to make the research replicable and for a discussion of the results relating not to individual contributions but rather to the results deriving from the combination of different studies.

For the research on Scopus, the articles were selected using the keyword "*artificial intelligence*" combined with the expression "*business model*," using the default field of the database as the search field of keywords: Article Title, Abstract, Keywords. The research conducted, without any restrictions with respect to the disciplinary area or the type of contribution, was limited only with respect to the year of publication.

According to Vicente-Saez and Martinez-Fuentes (2018) after having identified the studies and assessed their relevance to the research objective, we made a summary and, finally, an analysis of the results obtained.

Table 1 Screening methodology

Step		Number of selected paper	Number of excluded paper
1	Total paper from *Scopus*	457	
2	Title not relevant		93
	Total paper considered post Step 2	364	
3	Abstract not relevant		178
	Total paper considered post Step 3	186	
4	Full text not relevant		155
	Total paper considered	31	

Specifically, in this research we considered only articles focused on the application of AI to business models. This first step generated a total of 457 papers. Subsequently, we eliminated articles whose title had no relevance to the subject of our study (93), reaching a total number of 364 papers. For this latter, the abstract was carefully read, selecting only those that answered affirmatively to this question: *does the article analyse the application of artificial intelligence to business models?*

Finally, each of the selected articles was analyzed in its entirety, in order to select only papers addressing the application of artificial intelligence to business models as a main and not marginal topic.

After this final screening, the articles considered relevant to our study amounted to 31 articles (Table 1).

3 The Application of Artificial Intelligence to Business Models

3.1 Artificial Intelligence and Business Models: What Opportunities?

Starting a digital transformation process presupposes "*the application of digital capabilities to processes, products and resources*" (Schmarzo, 2017) in order to optimize business processes, offer consumers products of greater value and reduce the risks associated with business activity through the creation of more efficient (Neligan, 2018) and sustainable business models (Di Vaio et al., 2020; Maffei et al., 2019).

To obtain the advantages associated with the implementation of technological innovation, it is necessary to digitize the business strategy (Bharadwaj et al., 2013) and innovate the business model (Glova et al., 2014; Parida et al., 2019), through changes that must invest the entire value creation process (Gassmann et al., 2017). The business model describes the company from the point of view of the activity carried out and the results obtained which are reflected on the company's performance (Massa et al., 2017) and represents the structure through which the company creates value (Osterwalder et al., 2005).

The use of AI systems determines changes in the value creation process and, consequently, in the corporate business model that becomes so innovative (Matt et al., 2015). By innovative business models, we mean the incorporation of new technology into the existing business model (Zott & Amit, 2007), which allows companies to improve long-term competitiveness (Brooks et al., 2020).

In fact, technological innovation is known to affect performance (Zaheer & Bell, 2005). In this regard, some scholars have highlighted that technological innovation and business performance are linked together through the business model (Baden-Fuller & Haefliger, 2013). In particular, choosing an appropriate business model could ensure greater profits are achieved by influencing the way technology is monetized (Baden-Fuller & Haefliger, 2013). In this sense, the business model is essential in order to take full advantage of the benefits associated with the implementation of the new technology and must constantly adapt to the business context of the company (Valter et al., 2018).

AI is able to influence every aspect of the business organization and, in particular, the six building blocks (*suppliers, resources, processes, products, customers and society and social responsibility*) identified by the framework of the Business Model Canvas (Bagnoli et al., 2018).

The *Business Model Canvas*, applicable in all types of companies, was developed in 2004 by Alexander Osterwalder in the work "Business Model Ontology" and aims to apply the logic of "visual thinking" for the construction of innovative business models able to strengthen company competitiveness. The application of AI makes the supply chain more efficient thanks to the use of intelligent systems that allow a more accurate selection of suppliers, as well as the possibility of formulating demand forecasts, reducing warehouse and transport costs and the possibility of errors in quantity of orders (Bogataj et al., 2017). AI affects human capital in terms of retraining employees, entrusting them with less standardized and more intellectual tasks (Huang & Rust, 2018).

Some studies have highlighted the ability of AI to improve performance both at an organizational and process level (Wamba-Taguimdje et al., 2020) and to facilitate the innovation of products and services (Prem, 2019) as well as that the strengthening of competitive advantage (Brock & Von Wangenheim, 2019).

AI supports service providers through predictive analysis of market changes (Jalal et al., 2016; Kim, 2011; Liu et al., 2016) that allow them to anticipate customer needs and preferences (Glushko & Nomorosa, 2013).

With reference to the impact of AI on products, it is now known the ability of this technology to anticipate customer needs, through the processing of unstructured data that allow the creation of products that meet their expectations (Davenport & Ronanki, 2018).

As for customers, the AI has developed systems capable of customer engagement through virtual assistants or social networks that offer the customer the possibility of obtaining timely information by entering immediately in contact with the brand of interest (Kaartemo & Helkkula, 2018).

Finally, AI favours the adoption of sustainable behaviours, influencing corporate social responsibility, also promoting the transition to increasingly intelligent and sustainable cities (Valter et al., 2020).

Following the implementation of digital technologies, business models assume greater flexibility, changing easily to adapt to new circumstances (Langley et al., 2020), differently from traditional ones (Ignatyeva et al., 2019). Indeed, there is a strong interaction between technologies and the business model, representing the latter as the tool that allows the "technology" input to perform its functions in the best possible way, increasing company profitability (Yun et al., 2016).

3.2 Steps for Applying Artificial Intelligence to Business Models

Artificial intelligence is one of the tools available to companies to implement innovative business models (Lee & Oh, 2020).

To efficiently apply AI to corporate business models, separate steps must be followed (Ng, 2018; Reim et al., 2020). The first phase concerns the definition of projects that favour the innovation of the pre-existing business model, involving all the subjects interested in the company activity since the entire organization is affected by a profound change with reference not only to the strategies and the business, but also with reference to working methods (Müller et al., 2018).

According to Reim et al. (2020) it is necessary, in the first phase, to develop adequate skills to be able to face any difficulties encountered in the implementation of AI, such as transparency, lack of trust in artificial intelligence among employees, analogue processes and misunderstandings of the AI.

According to Ng (2018), the second and third involve the presence of a team of experts and training on the topic of AI for all employees, including company executives in order to develop strategic skills, technology, data and security useful to innovate the business model (Brock & Von Wangenheim, 2019).

Instead, the second phase consists of transforming the pre-existing business model into an innovative business model. Before starting the transformation, it is necessary to first understand the way in which the company creates and offers value to customers, trying to understand how to increase consumer satisfaction as a result of the introduction of new technology.

The fourth phase concerns the formulation of a strategy based on AI because only after having acquired knowledge and awareness of the potential and functioning of the technology it is possible to proceed with the definition of the most appropriate strategy. For the formulation of a valid strategy, it is important to build a valid data collection system (Johansson et al., 2019) because only in this way AI can support corporate decision-making processes (O'Leary, 2013) and identify the best solutions as well as solve abstract and complex problems (Lee et al., 2019).

The last phase emphasizes the importance of communication, to all corporate stakeholders, of the ways in which artificial intelligence is transforming the business model and the consequences that this transformation determines for them. Also according to Reim et al. (2020), the last phase concerns the approval by the entire organization of the implementation of the new technology. In fact, for a successful implementation of the technology and for the innovation of the business model, the corporate culture and the human resources employed play an important role, orienting the entire organization towards digital and automated behaviours (de Souza et al., 2020; Tonchev et al., 2017).

3.3 Artificial Intelligence and Business Models: What Differences Among Sectors?

The continuous evolution of technological innovation has favoured the emergence of new business models in various sectors, such as healthcare, technology, retail trade, agri-food as well as public administration and the education market (de Souza et al., 2020; Di Vaio et al., 2020; Garbuio & Lin, 2018; Renz & Hilbig, 2020; Serafini & Garcez, 2016). Furthermore, changes in business models have been identified following the application of artificial intelligence also in sectors such as the financial (Met et al., 2020), professional services, naval industry (Jung et al., 2018) and of the oil and gas industry to promote a higher level of sustainability (Mawlad et al., 2019). However, it remains unclear whether the difficulties associated with redefining the corporate business model are greater for some industries than others, as some studies suggest that business model innovation differs from one sector to another according to the resources and capabilities that are available within the respective company (Teece, 2018). In this regard, some authors argue that the major difficulties concern the information technology sector (DaSilva et al., 2013).

4 Conclusion

The objective of this work is to carry out a systematic literature review on the topic of artificial intelligence applied to corporate business models, in order to observe which aspects have already been explored and which ones require further study. From the Scopus database, with reference to the period 2010–2020, 31 relevant articles on the topic were examined, indicating that the topic is still in an exploratory phase.

The analysis shows that researchers mainly focused on three profiles of analysis, represented by the exploration of the benefits related to the implementation of AI to business models, the steps of its application and the differences among sectors.

The digital age has transformed traditional corporate business models (Glova et al., 2014; Parida et al., 2019), favouring the creation of digital business models, focused on new technologies (Zott & Amit, 2007).

The literature review reveals that there is a strong relationship between business models and new digital technologies (Bagnoli et al., 2018; Yun et al., 2016).

The business model represents the tool with which to implement (Yun et al., 2016), and monetize the technology (Baden-Fuller & Haefliger, 2013). In this sense, the business model is instrumental in obtaining the benefits associated with the implementation of technological innovation (Valter et al., 2018). At the same time, the application of artificial intelligence determines changes that affect the entire company structure and, therefore, the business model. As emerged from the framework of the Business Model Canvas (Bagnoli et al., 2018), AI exercises its influence on the six building blocks that make up the entire company organization, represented by suppliers, resources, processes, products, customers and companies and social responsibility.

Although the advantages associated with the adoption of AI are known, the business models that best accommodate the benefits deriving from the implementation of the technology are not yet clear, perhaps because many aspects are still in the exploratory phase (Prem, 2019).

In particular, less clear are the difficulties the firm may face in changing the pre-existing business model and whether these complications are found across all industries (Davenport & Ronanki, 2018; Kaartemo & Helkkula, 2018).

In this regard, some authors argue that the major difficulties concern the information technology sector (DaSilva et al., 2013). Therefore, among the possible future directions of research, there is that of analyzing the main difficulties associated with the change of traditional business models due to the adoption of artificial intelligence. Moreover, since the business model represents the structure to be implemented to ensure the correct implementation of technological innovation (Parida et al., 2019), it would be interesting to report successful cases of AI with an in-depth analysis of the changes that have occurred in the business model.

The prevalence of the studies analyzed uses a qualitative method for studying the phenomenon. Future research, through an empirical analysis, could explore the effects on business performance of the application of AI to business models.

Furthermore, given the importance of corporate culture for the construction of a business model based on AI (de Souza et al., 2020; Tonchev et al., 2017) it would be interesting to deepen the role and characteristics of the entrepreneur in promoting innovation as well as the topic of knowledge transfer (KT), in the field of business, management and accounting, associated with artificial intelligence, being little explored (Lombardi, 2019).

References

Antonescu, M. (2018). Are business leaders prepared to handle the upcoming revolution in business artificial intelligence? *Quality Access to Success, 19*, 15–19.

Baden-Fuller, C., & Haefliger, S. (2013). Business models and technological innovation. *Long Range Planning, 46*, 419–426.

Bagnoli, C., Bravin, A., Massaro, M., & Vignotto, A. (2018). *Business Model 4.0 -I Modelli Di Business Vincenti per Le Imprese Italiane Nella Quarta Rivoluzione Industriale*. Edizioni Ca' Foscari.

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *Management Information Systems Quarterly, 37*, 471–482.

Bogataj, D., Bogataj, M., & Hudoklin, D. (2017). Mitigating risks of perishable products in the cyber-physical systems based on the extended MRP model. *International Journal of Production Economics, 193*, 51–62.

Brock, J. K.-U., & Von Wangenheim, F. (2019). Demystifying AI: What digital transformation leaders can teach you about realistic artificial intelligence. *California Management Review, 61*, 110–134.

Brooks, C., Gherhes, C., & Vorley, T. (2020). Artificial intelligence in the legal sector: Pressures and challenges of transformation. *Cambridge Journal of Regions, Economy and Society, 13*(1), 135–152.

Charniak, E., & McDermott, D. (1985). *An introduction to artificial intelligence*. Addison-Wesley Longman.

DaSilva, C. M., Trkman, P., Desouza, K., & Lindič, J. (2013). Disruptive technologies: A business model perspective on cloud computing. *Technology Analysis and Strategic Management, 25* (10), 1161–1173.

Davenport, T. H., & Ronanki, R. (2018). Artificial intelligence for the real world: Don't start with moon shots. *Harvard Business Review, 96*(1), 108–116.

de Souza, C. A., Szafir-Goldstein, C., & Aagaard, A. (2020). *IoT in the context of digital transformation and business model innovation: The case of a traditional Brazilian wholesaler*. IEEE Global Internet of Things Summit, Proceedings.

Di Vaio, A., Boccia, F., Landriani, L., & Palladino, R. (2020). Artificial intelligence in the Agri-food system: Rethinking sustainable business models in the COVID-19 scenario. *Sustainability (Switzerland), 12*(12), 4851.

Dirican, C. (2015). The impacts of robotics, artificial intelligence on business and economics. *Procedia—Social and Behavioral Sciences, 195*, 564–573.

Dixon-Woods, M. (2011). Systematic reviews and qualitative methods. In D. Silverman (Ed.), *Qualitative research*. Sage.

Garbuio, M., & Lin, N. (2018). Artificial intelligence as a growth engine for health care startups: Emerging business models. *California Management Review, 61*(2), 59–83.

Gassmann, O., Frankenberger, K., & Sauer, R. (2017). A primer on theoretically exploring the field of business model innovation. *The European Business Review, 4* 45–48.

Glova, J., Tomáš, S., & Viliam, V. (2014). Business models for the internet of things environment. *Procedia Economics and Finance, 15*, 1122–1129.

Glushko, R. J., & Nomorosa, K. (2013). Substituting information for interaction: A framework for personalization in service encounters and service systems. *Journal of Service Research, 16*(1), 21–38.

Grubic, T., & Jennions, I. (2018). Remote monitoring technology and servitised strategies–factors characterising the organisational application. *International Journal of Production Research, 56*, 2133–2149.

Huang, M. H., & Rust, R. T. (2018). Intelligence in service. *Journal of Service Research, 21*(2), 155–172.

Ignatyeva, O., Sokolov, D., Lukashenko, O., & Shalakitskaia, A. (2019). *Business models for emerging technologies: The case of affective computing*. In 8th International Conference on Affective Computing and Intelligent Interaction Workshops and Demos (ACIIW).

Jalal, M. E., Hosseini, M., & Karlsson, S. (2016). Forecasting incoming call volumes in call centers with recurrent neural networks. *Journal of Business Research, 69*(11), 4811–4814.

Johansson, N., Roth, E., & Reim, W. (2019). Smart and sustainable emaintenance: Capabilities for digitalization of maintenance. *Sustainability, 11*, 3553.

Jovanović, M., Dlačić, J., & Okanović, M. (2018). Digitalization and society's sustainable development—Measures and implications. *Zbornik Radova Ekonomskog Fakultet Au Rijeci, 36*(2), 905–928.

Jung, I., Sun, H., Kang, J., Lee, C. H., & Lee, S. (2018). Big data analysis model for MRO business using artificial intelligence system concept. *International Journal of Engineering and Technology (UAE), 7*(3), 134–138.

Kaartemo, V., & Helkkula, A. (2018). A systematic review of artificial intelligence and robots in value co-creation: Current status and future research avenues. *Journal of Creating Value, 4*(2), 1–18.

Kasabov, N. (2018). *Evolving and spiking connectionist systems for brain-inspired artificial intelligence*. Elsevier.

Kim, S. Y. (2011). Prediction of hotel bankruptcy using support vector machine, artificial neural network, logistic regression, and multivariate discriminant analysis. *Service Industries Journal, 31*(3), 441–468.

Langley, D. J., van Doorn, J., Ng, I. C. L., Stieglitz, S., Lazovik, A., & Boonstra, A. (2020). The internet of everything: Smart things and their impact on business models. *Journal of Business Research, 122*, 853–863.

Lee, H. J., & Oh, H. (2020). A study on the deduction and diffusion of promising artificial intelligence technology for sustainable industrial development. *Sustainability, 12*(14), 5609.

Lee, Y. K., & Park, D. W. (2018). Design of internet of things business model with deep learning artificial intelligence. *International Journal of Grid and Distributed Computing, 11*(7), 11–22.

Lee, J., Suh, T., Roy, D., & Baucus, M. (2019). Emerging technology and business model innovation: The case of artificial intelligence. *Journal of Open Innovation: Technology, Market, and Complexity, 5*, 44.

Liu, X., Singh, P. V., & Srinivasan, K. (2016). A structured analysis of unstructured Big Data by leveraging cloud computing. *Marketing Science, 35*(3), 363–388.

Lombardi, R. (2019). Knowledge transfer and organizational performance and business process: Past, present and future researches. *Business Process Management Journal, 25*(1), 2–9.

Lundvall, B. A., Johnson, B., Andersen, E. S., & Dalum, B. (2002). National systems of production, innovation and competence building. *Research Policy, 31*, 213–231.

Maffei, A., Grahn, S., & Nuur, C. (2019). Characterization of the impact of digitalization on the adoption of sustainable business models in manufacturing. *Procedia CIRP, 81*, 765–770.

Marques, C. S., & Ferreira, J. (2009). SME innovative capacity, competitive advantage and performance in a "traditional" industrial region of Portugal. *Journal of Technology Management and Innovation, 4*(4), 53–68.

Massa, L., Tucci, C. L., & Afuah, A. (2017). A critical assessment of business model research. *Academy of Management Annals, 11*(1), 73–104.

Matt, C., Hess, T., & Benlian, A. (2015). Digital transformation strategies. *Business and Information Systems Engineering, 57*, 339–343.

Mawlad, A. A., Mohand, R., Agnihotri, P., Pamungkas, S., Omobude, O., Mustapha, H., & Razouki, A. (2019). *Embracing the digital and artificial intelligence revolution for reservoir management*. Intelligent Integrated Subsurface Modelling IISM. Society of Petroleum Engineers.

McCorduck, P. (2009). *Machines who think: A personal inquiry into the history and prospects of artificial Intelligence*. AK Peters/CRC Press.

Met, İ., Kabukçu, D., Uzunoğulları, G., Soyalp, Ü., & Dakdevir, T. (2020). Transformation of business model in finance sector with artificial intelligence and robotic process automation. In U. Hacioglu (Ed.), *Digital business strategies in blockchain ecosystems. Contributions to management science*. Springer.

Müller, J. M., Kiel, D., & Voigt, K. I. (2018). What drives the implementation of industry 4.0? The role of opportunities and challenges in the context of sustainability. *Sustainability, 10*, 247.

Neligan, A. (2018). Digitalisation as enabler towards a sustainable circular economy in Germany. *Intereconomics, 53*(2), 101–106.

Ng, A. (2018). *AI transformation playbook: How to lead your company into the AI era*. Mcgraw-Hill.

Nilsson, N. J. (2010). *The quest for artificial intelligence: A history of ideas and achievements*. Cambridge University Press.

O'Leary, D. E. (2013). Artificial intelligence and big data. *IEEE Intelligent System, 28*, 96–99.

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the Association for Information Systems, 16*(1), 1–27.

Pappas, I. O., Mikalef, P., Giannakos, M. N., Krogstie, J., & Lekakos, G. (2018). Big data and business analytics ecosystems: Paving the way towards digital transformation and sustainable societies. *Information Systems and e-Business Management, 16*(3), 479–491.

Parida, V., Sjödin, D., & Reim, W. (2019). Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises. *Sustainability, 11* (2), 391.

Parris, D. L., & Peachey, J. W. (2012). A systematic literature review of servant leadership theory in organizational contexts. *Journal of Business Ethics, 2015*, 1–11.

Prem, E. (2019). Artificial intelligence for innovation in Austria. *Technology Innovation Management Review, 9*(12), 5–15.

Reim, W., Åström, J., & Eriksson, O. (2020). Implementation of artificial intelligence (AI): A roadmap for business model innovation. *AI, 1*(2), 180–191.

Renz, A., & Hilbig, R. (2020). Prerequisites for artificial intelligence in further education: Identification of drivers, barriers, and business models of educational technology companies. *International Journal of Educational Technology in Higher Education, 17*(14), 1–21.

Rich, E. (1985). Artificial intelligence and the humanities. *Computers and the Humanities, 19*(2), 117–122.

Ruessmann, M., Lorenz, P., Gerbert, M., Waldner, J., Justus, P. E., & Harnisch, M. (2015). *Industry 4.0:The future of productivity and growth in manufacturing industries* (Vol. 9). Boston Consulting Group.

Salin, E., & Winston, P. (1992). Machine learning and artificial intelligence: An introduction. *Analytical Chemistry (Washington, DC), 64*(1), 49–60.

Schmarzo, B. (2017). *What is digital transformation?* Available at: https://www.cio.com/article/3199030/analytics/what-is-digital-transformation.html

Schwab, K. (2016). The fourth industrial revolution. World Economic Forum, Cologny, Switzerland.

Schwab, K. (2016). *The fourth industrial revolution*. World Economic Forum.

Serafini, L. & Garcez, A.A. (2016). Logic tensor networks: Deep learning and logical reasoning from data and knowledge. In *Proceedings of the 11th International Workshop on Neural-Symbolic Learning and Reasoning co-located with the Joint Multi-Conference on Human-Level Artificial Intelligence* (HLAI 2016), New York City, NY

Teece, D. J. (2018). Business models and dynamic capabilities. *Long Range Planning, 51*(1), 40–49.

Tonchev, K., Lindgren, P., Manolova, A., Neshov, A. N., & Poulkov, V. (2017). Digitizing human behavior in business model innovation. *Global Wireless Summit (GWS)*, 97–101.

Valter, P., Lindgren, P., & Prasad, R. (2018). The consequences of artificial intelligence and deep learning in a world of persuasive business models. *IEEE Aerospace and Electronic Systems Magazine, 33*, 80–88.

Valter, P., Lindgren, P., & Prasad, R. (2020). The future role of multi-business model innovation in a world with digitalization and global connected smart cities. *Wireless Personal Communications, 113*(3), 1651–1659.

Vicente-Saez, R., & Martinez-Fuentes, C. (2018). Open science now: A systematic literature review for an integrated definition. *Journal of Business Research, 88*, 428–436.

Wamba-Taguimdje, S., Wamba, S. F., Kamdjoug, J. R. K., & Wanko, C. E. T. (2020). Influence of artificial intelligence (AI) on firm performance: The business value of AI-based transformation projects. *Business Process Management Journal, 26*(7), 1893–1924.

Yun, J. H. J., Won, D. K., Jeong, E. S., Park, K. B., Yang, J. H., & Park, J. Y. (2016). The relationship between technology, business model, and market in autonomous car and intelligent robot industries. *Technological Forecasting and Social Change, 103*, 142–155.

Zaheer, A., & Bell, G. G. (2005). Benefiting from network position: Firm capabilities, structural holes, and performance. *Strategic Management Journal, 26*(9), 809–825.

Zott, C., & Amit, R. (2007). Business model design and the performance of entrepreneurial firms. *Organization Science, 18*, 181–199.