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Competency Requirement in Project Management and Digitalization

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Abstract

Project-based jobs are an integral part of current working life. It seems that the requirements related to project management work are changing due to the fourth industrial revolution. Various types of digital technologies can be used in working life, where digital transformation is considered as a mega trend, that changes societies. Because of this, new kinds of competencies are necessary. The aim of this research is to find out what are the requirements related to competences in working life in the era of digital transformation. Used data in this study consists of job advertisements from Finland and United States. The data is analyzed using content analysis. According to the results, there are less requirements focused on digital skills than expected. In addition, the traditional expectations are still important. Further research is also suggested on selected digital technologies or industries using wider sample of data.

Keywords: project management; competence; digital transformation

1. Introduction

Working life is full of project-based work and project manager is ordinary and quite traditional working title. Many of us have experience of working in projects. Even though project management is common phenomenon, it might not

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be seen as that novel. It is also changing because of the fourth industrial revolution and this can be seen as one of the major changes in working life, or even as a mega trend changing societies. As a result, new kinds of competencies are needed in working life and in project management. This industrial revolution provides many opportunities for improving project management with the help of digital technologies.

This article studies essential competencies within project management in the digital era. This article seeks an answer for a research question: "*What are the requirements related to competences in working life in the era of digital transformation?*" Used data in this study consists of job advertisements focused on project management from Finland and United States.

This research is important, because digital transformation is expected to cause big changes in the working life [1] and the work of project manager is changing [2], but on the other hand soft skills like leadership skills were most important skills in empirical study in construction industry [3]. Besides, the use of digital technology, like artificial intelligence, has been expensive [4]. So, there exists a research gap: we do not clearly know, what kinds of competences are required.

2. Literature review and theoretical background

2.1. Traditional Project Management Competences

In the project management certificates, the concept of competence is divided into three categories: 1) Input competencies (knowledge and skills that the project actor must have to effectively perform their tasks in a real work situation), 2) process competencies (the personality attributes and behaviors of the project actor), and 3) output competencies (the ability of the project actor to effectively realize his activities in accordance with the IPMA model, and this, by the effective application of his competencies in a real situation) [5].

According to some of the latest studies there are 65 factors contributing to project success. The most critical ones are communication, top management support, project manager's competency, clear objectives and realistic obligation, monitoring and feedback, and risk management [6]. To be effective, a project manager must have skills related to team building, leadership, conflict resolution, technical expertise, planning, organization, entrepreneurship, administration, management support as well as resource allocation [7]. In addition, also skills in leadership, interpersonal and technical skills are necessary and it is also claimed, that it is important to have background and experience that is consistent with needs of the project as well as proven managerial ability, that shows the ability to get things done [8]. On the other hand, lack of project management skills has caused harm in mega projects [9].

It has been noted, that communication, commitment and leadership are three most relevant aspects of project management competencies impacting on project performance. It seems that there is a trend towards soft skills and the need for an update on project management education to fill the gap between theory and practice. Project manager competencies lists have become too extensive, and the field is in constant change, which refer to the need more. research [10]

Project management soft skills consist mainly of communication skills, team building or teamwork skills, problem solving skills and leadership skills [11], [12]. In addition to aforementioned skills customer service skills have been considered also as a soft skill [13]. In another empirical study communication-, teamwork-, leadership- as well as conflict management skills, achievement motivation- and cognitive skill were categorized as soft skills [14]. There is a lack of consensus on definition of what belongs to the list of soft skills [13]. The PMBoK® framework and teaching of project management have been criticized because of emphasizing too much focus on the 'hard skills' of project management. 'Hard skills' are technical competencies which result in tangible project deliverables, such as project plans and charters, work breakdown structures, risk registers, project scheduling and monitoring, critical path analysis, cost monitoring and controlling, scope management, as well as managing deviations from agreed time along with cost and scope requirements. These skills are the core competencies of project management, and traditionally associated with the 'Iron Triangle'[2]. Walker and Lloyd-Walker [15] suggest, that necessary project management skills would focus on "knowledge, skills, attributes and experience (KSAE)". They also suggest, that in 2030 project management skills would cover both hard and soft skills, where the first would cover core competencies and skills and contributing experience, while the latter would cover personal attributes and relational orientation.

2.2. Digital transformation and project management – recruitment of talent

Digital transformation (DT) can be defined as the "innovative use of various advanced digital technologies to create value for stakeholders with both internal and external focus at a large scale" [16]. It aims to improve an entity, like a firm with the help of "triggering significant changes in its properties through combination of information, computing, communication, and connectivity technologies". The fourth Industrial Revolution (I4.0) is based on wide digitalization and the use of technological applications. Both DT and I4.0 bring fundamental changes to the working environment. In that the real challenge is to manage workforce, for instance by taking care of digital competencies, upskilling and reskilling [1].

Technologies connected to I4.0 like artificial intelligence (AI), machine learning (ML) and bots may take over many routine tasks associated with project management 'hard skills', but they will not be able to replace human judgement and decision making at any time in the foreseeable future. The future project managers do not need expertise in many of the traditional competencies (i.e. 'hard skills'), but they need to: "(i) understand and interpret the data provided to them by AI, ML and bots; (ii) use this information to solve problems and make recommendations; and perhaps most importantly, (iii) utilize this data to create and deliver human-centered project outcomes". The field of project management will see AI, ML and bots having a significant impact on both 'hard skill' and 'soft skill' based tasks and processes within the next five years, and a major shift in the field of project management education will occur within the next ten years, with "greater than 76.76% of 'hard skills' and 52.08% of 'soft skills' being undertaken by AI, ML or bots"[2]. This means that big changes are estimated to happen during the years 2025.

It is estimated that it is important for organizations to take care of digital competencies because of the changing demands of project management in data-centric digital operating environment. Digital competencies, talent management and project management can be seen as interconnected. There is a need for data-savvy talents in project management [17]. There has also been discussion about digital literacy, which refers to the "digital knowledge, understanding, and skills of managers to manage digitalization and operational activities digitally", that is supposed to impact sustainability of project management [18].

Definitions of digital skills often trace back to the definition of digital literacy as "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers". Digital skills represent much more than just a basic command of digital technology, like critical thinking and problem-solving skills. Dominant definitions of digital skills come from the public sector, like UK department of education and EU commission and research. At the EU framework there are five categories that constitute digital skills: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving [19].

Talent management refers to the attraction, development [20], [21] and retention or commitment [20], and selection [21] of talent. In addition to those main activities, talent management is supposed to include even fourteen practices [22]. Traditional talent management forms a solid foundation, but it should be developed so, that agile approaches and digital technologies and skills are more emphasized. According to a study made for 314 firms, DT impacts on talent management and talent management is the key to either help or prevent high level of digital maturity of an organization. DT leads companies to transform their talent management practices [23].

Various theories and frameworks have been used to study the adoption of technologies in organization, like diffusion of innovation theory, institutional theory, resource-based view, and technology-organization-environment (TOE) framework. The TOE framework offers a holistic and flexible perspective on technology adoption [24]. In the operations management field, like project management, we should not focus on rare and inimitable resources, like in strategic management frameworks, such as resource-based view. Instead, we can use practice-based view (PBV). In the PBV there are two primary classes of dependent variables. First, we have dependent variables associated with the adoption or utilization of specific practices. The details of these variables depend on the specific practices considered in any study. Second, we have performance outcomes instead of the competitive advantage of the PBV. Here too, the PBV offers some flexibility. The PBV allows for a wide variety of intermediate (like defect rates or cost per unit) and final (overall profitability) dependent variables, but also would encourage us to look at the connections between the two [25].

If digital technologies are adopted, it could be seen in the competencies required from project managers in the recruitment situation as a part of talent management. Digital technologies are a part of organizations' environment and the technologies may impact on organizations practices and when talents are recruited, digital skills may be required.

This means that organization and its environment have an impact on each other. As a result of talent management, there is supposed to be suitable human resources and competencies for project management jobs. The use of digital technologies is supposed to increase and thereby impact project management. These relationships between DT including the use of digital technologies and organizations talent management and project management are presented in figure 1. From the point of view of the TOE framework DT includes both operating environment and technologies and project management and talent management are part of an organization.

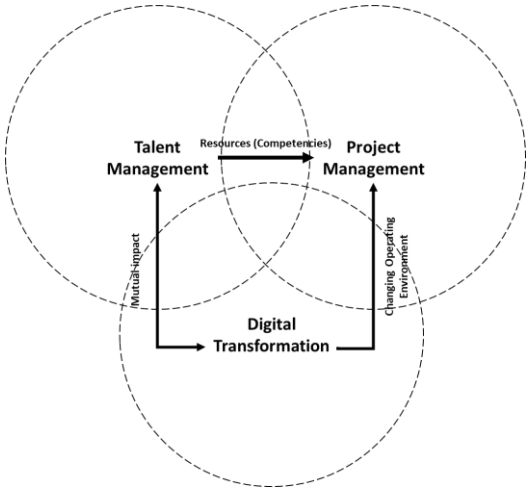

Fig. 1. Connection between digital transformation, talent management and project management.

2.3. I4.0 technologies – what kinds of digital competences are needed?

Industry 4.0 (I4.0) technologies allow companies to monitor, analyze, and control their operations and supply networks and these technologies are quickly becoming more common in various industries. [26] I4.0 is an umbrella term originated in 2011 from Germany and describing production processes that are "automated via technology and in which devices communicate with each other along the value chain activities" [27], or more broadly understood, it is supposed to "connect and link assets, products and people by breaking intra- and inter-organizational boundaries, thereby establishing a new industrial production ecosystem that combines the physical and virtual world" [28]. I4.0 refers to the rapid development of science and technology in production technologies in digital society and in addition to manufacturing it has occurred in many other industries as well, and therefore there are concepts like Health 4.0 [29], [30], Business 4.0 [29], [31] and Education 4.0 [29], [32], Industry 4.0 for services or Service 4.0 [33], [34]. I4.0 is a radical transformation process, which "has occurred and will occur" for industries and global supply chains as well as enhance efficiency in operations, but there are some disruptive effects [35] and negative impacts as well [36]. There are some design principles in I4.0 technologies, which are supposed to help supply chains to achieve high operational efficiency, productivity, customization, profitability, safety and automation. The principles are 1) interconnection or connectivity and linking digital devices by deploying ICTs; 2) decentralized decision making, like automatic decision-making in real time by installing artificial agents in production, planning and management processes; 3) intelligent awareness or autonomy in which machines must be equipped with self-awareness and the capability to provide assistance, knowledge or help to fulfil group goals; and 4) human factors critical role in implementing technological and organizational methods to achieve control and production targets [28].

Table 1. A summary table of concepts found in I4.0 literature.

Article	IoT	CPS	AI	ML	BDA	cloud com. ***	blockchain	AM, 3D*	AR, VR	robots **	Sensors ****	DT, simulation	Other words used in lists
1) Lemstra &de Mesquita (2023) [37]	x	x		x	x	x	x	x	x	x			reconfigurable manufacturing system
2) Mukul & Büyüközkan (2023) [29]	x	x	x	x	x	x		x	x	x	x		
3) Dieste et.al (2024) [36]	x	x	x		x	x	x	x	x	x			
4) Görçün et.al (2024)[35]	x			x	x	x		x		x	x		digital image processing, DL
5) de Mattos Nascimento et.al (2024) [38]	x		x		x	x	x	x	x	x			quantum computing
6) Billey & Wuest (2024) [26]	x	x	x	x		x	x	x	x	x	x	x	cybersecurity 5G-networks.
7) Zhao et.al (2024) [28]	x	x	x		x	x	x	x	x	x		x	
8) Uztürk & Büyüközkan (2024) [39]	x		x	x	x	x		x		x	x	x	WSNs, DL, GPS, RFID
9) Ostadi et.al. (2024) [40]	x	x	x		x		x		x				MR
10) Jiang et.al (2024) [41]	x		x		x	x	x	x		x			digital training toolkit
Sum	10	6	8	5	9	8	7	9	7	9	4	3	

* = 3Dprinters and/or AM devices, ** = robots refer to human-robot collaboration (1), social robots, educational robots and autonomous robots (2), (autonomous) robots (3), self-directed navigating (4), autonomous vehicles, drones (5), automation and robotics (6), automation and industrial robots (7), robotics (drones and autonomous robots) (8) and drones (10). *** = cloud computing, fog computing and edge computing. **** = refers to the sensors, smart sensors or remote sensing technologies

Because of the Industry 4.0, newer smart manufacturing technologies and tools are quickly becoming more common in various industries. These technologies allow companies to monitor, analyze, and control their operations and supply networks [26]. Table 1 shows, that there might not be a common agreement of what technologies are included in I4.0. Anyway, it can be said that I4.0 includes at least AI, ML, IoT, CPS, BDA, cloud computing, blockchain, AM/3D printing, robotics, sensors and simulation in its different forms, like digital twin.

2.4. Competences for managers

I4.0 is seen almost as a synonym to smart manufacturing [26] or smart factory [37]. Digital transformation has transformed traditional factories into smart factories and work requires new skills, if attempts to implement I4.0 technologies takes place [37]. There are skill gaps, which cause significant challenges for implementation for I4.0 [27], although I4.0 have mainly positive consequences [37]

Competencies are “sets or combinations of behaviors that are instrumental in driving and delivering fixed desired results, performances, and outcomes”. Competencies are combinations of knowledge, skills, and attitudes, which lead to overall good job performance. A ‘competency model’ is a combination of competencies that describe the knowledge, skills, and characteristics necessary to play a given role and show what is relevant for effective job performance. If competency models are matched with organizational goals, they help to determine the performance standards against which to evaluate an individual's as well as organizations or teams performance [42]. The successful adoption and practice of I4.0 requires *managerial competencies* from a human resources (HR) perspective. These competencies are the following:

- ability to work on different activities simultaneously and to switch between them
- ability to define goals or agendas for his/her team and to motivate it to achieve them
- to know how to build connected technology architecture to deliver business results
- understanding of business needed in complex situations and decision making
- willingness to listen to co-workers across organizational levels (collaborative mindset)

- ability to apply AI and big data to activities throughout the whole value chain (data analytics).
- ability to ensure the readiness for a comprehensive digital transformation
- research skills and knowledge to successfully integrate these technologies in manufacturing
- ability to use real-time data processing and data analytics to promote sustainable development
- ability to use robotic process automation and digital intelligence modelling (AI, robots, and sensor techniques)
- ability to handle many challenges in jobs like automation of processes and utilizing I4.0 technologies. [42]

3. Methodology

A comparative multiple case study was chosen to be used research approach in this study. Used data is qualitative, thus making this study a qualitative comparative case study. In this study, a published job advertisement were used as a unit of analysis, while the selection of job advertisements is based on finding two substantially similar geographical areas that share similar characteristics, so that comparison makes sense. Selected locations are Finland and three similar sized states from United States along with one additional state, that is expected to be highly advanced in digitalization as a high-tech state. Motivation for including the fourth state in the selection is the high level of digital skills in Finland [43], and in that sense high-tech state is comparable.

This study applies multiple case study approach, where the research begins from the theory, and this is followed by applying inductive analysis on the selected data [44]. Theory building case study approach by Eisenhardt [45] was applied in this study, and the way how it was applied is described in the table 2. The aim is to understand project management competencies and to recognize major trends in the field. In order to make generalizations, case study research is a valid approach for generalizing from empirical descriptions to theory [46].

Table 2. Process of this case study.

Steps in theory building case study approach [45]	**Description of the phase in this study**
1. Getting started	Definition of the research question
2. Selecting cases	Selecting cases form countries (Finland and USA)
3. Crafting instruments and protocols	Data (job advertisements were collected from databases of target countries by 2 researchers using both open sources and official databases
4. Entering the field	Data was collected in Finland in December 2024, in the USA April 2025
5. Analyzing data	Content analysis of each country was made and after that a comparison of the cases (countries)
6. Shaping hypotheses	Iterative tabulation of evidence and looking of relationships were made in the research group
7. Enfolding literature	Comparison with conflicting as well as similar literature
8. Reaching closure	Process was ended, when theoretical saturation was found.

The data consisted of job advertisements, where each separate job advertisement represents one unit of analysis. These were collected from two countries, the USA and Finland. The number of advertisements was 94 from Finland and 73 from four states of the USA. Finland is a country in the Northern Europe, which is about the same size as South-Carolina, Minnesota and Missouri from the United States. They can be compared to Finland in that sense. California was selected, because it is well developed region, that is supposed to adopt actively various digital technologies. Description of the cases is seen in the table 3 [47], [48], [49]. In table 3 these statistics are presented.

The data regarding Finnish job announcements was collected directly from the database of the Ministry of Economic Affairs and Employment of Finland. The data from the USA was manually collected from Jooble database (https://jooble.org/) during the April 2025. Only the jobs, which were clearly project management work, i.e., the advertisement included words “project management” in some format, were selected.

The research data in Finland was collected on the 17th of December in 2024 from the työmarkkinatori -website. All downloaded job applications were processed through artificial intelligence for optical character recognition, so the printed text can be copied and pasted from the pdf files. Total number of downloaded and processed job advertisements

was 146, and after screening the content, 94 of them were selected. The data had to be collected on that time, because there was a risk that data gathering from Finnish database would not be possible in the spring due to organizational as well as technical changes.

Table 3. Research data and analysis of the data.

Job advertisements	Population	Biggest employers	F
Finland	5,6 milj	service industries (58 %), health, production (24 %)	94
USA, California	39,5 milj	service industries (60 %), health service and trade	39
USA, South-Carolina	5,1 milj	health service and other services and trade	14
USA, Minnesota	5,7 milj	health service and other services (75 %)	11
USA, Missouri	6,2 milj	health and other services, retail trade, manufacturing	9
Total	62,1 milj		167

The data collected was analyzed with the help of content analysis. First each country was analyzed, and after that the countries were compared to each other. The results of the analysis were presented in tables and in iteration of the results the hypotheses were formatted. After this the results were compared to literature until nothing new was not found. The reliability of the content analysis was ensured in three phases of content analysis. In the preparation phase, the most suitable data was selected, and unit of analysis was defined as job advertisements. In the organization phase, categories were carefully created based on former research, and in the reporting phase, all the reporting was made in a systematic way [50]

4. Results

The focus of this research was to study what the requirements are related to competences in working life in the era of digital transformation. The key issue is what are the impacts of digital transformation and I 4.0 technologies on the requirements of the competences of a project manager. The skills were divided into hard skills like management, administration and planning and to soft skills like leadership, teamwork and co-operations, communication as well as marketing and customer-oriented work. Teamwork, co-operation and communication were most common skills required. The most common hard skills were project planning, scheduling and economic skills. Digital competences were not in focus in the job advertisements.

When requirement of the competences related to digital transformation and I4.0 were analyzed inductively, four main groups of competences were found in Finland: ability to use industry specific production related software like CAD in construction industry, ability of use of project management software, ability to use office software as well as ability to work in distance mode. The last one may be connected to cloud computing. Some I4.0 technologies were mentioned too, like AI and cloud computing. The most extensive requirements of digital competences were in IT industry and social- and health care services, the lowest requirements were in the public services and production and manufacturing (see Table 4).

Table 4. Skills required in Finland.

INDUSTRY (FINLAND)	F	AVERAGE
IT	3	2,33
Social- and health care	9	2,0
Security	6	1,83
Education	5	1,8
Construction	21	1,57
Third sector	5	1,4
Planning and consulting	16	1,33
Energy	4	1,25
Public services	10	1,2
Production/manufacturing	9	1,11

In the United States (USA), the most common skills required were the use of project management software and the use of Microsoft Office software. Industry 4.0 related technologies were mentioned, only once, when the use of cloud platforms was mentioned. The biggest requirements of digital competences were in steel industry and service industries, the lowest requirements were in production and manufacturing and well as in the energy industry (see Table 5).

Table 5. Skills required in the USA.

INDUSTRY (USA)	F	AVERAGE
Steel	4	2,75
Services (HEI)	3	2,33
Services (health)	3	2,33
Services (others)	4	2,00
Construction	45	1,78
Manufacturing/production	4	1,25
Energy	4	1,25

On average, there were more requirements for project managers in the USA than in Finland. Only in the manufacturing and production industry and in the energy industry, the requirements were at the same level. Programming was mentioned once in the USA and in Finland three times. It was much more common in both countries that, digital competencies were not specified in job advertisements, but it was noted that good IT skills or computer skills are needed.

The change caused by digital transformation does not seem to be that great, and only few skills related to I4.0 technologies are required in working life. It seems that the requirements are quite traditional. This could be interpreted so, that the main impact of I.40 technologies is in making the work of project manager easier and this means that there are not very big requirements of competence. On the other hand, it is also possible that change is happening now, like it was mentioned in the former studies, and it is more clearly seen in the USA. Only big data analytics, AI, simulation and cloud computing were clearly mentioned in both cases, but not the other I4.0 technologies, which were mentioned in the former research.

5. Conclusions and discussion

This study analyzed data that consisted of project management related job advertisements in USA and Finland, and the goal was to answer a research question: "*What are the requirements related to competences in working life in the era of digital transformation?*" It was presumed that the digital transformation or emergence of I4.0 technologies might have strong impact on working life requirements. This is because digital transformation is considered a megatrend, that should impact widely the whole working life in different countries. Digital transformation may not have a significant impact on talent management, which is seen in the recruitment process, like in job advertisements.

There were four main groups of competences in Finland, namely ability to use industry specific production related software, ability of use of project management software, ability to use office software as well as ability to work in distance mode. The biggest requirement of digital competences were in IT industry and social- and health care services, while the lowest requirement were in the public services and production and manufacturing.

In the USA, the most common skills required were the use of project management software and the use of Microsoft Office software. I4.0 related technologies were mentioned, thus only once when the use of cloud platforms was mentioned. The highest requirements of digital competences were in the steel and service industries, while the lowest requirements were in the production and manufacturing and well as in the energy industry.

On average, there were more requirements for project managers in the USA than in Finland. Much more common in both countries was, that digital competences were not specified in job advertisements. Interestingly, the change driven by digital transformation does not seem to be so extensive, and only a few skills related to I4.0 technologies are required in working life. This could be interpreted in many ways. Maybe skills are supposed to be developed in

working place as a part of talent management. Only big data analytics, AI, simulation and cloud computing were clearly mentioned in both cases, but not the other I4.0 technologies which were mentioned in the former research.

In the future, there might be a need for longitudinal research that focuses on opportunities related to I4.0 technologies. Technology is developing so rapidly that the new emerging benefits might lead to increasing requirements of competences of project managers. This should be known for instance in educational institutions and HRD units of companies early enough. Further research is suggested to focus on industrial companies in some specific areas, like the energy or steel industries.

Declaration on Artificial Intelligence

A During the data processing stage. Artificial intelligences were used to convert pdf files by optical character recognition to form where strings can be copied from the pdf files.

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