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Research Article

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Data-Driven Management: The Impact of Visualization Tools on Business Performance

Authors:

Siddharth Konkimalla[1*], Gagan Kumar Patra[2], Chandrababu Kuraku[3], Janardhana Rao Sunkara[4], Sanjay Ramdas Bauskar[5], Chandrakanth Rao Madhavaram[6], Kiran Polimetla[7]

[1]Adobe Inc, Sr Network Development Engineer. Email: Siddharth.konkimalla@gmail.com
[2]Tata Consultancy Services, Senior Solution Architect. Email: gagankpatra@outlook.com
[3]Mitaja Corportaion, Senior Solution Architect. Email: chandrababu.kuraku@gmail.com
[4]CVS Pharmacy Inc, Sr. Oracle Database Administrator. Email: Janardhanasunkara9@gmail.com
[5]Pharmavite LLC, Sr. Database Administrator. Email: sanjaybauskar@gmail.com
[6]Microsoft, Support Escalation Engineer. Email: Chandrakanthmadhavaram@gmail.com
[7]Adobe Inc, Software Engineer. Email: Kiran.polimetla@gmail.com

[*]Corresponding author: Siddharth Konkimalla, Adobe Inc, Sr Network Development Engineer.

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Abstract

This research examines how data visualization affects business performance with a view on what organizations can do to make the best out of these tools as a way of leveraging competitive advantage. The study examines the usage of decision-visualization tools, business intelligence systems, and big data analytics (BDA) in the manufacturing, agriculture, and high-tech industries using a real-time bibliometric analysis from 2017 to 2022. Additional research into this topic should compile and quantify patterns pertaining to the aforementioned tools, as well as examine any gaps in their use to improve innovation and decision-making. This shows that data visulisation tools ease the handling of large sets of data and help to determine trends and patterns quickly since they reduce the amount of clutter present in a single set of data. It was found that visualization tools are highly effective in improving various manufacturing activities and innovation. Nevertheless, some issues still persist Such as; There is meager definition of KPIs that measures efficiency, lack of qualified personnel and weak culture of data within organizations. To sum it up, analysing the outcomes of data-driven management, it can be claimed that, as well as enhancing the business performance, this approach has some essential weaknesses, including the shortage of specialists in the field and resistance from different organizations. Looking at the study, it is suggested that best KPIs for big data and AI should be set and maintained across the organization and also constant training should be given to big data and AI specialists along with a data-oriented culture being promoted for the enhancement of big data and AI use.

Keywords: *Data visualization, business performance, big data analytics, decision-making, business intelligence.*

1. Introduction

Data visualisation and information translation are becoming increasingly important in today's business world [1]. As more and more data become available, it gets harder to tell what is useful and what isn't. Taking into account the various data visualisation tools and dashboards undoubtedly helps officials to make quick decisions [2]. One of the most important steps in cleaning up raw data is using data visualisation. It makes a difference to present data in a positive light no matter what field you get into. The process of obtaining raw data, modelling it, and presenting it to make conclusions is a vital stage in any organisation[1]. One of the most important steps in cleaning up raw data is using data visualisation. No matter your career path, it is important to present data in a positive perspective. An essential step in every organization's process is gathering raw data, modelling it, and then presenting it to draw conclusions [1]. A mountain of data is laid out in a way that anyone can pick up and run with.

Because it simplifies and clarifies otherwise opaque data sets, data visualisation is an essential tool for data-driven decision-making [3]. Compared to staring at the raw data, decision-makers can more easily see trends, patterns, and outliers in data visualisations. Better results for their organisations are the result of their decisions being based on evidence rather than gut feelings or speculation [4]. Data visualisation also helps with stakeholder communication and collaboration. The use of visualisations facilitates the sharing of insights and results, which in turn helps to establish consensus on important decisions by making sure that everyone is using the same information [5]. If businesses want to make better decisions based on their data, data visualisation is a must-have tool. Business success and enhanced performance are the results of data-driven decisions made possible by visualisation, which makes data easier to understand and use [6].

Finding out how data visualisation tools effect business performance is the driving force behind this research, which aims to undertake a comprehensive literature review in this area. This study aims to offer insights into how organisations can improve their operational efficiency and competitiveness using data-driven management methods by conducting a comprehensive literature analysis.

2. Literature review

[7] Academics and experts in the industry have been concentrating on business analytics and big data for almost a decade. With the use of business analytics and the wealth of data available in big data, companies can now get the kind of in-depth understanding that is essential for making sound decisions. An extensive and fruitful history of scientific investigation in this multidisciplinary field may be traced back to the European Conference on Information Systems (ECIS). They provide key points from the "Business Analytics and Big Data" session at ECIS during the last decade. They offer a narrative of the field's evolution and our predictions for future research endeavours based on the synthesis. Our focus here is on three areas that we anticipate seeing a lot of future research activity in. In each of these three domains, we outline various critical issues that must be resolved. Finally, we provide a synopsis of the six papers that make up this special issue, outlining their respective contributions to the field's knowledge.

[8] lays out a methodical framework for enhancing BPM life cycle data-based process development. To improve process excellence and make decisions based on evidence, we demonstrate how to include tools and models inspired by Industry 4.0 into the BPM life cycle. Industry 4.0 redesign phases can be aided by business process management (BPM), design science research tools, and standards for machine learning (CRISP-ML(Q)). An assembly company is used to test the suggested technique, with important key performance indicators used to evaluate the suggested improvement steps and simulations used to study them.

[9] Many believe that in order for organisations to become sustainable, they must innovate their business models. But putting business model innovation into practice is fraught with difficulties. An artefact to aid in business model innovation was developed by us using a design science methodology. This artefact utilises Big Data analytics to track how well the company's business model is doing, which allows for customer-driven business model evolution. Next, they conducted a critical case study using the artefact. The chosen business is an online clothing retailer that promotes veganism and sustainability by eliminating the use of any product derived from animals and by making all of its products from recycled plastic bottles. Their research proves that the artefact is useful for facilitating an ongoing and proactive strategy for business model innovation. The artefact supports the democratisation of business model innovation and BDAs beyond large organisations by making these techniques accessible to small firms, even though they are based on technical notions. With the help of links to performance management and Big Data, as well as pathways for its operationalisation, we add to the literature on business model innovation. Therefore, the proposed artefact can be useful for managers who are working with the business model as a dynamic component of a sustainable company.

[10] examined the connection between Business Analytics and innovation from both a theoretical and practical perspective. In order to accomplish this, a research model is developed with absorptive capacity theory as the theoretical lens. According to the principle of absorptive capacity, a company's success hinges on its capability to take in and make use of fresh, external information. The research paradigm incorporates concepts such as data-driven culture, innovation, environmental scanning, and business analytics. To test the study approach, a questionnaire survey is administered to 218 enterprises in the UK. Based on the findings, implementing Business Analytics can boost creativity inside a company by making environmental scanning more efficient. Business analytics enhance data-driven culture, which impacts environmental scanning. An equally important function of data-driven culture is to mitigate the effect of environmental scanning on the relevance of new product developments. Findings stress the value of data-driven culture, environmental scanning, and corporate analytics for fostering creativity. To get the most out of business analytics, companies should stop looking outside and start looking within.

[11] Although previous research on big data analytics has highlighted the significance of particular big data competencies for organisational success, very little has been done to examine the contribution of cross-functional teams' competencies, the significance of data-driven decisions, and the impact on company performance. Combining the firm's resource-based vision (RBV) with one-of-a-kind data gathered from 240 big data experts working in global agri-food networks, we examine the relationships between the capabilities of big data savvy (BDS) teams, big data driven (BDD) actions, and company success. BDS teams rely on a wide range of expertise to transform their conventional business processes into data-driven insights, which in turn inspire BDD activities that boost company performance. A significant factor for BDD activities, which contribute to company performance, is the skills of BDS teams that generate valuable insights, according to our results from structural equation modelling. Companies that place an emphasis on BDD actions outperform those that do not when it comes to meaningful insights and applications.

[12] combining insights from institutional theory, organisational culture, and the resource-based view of the firm to create and test a model that explains how resources are crucial for developing skills, capabilities, and a culture of big data, all of which lead to better cost and operational performance. In order to evaluate our hypothesis, we used 195 surveys that were obtained using a questionnaire that had already been pilot tested. We provide new understanding of the impact of external forces on resource selection, how big data culture moderates this effect, and how capability building impacts cost and operational performance.

3. Methodology

An extensive literature review on data-driven management and decision-visualization tools across many industries forms the basis of this study's methodology. A systematic approach was employed to gather, analyze, and synthesize peer-reviewed journal articles, books, and reports published between 2017-2022. The selection criteria focused on studies that explored the impact of visualization tools, big data analytics, and business intelligence systems on decision-making, innovation, efficiency, and workforce development. This qualitative analysis aimed to identify key themes, trends, and gaps in the current body of knowledge to provide insights into the effectiveness of these tools in enhancing organizational performance. Key findings were compared across industries, with particular attention to the manufacturing, agricultural, and high-tech sectors.

4. Results

Table 1: Systematic Review Studies.

Author Name	Aim	Methodology	Main Findings
[2]	To assess the role of data visualization tools in helping businesses identify trends and facilitate decision-making.	Secondary data analysis of data visualization tools and methodologies.	Data visualization is crucial for businesses of all sizes to identify trends rapidly. It simplifies large datasets through graphical representations (charts, diagrams) and helps with decision-making.
[13]	Specifically, we want to learn how the manufacturing sector is managing product and service quality through the application of Industry 4.0 standards and technology.	Review of Industry 4.0 technologies, industrial standards, and performance measurement systems in smart manufacturing.	Industry 4.0 transforms manufacturing through IoT, AI, and big data, improving efficiency and reducing costs. However, there is a knowledge gap in performance measurement and quality management. The study highlights the importance of industrial standards and KPIs.
[14]	Examine how the capacity for big data analytics (BDA) affects the quality of decisions and how it helps with the performance of the circular economy (CE).	Data from 109 manufacturing enterprises in the Czech Republic was used in an empirical study that utilised partial least squares structural equation modelling.	Using BDA and BI, decision-making becomes better. Contributing to the success of the circular economy, data-driven insights fortify the bond between BDA competence and decision-making. Insights derived from data, however, do not serve to mediate this connection.
[15]	To identify workforce trends, skills gaps, and opportunities in the BD&AI domain, and to provide recommendations for workforce development.	Bibliometric analysis of BD&AI-related articles and job posting data analysis. SWOT analysis of university curricula for BD&AI programs.	A substantial skills gap and shortage of personnel exist, despite the fact that BD&AI technologies are essential for competitive growth. The study recommends strategies to align academic training with industry needs to prepare the workforce for BD&AI-driven industries.
[16]	To assess the most widely used data visualization tools for managing large datasets and their role in business decision-making.	Secondary data analysis of various data visualization tools and methodologies.	Data visualization is an essential tool for presenting large datasets graphically, facilitating better decision-making. The study evaluates the functional and non-functional characteristics of several visualization tools used in managing massive data sets.
[10]	With the use of absorptive capacity theory, we will investigate how business analytics relate to innovation.	Absorbent capacity theory was used to analyse data from a questionnaire survey of 218 UK enterprises.	A data-driven culture and better environmental scanning are two ways in which business analytics boost creativity. These components are crucial for gaining a competitive edge and making new products significant.
[17]	To propose a big data infrastructure for the construction industry to improve decision-making and business processes.	Case study of construction companies using the proposed Enterprise Integrated Data Platform (EIDP).	The proposed EIDP helps construction companies overcome inefficiencies in data collection, sharing, and interoperability, leading to optimized supply chain management, cost control, and better decision-making.
[18]	To demonstrate how business intelligence tools can enhance decision-making through the development of visual models of KPIs in high-tech industries.	Application of visual analytics tools to create KPI models for decision-making in a high-tech enterprise in telecommunications.	Visual analytics and business intelligence tools help develop KPI models that support strategic decision-making. These models improve competitiveness, cost reduction, and business process optimization in dynamic, high-tech environments.
[12]	To explore how external pressures and big data culture influence resource selection and capability building in manufacturing, and how these capabilities	Surveys collected from 195 respondents, analyzed using resource-based view theory and institutional theory.	Efficacy and efficiency in operations and cost management are enhanced when resources for developing big data capabilities are chosen in response to external demands. An organization's culture plays a significant role in developing its capabilities, as big data culture

	affect cost and operational performance.		mitigates the effect of resources on performance outcomes.
[11]	Aiming to investigate how global agri-food networks' business performance is impacted by the abilities of big data savvy (BDS) teams, the actions of big data driven (BDD), and other related factors.	Information gathered from 240 professionals in the field of big data inside international agri-food networks and evaluated using structural equation modelling.	By combining knowledge from several fields, BDS teams are able to improve company performance through the conversion of operational data into data-driven insights. Businesses that place a premium on BDD acts tend to do better.
[19]	Using Self-Service Business Intelligence as a framework, assess how data visualisation technologies contribute to better decision-making and increased company agility.	Examine the role of data visualisation tools in enhancing business agility and decision-making using the Self-Service Business Intelligence framework.	By empowering people to generate reports autonomously, data visualisation solutions such as Tableau, Power BI, Sisense, and QlikView improve decision-making and agility. The choice of tool must be based on an organization's specific needs.
[20]	This study aims to examine the connections between environmental sustainability, relationship-based business networks (RBNs), and top-level management's tangible capabilities (TMTCs) in the food import/export industry.	Using structural equation modelling, we examined data from 175 representatives of upper management.	RBNs mediate the relationship between TMTCs and environmental sustainability, and TMTCs are essential for their construction. Firms with strong networks perform better in environmental practices.
[21]	To identify trends in business visualization and visual analytics literature that address data challenges and enhance decision-making, problem-solving, and trend identification.	Survey of business visualization and visual analytics literature, classifying topics into business intelligence, business ecosystems, and customer-centric visual design.	With visual analysis, data is better understood, more people can understand it, and decision-making and creativity are both improved. The survey highlights mature and less developed areas of research in business visualization.
[22]	Focusing on digitisation technologies like Big Data and Data Science, this study aims to examine the primary drivers of digital business models and how they impact the potential of businesses.	Key performance indicators, personalisation, efficiency, and communication are the four key drivers of digital business models, according to an empirical study that used structural equation modelling (SEM).	All four determinants positively influence digital business model potential, with key performance indicators having the greatest impact.
[23]	To assess the significance of big data visualization, the protocols for selecting visualization tools, and the classification of these tools based on various factors.	Review of conventional and Big Data-specific visualization tools, with a framework designed for tool selection based on business needs.	Big data visualization impacts business by discovering hidden insights and improving decision-making. The study emphasizes the need for precise tools for storing, processing, and visualizing large datasets.

There is widespread agreement in the research on data-driven management and decision-visualization tools' usefulness in performance mapping that these resources are invaluable to businesses in any industry. Data visualization helps acquire and present large datasets in simple forms as it also enhances the speed with which trends are spotted and improve on decision-making. It has been especially beneficial for the companies and organizations across various industries that aimed at the output increase and search for the effective solutions for their internal processes. [2] point out that it is expedient and important for small, medium and even large organisations to find trends rapidly using such tools. When generally large amounts of data is available in the form of tables or other cumbersome formats, they can be transformed into more understandable forms charts, diagrams etc. It makes the decision-making process efficient because it is easy to understand such graphics than large volumes of information. In the same vein, [16] further stressed on the usefulness of visualization tools when dealing with large amounts of data. They give a clear assessment of different tools, functional and non-functional requirements, which when used enable business organizations to handle and analyze large data hence arriving at the right business decisions.

In manufacturing, [13] shed further light about the status and potential of data-driven management by studying the impact of Industry 4. 0 technologies including; IoT, AI, and big data on performance measurement and quality management. Their review shows that although these technologies have revolutionized manufacturing through increases in efficiency and reduction of cost, there is still space for improvement in the means through which efficiency is measured; this paper identifies a lack of coherent set of KPIs required to fully tap into

the underlying technologies for the improvement of efficiency in the manufacturing process. In similar context, [18] opine that in manufacturing high-tech organizations the development of KPI models through Visual analytics has improved the decisions making. From this, they were able to conclude that visual analytics enhances competitiveness with a view to business process enhancement, a key aspect when it comes to organisations within the setting of complex and volatile environments. Another area of significant change through data-driven management is the application of big data analytics (BDA) in business decision making. Using the perceptual obtrusiveness instrument, [14] amplify what impacts BDA capabilities impose on decision-making quality and CE performance. Based on their findings of Czech manufacturing firms, they pointed out that BDA enhances decision-making dexterity as it brings data to firms as he basis of making crucial decisions for CE performance. Yet, the same studies indicate that BDA's impact on decision quality is not entirely moderated by data-based information, which may suggest that there are other factors affecting BDA. [10] work in a different direction approaching the problem from the point of view of the connection between business analytics and innovation. A survey of UK businesses done by them reveals that business analytics improves innovation by increasing environmental scanning and data culture. These elements necessary for generating new product and sustaining competitive edge proofs worth and importance of data driven management in making businesses adaptive to change occurring in industries.

[19] did a research on the utilization of visualization tools in advancing business flexibility by the help of Self-Service Business Intelligence (SSBI). The authors' comparative analysis of the tools such as Tableau, Microsoft Power BI, Sisense, and QlikView explains that those tools enable businesses to build the reports and visualizations needed for decision making on their own. This in turn makes it easier for the organizations to come up with prompt intelligence that in turn helps them meet market needs hence making the organizations more flexible. Human capital development is another current topic that has been examined in relation to the evolution of big data, as [15]. Business progress in the domains of big data and artificial intelligence (BD&AI) is being impeded, according to their analysis, by a massive skill gap in these areas. According to the authors, there is a need to ensure that the training of academics meets the needs of the industries to help solve the problem of talent deficit. Specifically, they emphasised how important it is to provide employees with the knowledge and skills necessary to analyse and make use of data in order to facilitate data-driven decision-making. The value of organizational culture for maintaining and enhancing data-driven work environment is illustrated by[12]. Their work shows that the forces from outside push companies to make the proper choices of resources to develop big data capacities. But they also stress that the strong big data culture adopts a moderating effect on those capabilities in order to enhance the performance. Thus, the absence of the right organisational culture can limit the ability of organisations to harness their existing data advantages, thus holding back potential enhancements of cost and operational performance.

The expansion of the use of data systems also impact the agricultural sector as highlighted by [11]. In their analysis of networks of global agri-food, they conclude that multidisciplinary BDS teams convert operational processes into insights producing BDS, resulting in BDD activity that greatly improves business outcomes. This study, therefore, provides a testimony of the usefulness of BDS teams in analyzing data for operational changes, thus highlighting the importance of the data-driven management approach in different businesses. Besides these examples of the data visualisation usage in the industry, [22] introduced the aspect connected with data visualisation use in the main business model innovation. As per their study, they have en labeled four forces for the digital business models: KPIs, individualization, efficiency, and communication all of which are moved positively by Big Data and Data Science technologies. This shows how through data management, organisations can disentangle digital growth prospects that give way to new opportunities in business models.

In total, all the presented studies unconditionally confirm the relevance of using data-driven management and visualization tools for improving business performance. All of them are critical for managing organizational activities in today's data-oriented context, whether it is enhancing decision-making, encouraging innovations, increasing efficiency, or handling workforce issues. This way, companies will better prepare themselves through technological advances and employees enhancement to catch up with data analytics future.

5. Conclusion

Drawing from the facts in literature on data-driven management and decision-visualization tools, the imperative place of such tools for enhancing business performance in diverse industries cannot be overemphasized. These tools provide simplicity to large data sets hence businesses are able to identify trends faster to aid in their decision-making processes. In any kind of organization – small or big, developing such tools as data visualization aids the simplification of information, because organizational hierarchy transforms detailed information into easily understandable like charts and diagrams to support management efficiency in its decision-making processes. Notably factory operations, production, farming, and other advanced sectors of the division have benefitted highly from them Industry 4. No technologies include big data analytics & Self-service BI tools. Research also indicates to the elevating effects of such tools for competitiveness, operations and the ability to adapt to the needs of the market. The specifics of the implementation of such tools are far from being exhausted by the methods of managing organizational operations. These tools have been found useful in enabling organisations to come up with innovations, making right decisions whenever there is a problem with the workforce given the emergence of big data. To make the most of these technologies, it's important to build data-oriented teams and foster a strong big data culture. Those few companies which will be investing on both the technology networks and human capital will go a long way in sustaining competitive advantages and growth in the future. Besides, tools help business to be more flexible in case of the changing environments and demands of the market.

However, several limitations still persist with data-driven management as explained below. For instance, absence of clear and acceptable KPIs that one can use to assess the efficiency of Industry 4.0. Lack of technologies in manufacturing indicates that numerous firms might not be engaging the full possibilities of analytics. In addition, though big data increases the quality of decisions through analytics, it becomes clear that other nonanalytical factors affect the quality of decisions and this makes the adoption of such technologies challenging. A third

issue is that there is a serious problem of insufficient qualified personnel with expertise in big data or artificial intelligence, which has an impact on organizational development and still does not allow organizations to utilize the potential of data-focused management to the maximum. Further, lack of organizational culture support may mean that these tools could only offer suboptimal gains in performance. In order to avoid these limitations, the recommendations are as follows; First, an effective set of KPIs which will help to create a unified definition of increases in efficiency due to data-driven technologies, especially in the manufacturing industry, needs to be identified. Second, organisations should embrace ongoing training and development as a way of achieving a closure gap for now in big data and artificial intelligence. These programs should closely conform to the needs of the industry so as to be able to produce a steady stream of human resource capable of performing data analytics and visualization. Third, strong data culture or, in other words, the culture of data-driven management is crucial for improving the management effectiveness through the application of data-driven management tools. Finally, businesses should always remain on the lookout for newer exciting revenues in the field of data analytics and visualization techniques so that the business can stay on its toes besides being adaptive and innovative to changes that may take place in the market.

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