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Human Resources Management:
Meta-Study - Analysis of Future Competences in Industry 4.0

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Abstract

Purpose: Industry 4.0 represents a special challenge for businesses. This systematic review will examine the impact and consequences of future technologies as well as the ongoing digitization within Industry 4.0 for the employees' competencies by providing an overview and analysis of twelve recent studies that have been conducted in this area. Results should provoke reflection and debate as part of the process of preparing for the challenges and opportunities of the future.

This research work is integrated in the EU H2020 funded project EPIC (Excellence Center for Production Informatics and Control). Besides the main focus of the project on building up an excellence center for production informatics and control, the project aims to have a significant and sustainable impact on the development and management of education and training programs for engineers, managers and researchers of the future in the field of digitization. A particular goal of the EPIC project is to develop a modular concept for specific trainings, coaching and e-learning components to transfer knowledge to the industry, which will be based on the results of this research work.

Key Words: Competence Management, Competencies, Human Resource Management, Digitization, Industry 4.0, Survey, EPIC

1. Introduction

Due to disruptive changes throughout the ongoing digitalization, the work environment within many corporate manufacturing industry areas will fundamentally change within the next two decades. Many developments from different domains are contributing to product and process innovation such as genetics, artificial intelligence, robotics, nanotechnology, 3D printing and biotechnology, which will lead to make everything smart and connected (e.g. smart city, smart building, smart factory, etc.). Increasing automation of simple manufacturing processes, the use of state-of-the-art technology as well as shorter innovation cycles will lead to the reduction of simple operational jobs and a higher flexibilization of work itself.

Accordingly, qualification strategies need to take place on the horizontal axis across all employees in the entire value-chain as well as on the vertical axis across all organizational levels. This will result in new challenges to the strategic competence management as a crucial competitive factor. Therefore, this paper aims to identify competencies that will be required within a digitized business environment as a basis for agile competency modeling and strategic HR management. The following research question will be examined: Which competencies are identified and described by well-known institutions as critical competencies for future developments in businesses of Industry 4.0?

By answering this main question, the following additional questions will also be considered:

- Which approach can be used to identify and analyze well-known sources for studies describing competences in Industry 4.0?
- Which competencies are critical for job positions that require higher education for reaching business success in Industry 4.0?
- Which generic structure can be used to group competencies and which different approaches can be taken for structuring competencies?

2. Methodology

In order to answer the defined research questions, it is necessary to develop a comprehensive approach to the identification and analysis of studies from suitable and reliable sources that describe competencies in the context of the development of Industry 4.0 and digitization in general. To this effect, a four-step approach is developed and visualized in figure 1. The empirical data at hand does not fully allow for a quantitative summary of the results to carry out a meta-analysis. Thus, these four steps are embedded in the framework of a systematic review.

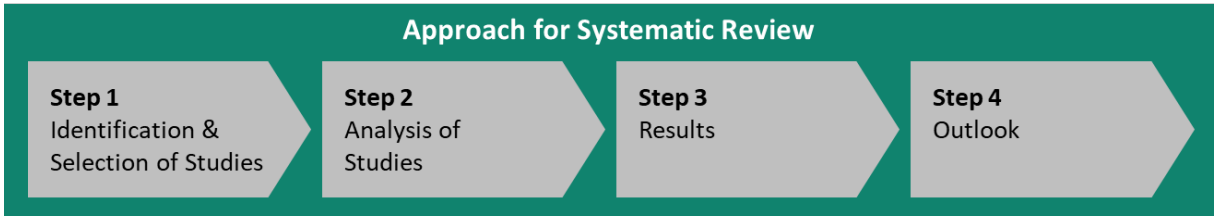

Figure 1: Methodological approach to analysis of future competencies in Industry 4.0

The shown steps to identify and structure competencies that are necessary for businesses facing the changes based on Industry 4.0 are described as follows:

- Step 1: Identification and selection of suitable studies describing competencies that are necessary to work in future businesses of Industry 4.0. Following the guideline for selecting studies of Meline (Meline 2006), in a first step inclusion and exclusion criteria for the selection of studies concerning the given research question are defined. Suitable studies are listed and sorted by category and, if existing, sample size.
- Step 2: Analysis and comparison of studies in regard to competencies necessary for Industry 4.0. The examination of these studies includes the extraction and comparison of competencies. Therefore, sighted content related to the subject of competence is extracted and compared.
- Step 3: As a result, the findings are classified and aggregated in a comprehensive competence catalogue within the context of Industry 4.0.
- Step 4: Finally, an outlook will be given. The outlook will outline the need for further research and developments in enterprises facing arising challenges.

3. Step 1: Identification and selection of suitable studies

For the systematic review of selected studies describing competencies for Industry 4.0 the described four-step-approach will be executed. The first step describes the identification and selection of suitable studies.

3.1 Definition of criteria for study selection

To be able to identify and select suitable studies of sources as a basis for this systematic review, a set of criteria has to be developed. The defined inclusion criteria are the following:

a) Only studies with a focus on Industry 4.0 and digitization within the timeframe 2014-2017 are considered.
b) These studies have to be carried out and published by renowned researchers / scientific institutes / universities or consultancies.
c) Only the following categories of studies with a solid scientific foundation and / or adequate sample sizes are taken into account:
   - Enterprise surveys with a sample size of N≥80
   - Expert interviews with a sample size of N≥12
   - Scenario analyses
   - Case studies
d) The majority of business representatives participating in the studies had to be either senior executives or chief digital officers with top-level responsibility in their company for Industry 4.0 strategy and activity.

Studies that did not match all of the criteria have been excluded.

3.2 Selection of suitable studies

Considering the defined research questions in chapter 3.1, the study selection process was conducted for searching the keywords

- "Industrie 4.0", "Industry 4.0", "Digital Transformation"

in combination with

- "drivers", "trends", "jobs", "skills", "knowledge," "qualifications", "work", "ability", "competence" and "competency".

Besides an extensive investigation of published studies, an advanced internet research as well as the following chosen top-databases covering a wide range of publications concerning Information Systems, Information Technologies and Engineering accessible from Technical University Berlin were used:

- Business Source Complete
- Web of Science Core Collection
- EconBiz
- OLC Wirtschaftswissenschaften

The search included all studies that were published until July 2017. All hits were first screened based on the title and abstract. Secondly, the whole studies were screened. At the end of the selection process a total of 12 studies were meeting the criteria and therefore selected for analysis (see

Table **2**). The studies form a database of 2709 enterprise interviews and 90 expert interviews. Although it cannot be ensured, that some of the asked experts respectively enterprises have taken part in more than one study, this fact will not be taken into consideration as not every study includes accessible in depth-information concerning the interviewed experts/enterprises.

While the studies A-E are based on sheer empirical enterprise interviews, the studies G-L contain different approaches including expert interviews, scenario analyses, case studies or a combination of these, mainly conducted by leading consultancies. Table 1 shows the cumulated total number of interviewed enterprises and experts.

Table 1: Cumulated sample size of studies

Cumulated sample size of studies	
Total enterprises surveyed	~2.709
Total experts interviewed	~150
Scenario analyses	5
Case studies	2

Table 2: List of studies

No	Title	Year	Sector / Size of Enterprise	Publisher / Country	Category / Volume
A	Qualifikationsbedarf und Qualifizierung | Anforderungen im Zeichen der Digitalisierung (Hammermann, Stettes 2016)	2016	Different Sectors /all sizes	IDW / Germany	Enterprise survey N=1.394
B	Industrie 4.0- Eine Revolution der Arbeitsgestaltung (Bauer 2014)	2014	Different sectors / all sizes (Focus on automotive, machinery and plant construction)	Fraunhofer IAO / Germany	Enterprise survey N=518
C	The Future of Jobs (Leopol et al. 2016)	2016	Different sectors / all sizes	World Economic Forum / worldwide (ASEAN, Australia, Brazil, China, France, Germany, GCC, India, Italy, Japan, Mexico, South Africa, Turkey, UK, USA)	Enterprise survey N= 371
D	Kompetenzentwicklungs-studie Industrie 4.0 (acatech et al. 2016)	2016	Different sectors / all sizes (focus on automotive, machinery & plant engineering)	acatech – Deutsche Akademie der Technikwissen-schaften / Germany	Enterprise survey N=345
E	Skills for Digital Transformation (Hoberg et al. 2015)	2015	Different sectors / all sizes	Hoberg et al. / worldwide (Argentina, Australia, China, Germany, Italy)	Enterprise survey N=81
F	The Future of work: Jobs and Skills in 2030 (Störmer et al. 2014)	2014	Different sectors / all sizes	UK Commission for Employment and Skills / UK	Scenario analysis, incl. expert interview N=34
G	Man and Machine in Industry 4.0 (Lorenz et al.)	2015	Manufacturing / all sizes	Boston Consulting Group / Germany	Scenario analysis, incl. expert interview N=20
H	Industrie 4.0 - Auswirkungen auf Aus- und Weiterbildung in der M+E Industrie (Spöttl et al. 2016)	2016	Metal & electrical / SMEs	bayme vbm / Germany	Expert Interview N=42, Literature analysis, Case studies, Expert workshops

I	Innovations- und Effizienzsprünge in der chemischen Industrie? (Malanowski, Brandt 2014)	2014	Chemical / all sizes	VDI/ Germany	Expert Interview N=12, Literature analysis
J	Industrie 4.0 und die Folgen für Arbeitsmarkt und Wirtschaft (Wolter et al. 2015)	2015	Different sectors / all sizes	IAB/ Germany	Scenario analysis
K	The Industrie 4.0 transition quantified| How the fourth industrial revolution is reshuffling the economic, social and industrial model (Blanchet, Rinn 2016)	2016	Different sectors / Automotive	Blanchet, M. & Rinn, T. (Roland Berger) / (South Korea, China, Brasil, USA, Italy, Japan, UK, France, Germany)	Scenario analysis
L	Industry 4.0 |The Future of Productivity and Growth in Manufacturing Industries (Rüßmann et al. 2015)	2015	Manufacturing / all sizes	Boston Consulting Group / Germany	Scenario analysis, Case studies

The listed studies build the data basis for the following analysis regarding competencies that will be necessary for companies in Industry 4.0. Collectively, they cover up 17 major developed and emerging economies and regional economic areas (see figure 3). However, Germany is focused as it is examined in the vast majority of eleven studies, followed by UK (4) and China (3).In the scope of emerging and third world countries, especially focusing on Africa, very few countries have been analysed. This is due to the missing digitization and the lack of industries. However, a series of important industry nations is missing completely, like the Netherlands, Sweden and Canada, which would also be interesting to be considered as these countries focus on different economic challenges and are part of G10.

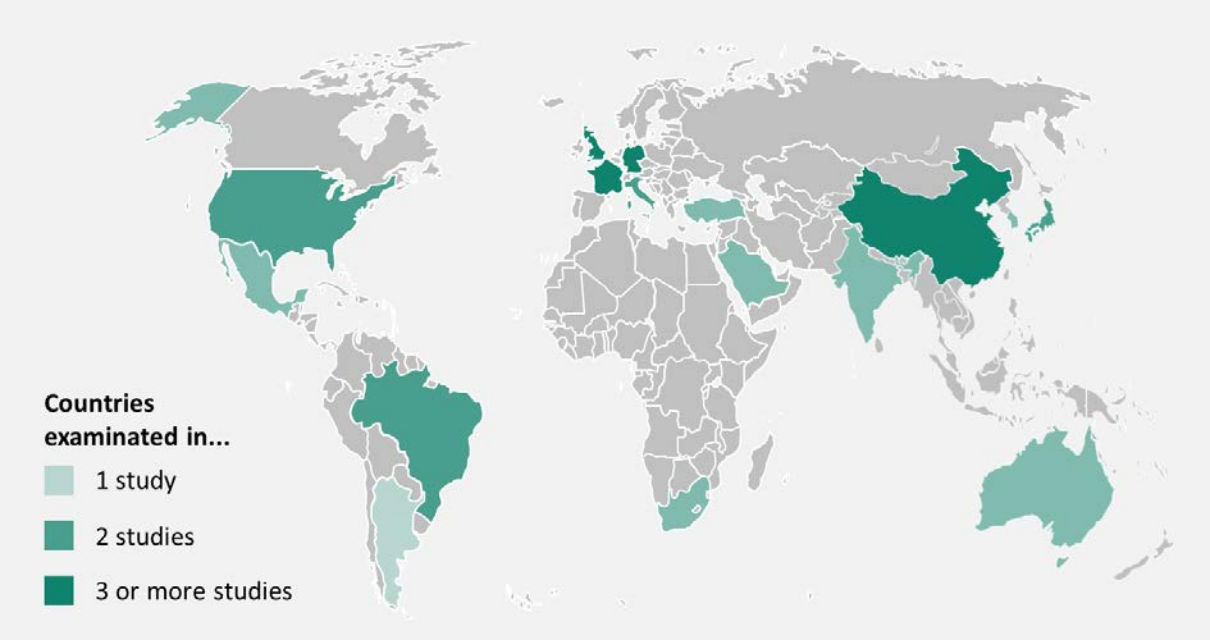

Figure 2: Total Sample Overview by geographic coverage (own illustration)

4. Step 2: Analysis and Comparison of Studies concerning competencies needed in Industry 4.0

For the analysis of competencies needed in a digitized environment, sighted competencies from each study are extracted (see appendix). If the same competency was covered synonymously in different studies, e.g. “creative thinking” and “creativity”, the terms are integrated into one competence using the more common term.

In the following, the empirical results of the enterprise interviews A-E are integrated, analysed and compared. They form the main content of the analysis due to their meaningful database and quantitative comparability. The studies F-M containing expert interviews, scenario analyses and case studies are analysed qualitatively, since their different approaches do not allow for quantitative analysis but deliver important insights into expert opinions.

4.1 Enterprise surveys

Firstly, the competencies derived from the enterprise interviews A-E are considered. They form the main content of the analysis because they deliver quantitative results and cover a wide, global range of contributing enterprises. Although it cannot be ruled out that enterprises took part in more than one study due to a lack of accessible data, the number of enterprises participating in each study is weighted in comparison to the total amount of experts, that have been asked within all studies (e.g. “The future of jobs”: N=371 out of 2.709 = 14%). Figure 2 gives an overview of the percentage share of competencies that are mentioned by the interviewed enterprises.

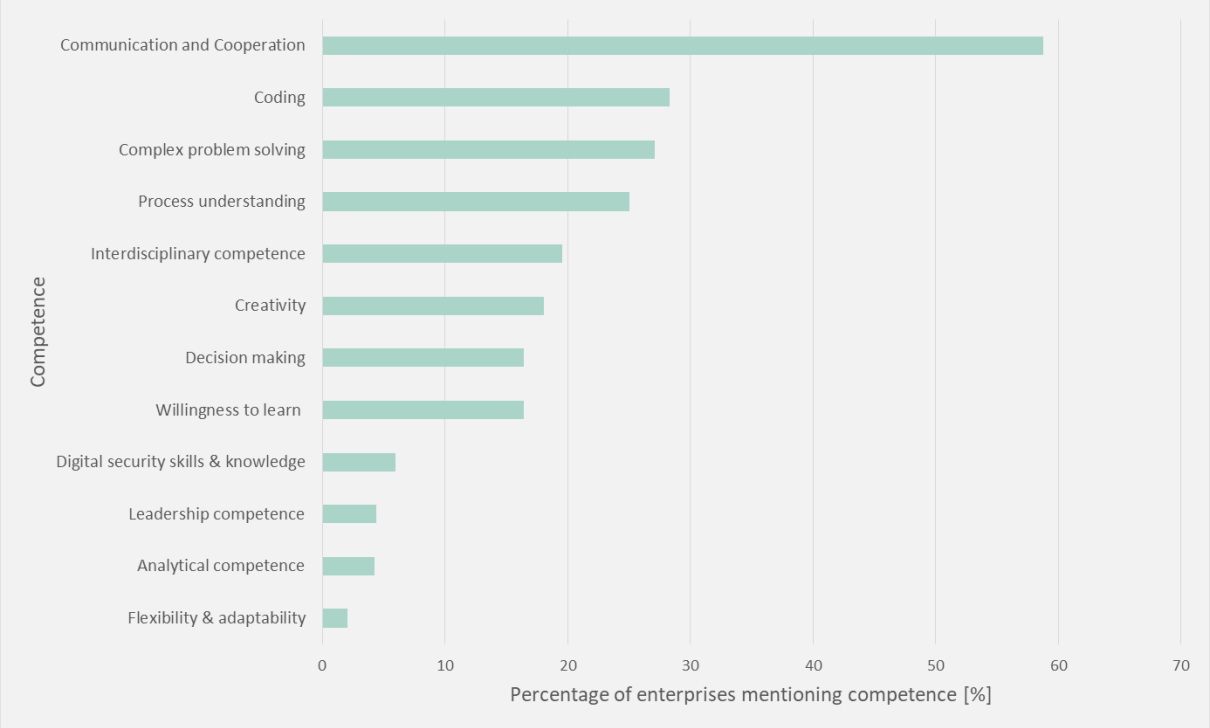

Figure 3: Overview of most important competencies mentioned by enterprises (N=2628)

For more than half of the participating enterprises *communication and cooperation (59%)* represents the most important competence. In this context, especially working in strongly connected business ecosystems on virtual platforms, international teams and more indirect contacts represent significant challenges that lead to this high rating.

Given the fact that information and communication technologies as well as the Internet are the basis for digitization processes in the economy, it is comprehensible that almost every second enterprise sees the need for general higher IT competence (45%) in *and* beyond IT departments. In this regard, *coding competence (28%)* including the understanding and writing of codes plays a decisive role. A qualified professional handling of the Internet and sensitive data also includes skills & knowledge for *digital security (6%).*

One out of four enterprises sees the need for a comprehensive *process understanding (25%)* to be able to take on process responsibility, to develop it further and to think and act in networked and cross-cutting processes. Within highly disruptive and innovative ecosystems, where employees have to develop new expertise and

comprehensive knowledge in order to understand the context, the personal competencies *creativity (18%)* as well as the *willingness to learn (16%)* gain new importance. More frequent work related change requires access to new forms of learning. Against the expectations, *analytical competence (4%)* as well as *flexibility and adaptability (2%)* have not been as highly rated, although they play a decisive role in the studies examined in the following chapter 4.2.

4.2 Expert Interviews, scenario analyses, case studies

The studies F-M do not provide quantitative data, but rather current assessments and expectations of future competence requirements. As they contain different approaches that do not allow for quantitative analysis including scenario analyses, expert interviews and case studies or a combination of these, the value of their results mainly lies in insights into current discussions in specialist circles, which support and expand the results from chapter 4.1. In the following, the mentioned competencies will be contextualized in reference to the studies.

The higher level of technology integration, exponential growing amount of data transferred, collected and stored as well as the resulting scope and complexity of work itself leads to a wide range of authors arguing that *analytical competence (F,G,H,K)* plays a decisive role for Industry 4.0 employees; especially regarding Big Data analytics and data management, IT-network systems and business analysis. The understanding of information and data will have to increase amongst employees in order to be able to implement the technical potentials within enterprises. Moreover, various studies underline the importance of complex *problem solving (J,K),* which is coordinated within the processes in teams, but also increasingly implemented on its own responsibility. Since decision making processes and the assumption of responsibility are more and more shifted to the process level, *decision-making competence (H)* gains new importance for Industry 4.0 employees.

On the social level, the growing virtual work leads to the fact that to a greater extent employees are working in virtual environments and collaborating with one another. The virtual collaboration on platforms requires a high level of *communication (G,H).*, which is also related to *cooperation (A,H)* to enable efficient work of Industry 4.0 employees within more dynamic and heterogeneous teams. Furthermore, the growth of strategic tasks with more responsibility requires new types of appropriate *leadership (G)* competencies. Managers of future production systems will need to transform their management methods from power-driven to value-driven due to highly diverse teams in terms of culture, education and geographical location (K).

In the scope of an increasing demand for cross-functional work, more innovative products and the general need to become more flexible and responsive, companies are increasingly oriented on the internal processes, so that *flexibility and adaptability (C,F)* become mandatory. Moreover, telecommuting, co-working spaces, virtual teams, freelancing and online talent platforms altogether transcend the physical boundaries of work places and therefore redefine the boundary between work and life.

Focusing on domain competence, employees increasingly have to be able to deal with and understand *digital networks (H).* It is not the individual technologies that are the central, but rather the interconnectedness and interaction within the network. Due to the availability of complex data sets, however, employees will be able to display application-sensitive information directly on mobile devices in the future. Therefore, *digital security (H,K)* must be focused and employees sensitized in order to protect data from unauthorized access. The growing demand for *coding competence* (C,H) is a decisive factor in changing job profiles, whether for the handling of data or the control and networking of technical systems. All employees must be trained for the sensitive use of the data and be able to follow the instructions for work according to the rules. Due to increasing interdisciplinarity and complexity of work, the need for *interdisciplinary competence (G)* will be more copious. For instance, the combination of know-how related to a specific job or progress (e.g. techniques for working with robots or changing tools on machines) and IT competence, from basic (e.g. accessing interfaces) to advanced (e.g. programming) as well as stronger generic interdisciplinary thinking and acting will play a big role.

5. Step 3: Results of the analyzed studies

This chapter summarizes the identified competencies of the analyzed studies

5.1 Aggregation and classification of identified competencies

Altogether, a total of 14 competencies could be identified. The studies used different terms and definitions for competence and its elements (e.g. “skills”, “abilities”, “knowledge”, “know-how”) inconsistently. Therefore, in

the following table 3 the identified competencies are clustered into the four main categories *personal, social, methodological* and *domain-related* competencies that suit all studies and put in the context of Industry 4.0 / digitization. In order to create a more solid evidence base, only competencies, which were mentioned in two or more of the studies A-L are taken into consideration with references that emphasize the prospective significance of each competence.

Table 3: Overview of social, methodological, domain-related and personal competencies for Industry 4.0

Competence		**I4.0 / Digitization context**	**Comparative references**
Social	Communication & cooperation	Service-orientation demands good listening and presentation skills, whereas more indirect contacts and increasing virtual work require sufficient virtual communication skills	A,B,D,G,H
	Leadership competence	Growth of strategic tasks and flattened hierarchies will make more employees to leaders	D,G
Methodological	Analytical competence	Structuring and examining large amounts of data and complex processes becomes mandatory	C,D,E,F,G,H,K
	Complex problem solving	Employees must be able to identify sources of errors and be able to improve processes independently as well as in teams	B,C,D,J
	Decision making	Responsibilities are shifted to the process level, more decisions have to be made independently as well as in teams	B,C,D,H
Personal	Creativity	Need for more innovative products as well as for internal improvements requires creativity	C,F
	Willingness to learn	In highly disruptive ecosystems changing conditions and changing situations do not create any problems. New challenges can be adequately addressed. New teams are formed with joy, and success and failure can be learned. Within a reasonable period of time, new knowledge and skills can be obtained that enable the person to perform other tasks.	B,C,F
	Flexibility & adaptability	Increasing virtual work makes employees become time and place independent; work-task rotation further requires employees to be flexible with their job responsibilities	C,F
Domain	Digital networks	Working in a highly globalized and intertwined value chain requires the knowledge networks	B,D,E,H
	Digital security	Virtual work on servers or platforms obligates employees to be aware of cyber security	D,E,H,K
	Coding competence	Growth of digitized processes creates a higher need for employees understanding and writing codes	A,C,G,H
	Process understanding	Higher process complexity demands a broader and deeper process understanding, thinking and acting in networked and cross-cutting processes	B,C,D,G,H
	Interdisciplinary competence	Increasing complexity of work requires multiple competence sets and knowledge, which is necessary for the performing outside of own profession	B,D,G

5.2 Approach for the integration of competence cluster methods

Since there is no established definition of "competence" in this chapter a generic concept of competence is developed that can be used for identifying, classifying and aggregating competencies as a basis for an effective and efficient competence management of digitized enterprises.

According to a wide range of authors competence includes motivation, attitude, abilities, skills and knowledge needed by employees to cope with job-related tasks and challenges in order to reach business success. There are two main types encompassing these elements, commonly referred to as: "behavioral" competencies and "technical" competencies. Behavioral competence includes motivations, attitudes and abilities. Abilities rely on natural or inherent behaviors as opposed to learned. Although they can be acquired to some extent, the majority of what constitutes ability cannot be learned. Technical competencies involve the knowledge and skills elements, which are learned through study and practice. Skills are the application of knowledge in a trade or profession. For example, coding skills involve applying knowledge of the commands and functions of a coding language. The combination of the two elements is mandatory to effective performance. Knowledge of „how" to do something does not necessarily correlate with carrying out the task. (Armstrong, Taylor 2014; Grassmann 2005; Solga, Ryschka, J., Mattenklott, A. 2011; Bernien 1997; Erpenbeck, Heyse 1996; Schiersmann, Thiel 2014; Wien, Franzke 2013)

Categorizing competence into personal, domain, social and methodological elements constitutes another widely known way of defining competence. Personal competencies include an employees' motivations, attitude, as well as social values. Because these competencies are purely *personal*, they are difficult to measure and train. Comprising the elements skills and knowledge, domain competencies are equal to technical competencies. Social competencies include attitudes, abilities and skills to form social relationships easily and cooperate and communicate with others. These competencies enable a person to reach common goals at a fair level in social interactions. Finally, methodological competencies include all abilities and skills for general problem solving and decision-making. They enable employees to solve new and complex problems independently, purposefully and with the help of learned thinking and working methods. (Bernien 1997; Eck, Rietiker 2010; Solga, Ryschka, J., Mattenklott, A. 2011; Wien, Franzke 2013)

Core competencies connect the organization at the most strategic level. As a specific type of competence, they go hand in hand with the *key values and strengths shared by everyone* in the organization and create a shared culture and learning across the organization. Core competencies can be identified by three main characteristics: firstly, they provide potential access to a wide variety of markets. Secondly, they contribute to the perceived customer benefits of the end product and, thirdly, they are difficult for competitors to imitate. They empower individual businesses to adapt quickly to changing opportunities and do not refer to standard qualifications expected for the professional performance of a typical function or task, which are to a certain extent the same in most industrial companies. Instead, they form the structure of particular knowledge and skill in an organization, which is necessary for the gain of competitive advantage. To ensure long-term growth and success, an organization should identify its core competencies and then invest in them, focusing resources on building and maintaining generally everything that contributes to the competencies. (Prahalad, Hamel 1990)

Within the job-family layer of the architecture, which connects related jobs that have common functions and form a logical career path, both behavioral and technical competencies can be required. Thus every employee within the job family shares these competencies, the majority of these are behavioral competencies. Even highly technical jobs require different sets of technical competencies. Therefore, generally at the job-specific layer of the architecture technical competencies are used most frequently. Specific jobs within the organization will be defined as a unique set of technical skills, with even small upward or lateral career moves within the same job family requiring the employee to acquire and demonstrate new skills and proficiency levels. (Human Resource Systems Group 2016)

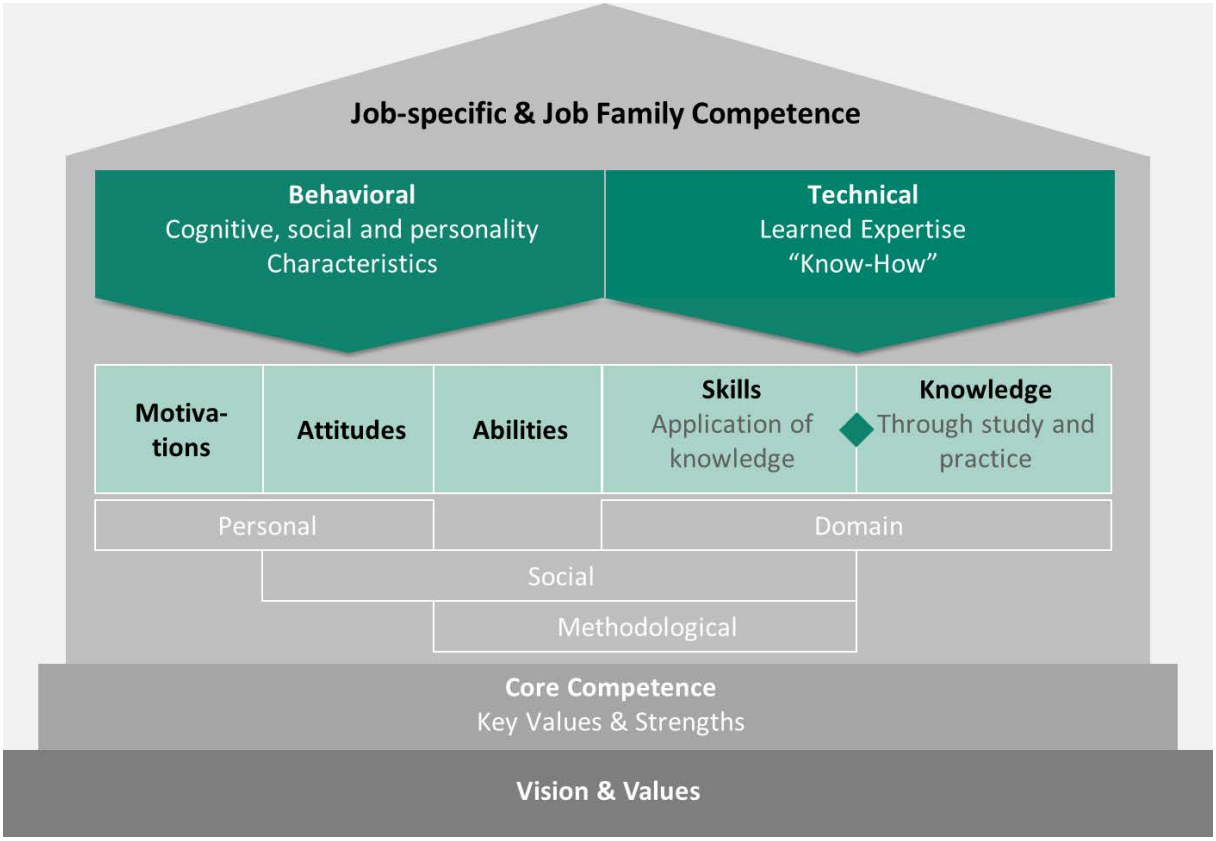

Figure 3: Definition and classification of competence in an organizational context (own representation with reference to (Human Resource Systems Group 2016; Wien, Franzke 2013; Erpenbeck, Heyse 1996))

6. Step 4: Future Outlook

In this systematic review a comprehensive list of clustered competencies for reaching business success in a digitized environment was compiled and the necessity of building staffs competences within businesses in Industry 4.0 was identified. As well-developed competences are already becoming more important, they need to be taken into consideration for future competence modelling as well as the strategic competence management as a whole.

Further development and research activities should focus on the flexibilization and integration of specific job competencies, since highly disruptive business ecosystems increase the need for agility and speed. This was one reason for Fraunhofer IPK to participate in the European R&D project EPIC (Centre of Excellence in Production Informatics and Control) in 2017, which is supported by the European Commission through H2020. The main objective of this project is to establish a Centre of Excellence in Production Informatics and Control (EPIC CoE) as a leading, internationally acknowledged focus point in the field of cyber-physical production systems representing excellence in R&D&I.

As one of Fraunhofer IPKs core competences is the strategic management and planning of innovative institutions, the specialists of Fraunhofer IPK are responsible for the development of the Human Resources Concept. According to the structural governance and management model, necessary functions and roles to operate the Centre of Excellence will be defined. In this context job descriptions and skill profiles with the underlying competencies for the respective functions will be elaborated. Based on these results, the human resources strategy for the EPIC Centre will be derived. Essential activities of HR development within the EPIC CoE will be identified to achieve a profound comprehension of the current and future development needs. The HR concept will create transparency on required competences and provides the detailed planning status of the human resources.

Additionally, training for complementary skills will be developed. Strategies of approaching industry partners and core issues of exploiting scientific results will be discussed in regular trainings. Lessons learnt on successful collaboration and research assignments ordered by industries will be shared. Additionally, non-successful

strategies and practices to avoid will be discussed. Fraunhofer's knowledge from trainings and certifications will be shared and made available as intra-project education material.

All the analysed studies as well as the results of this meta study show the high importance of a future driven competence management and development for businesses facing Industry 4.0. Therefore, further efforts have to be made to develop and establish the right competences for the future, not only by research organizations, but also within digitized businesses.

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Appendix: Extracted competencies

Table 4: Overview of extracted competencies

0No	Competencies
A **N=1394**	- Planning and organizational skills / self-employment (76.4%) - Communication and Cooperation (77.5%) - Skilled craftsmanship (26%) - Professional empirical knowledge (65.9%) - Technical expertise (56.7%) - Business expertise (56.1%) - IT-domain knowledge and programming skills (51.8%) - Online competencies (61.8%)
B **N=518**	- Willingness for lifelong learning (86%) - Stronger interdisciplinary thinking and acting (77%) - Higher IT-competence (76%) - Ability for permanent interaction with machines and network systems (75%) - More active participation in problem solving and optimization processes (75%) - Higher system knowledge (generic knowledge and control of processes) (72%) - Control of increasingly complex labor content (71%) - Stronger control of communication (68%) - Ability for more indirect contacts within and outside the business (65%) - Stronger participation and shape of innovation processes (61%) - Increasing coordination of work procedures (60%) - Ability to deal with less direct contacts to colleagues (55%) - More independent decision-making (53%) - Enforced social competence (43%)
C **N=371**	**Abilities** Cognitive (15%) - Cognitive flexibility - Creativity - Logical Reasoning - Problem Sensitivity - Mathematical Reasoning - Visualization Physical (4%) - Physical strength - Manual dexterity and precision **Basic Competencies** Content (10%) - Active learning - Oral expression - Reading comprehension - Written expression - ICT literacy Process (18%) - Active listening - Critical thinking - Monitoring set and others

	Cross-functional Competencies Social (19%) - Coordinating with others - Emotional intelligence - Negotiation - Persuasion - Service Orientation - Training and teaching others Systems (17%) - Judgment and decision-making - Systems analysis Complex problem solving (36%) - Complex problem solving Resource Management (13%) - Management of financial resources - Management of material resources - People management - Time management Technical (12%) - Equipment maintenance and repair - Equipment operation and control - Programming - Quality control - Technology and user experience design - Troubleshooting
D	**Employees' competencies** **N=216** - Interdisciplinary thinking and acting (61.1%) - Increasing process-know how (56.2%) - Leadership competence (55.4%) - Participation in innovation processes (54.2%) - Problem solving- and optimization competence (53.7%) - Independent decision-making (50%) **N=207** - Social/Communication competence (42.9%) - Ability to coordinate work procedures (46.8%) - Service orientation (46.1%) - Mastering of complex work content (46.37%) - Ability to interact with machines (34%) **Enterprise competencies** **N=220** - Data analysis (60.6%) - Process management (53.7%) - Customer relationship management (46.5%) - Deal with specific IT-systems (45.6%) - IT-business analysis (44.1%) - IT-security (41.6%) - User support/ service technology (- Data security - Network/Database administration

	- Cloud architectures - IT-architectures - eCommerce/Online-Marketing - AI/algorithms
E **N=81**	- Digital Security skills (86.4%) - Business change management skills (84.0%) - Business networks skills(79.0%) - Big Data analytics skills (72.8%) - Internet of Things skills (66.7%) - Product service offerings (65.4%) - Mobile technologies (63.0%) - InMemory databases (61.7%) - Cloud Computing (60.5%) - Social Media (60.5%) - Entrepreneurship (53.1%) - Novel interfaces (28.4%)