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Digital literacy and impacts on future of work

Ângela Inês Abrantes Meneses

Master Thesis

presented as partial requirement for obtaining the Master Degree in Statistics and Information Management

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
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Digital literacy and impacts on future of work

by

Ângela Inês Abrantes Meneses

Master Thesis presented as partial requirement for obtaining the Master Degree in Statistics and Information Management, with a specialization in Risk Analysis and Management

Supervised by

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

Lisbon, May 2024

Ângela Meneses

ABSTRACT

Digitalization has led the labor market to rapid changes, and we have been facing shifts in work conditions, job dynamics, and mainly the readapting to the skills required by organizations. As a consequence, digital literacy has become an essential skill for individuals to face the complexities of today's professional landscape and avoid digital discrimination. Not only individuals but companies also need to readapt their strategies to respond to the evolving market landscape. Hence, it is important to understand the relationship between digital literacy and the future of work and the impact future of work has on change management, too. The main question of this study is if digital literacy and future of work are related, within the context of digitalization and identify the key skills needed to enhance digital literacy. The research methodology is based on the construction of the theoretical model that delineates the determinants of digital literacy and future of work by the insights from a review of existing literature. The empirical validation of the theoretical model was conducted through the survey. The present study pretends to analyze the relationships between variables, with a focus on maximizing the explanatory power of latent constructs by using the PLS-SEM model. As a result of the model analysis, we can say digital literacy doesn't have an impact on the future of work, but it does have a negative effect on change management, underscoring the importance of problem-solving and digital innovation for organizational competitiveness in the rapidly evolving landscape. The study also emphasizes the necessity of investing in digital skills and fostering adaptability for success in the digital era.

KEYWORDS

Change Management; Digital Literacy; Future of Work; ICT; Digital Skills; Technologies

Sustainable Development Goals (SDG):

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LIST OF ABBREVIATIONS AND ACRONYMS

CM	Change Management
CS	Communication Skills
DI	Digital Innovation
DL	Digital Literacy
DS	Digital Skills
FoW	Future of Work
ICT	Information and communication technology
IMS	Information management technology
PS	Problem – Solving

1. INTRODUCTION

Both digitalization and ICT have shown a strong and important impact on the labor market by changing the dynamic of the jobs, the working conditions and a very important matter, the required knowledge, and skills (Bejaković & Mrnjavac, 2020). Globalization has created the perfect environment for technologies disrupt in economic and social sectors. Companies like McDonald's have made a big investment in innovation and automation, the fast-food company recently opened its first store in Texas which mitigates human contact - the orders are delivered to the customers by a treadmill. The only human intervention is in food making. Regarding this newly opened store, the opinions are divided, some believe projects like this might be the future because of the easier process, others are worried about the idea of being replaced by machines soon. Petrakis et al. (2015) estimate that 40% to 60% of the available jobs in the EU are at risk due to digitalization.

The growth of information technologies is the major cause of the changing nature of work (Lee, 2015). Digitalization has created new job roles like networking specialists, big data and internet engineers, app developers and so many other new functions (Spiezia et al. 2016). On top, has been reshaping existing jobs by changing the job's contents and requirements as well as the way some tasks are performed. These lead us to an urgent update in the skills needed (Petrakis et al. 2015). This is the explanation for the increasing demand for ICT skills and justifies the importance of digital literacy in the nowadays labor world (Lee, 2015). The COVID-19 pandemic accelerated digitalization due to the changes it caused in the work nature. This combination of digitalization and the pandemic highlights the need for a quick adaptation to technological changes and for employees to develop the skills required to be succeed in today's job market and meet organizational demands, too.

Digitization around the globe has led to a divided labor market – first, has created a trend towards a high demand for skilled workers with cognitive, digital, and technical expertise. On the other side, there's a decline in opportunities for low and medium-skilled workers as routine tasks become automated. This highlights the need for upskilling initiatives to address the growing skill gap and promote inclusivity in the workforce (Dolpin, 2015). To succeed in the ICT revolution, actual and future workers must have skills of creativity, originality, critical thinking, persuasion and negotiation, communication and so on. The ones who cannot follow this trend might have to be allocated to jobs with routinized tasks (World Economic Forum,2018; ILCUS, 2018). There's a link between ICT and technological change, which indicates an economic growth through increased productivity (Eze et al. 2018). The pandemic accelerated inequality among employees. By enabling people to find and consume valuable information online, ICT plays and will continue to play an important role in economic development (Sharma et al. 2018; Farhadi et al. 2012). In conclusion, nowadays, having digital skills is crucial for workers to boost efficiency and productivity and managing them becomes vital for companies to ensure employees perform at their best, benefiting business

productivity (Sartika et al. 2023) so, understanding how these skills impact employee performance is key.

This study, which focus on digital literacy, addresses itself a pertinent issue in today's society, recognizing the significance of evolving job roles due to automation and AI. In this context, DL has gone beyond basic tools, and skills like understanding data analysis, programming, critical thinking in a digital context, and cybersecurity become crucial. Aly (2022) notes a positive relationship between digital transformation and economic development, as well as a similar positive association with labor productivity and job employment. This underscores the crucial role of digital skills in contributing to positive outcomes across various aspects of the economy.

In a study by Brasse et al. (2023) on future skills identification the authors propose that future studies should identify future skills for workforce success, track changes in demand over time, and assess the evolving relevance and importance of these skills in the job market. This highlights the need for ongoing research to adapt to the dynamic nature of skills required in the evolving job landscape. The goal of this master thesis is to learn more about digital literacy and examine the relation between this concept and the future of work.

The main question of the proposal is:

How does digital literacy impact the future of work, considering the evolving technological landscape, and what are the key skills to enhance digital literacy?

In order to answer this question, were defined the following objectives:

- Digital Literacy and Change Management definition and components.
- Model construction – Theoretical model development with the determinants of DL and CM.
- Test the theoretical model.

1.1 METHODOLOGY

To reach the objectives mentioned above, an extensive body of literature about digital literacy, the future of work, and change management was analyzed, and many insights were provided that helped develop the theoretical model. To empirically validate this model, a survey was conducted to collect the population's perceptions the data was then used to determine the correlation between variables using the PLS-SEM model, a causal modelling approach that aims to maximize the explained variance of the dependent latent constructs (Hair et al. 2011).

1.2 CONTRIBUTIONS OF THE THESIS

As a contribution of the study, we found that digital literacy doesn't directly impact the future of work but is positively influenced by latent variables - communication, information

management, and problem-solving skills - by approximately 25.6%. Digital literacy demonstrates a negative effect on change management, which is explained by itself and the future of work by 23.5%. The future of work is explained by problem-solving skills and digital innovation by about 34.2%, with digital literacy being insignificant in this percentage.

Contrary to some expectations, our study suggests that digital literacy has a limited influence on the future of work, diverging from previous research. While digital literacy may not directly drive workplace changes, other variables like digital innovation and problem-solving skills appear to play a more significant role in helping organizations stay competitive and adapt to constant changes.

Furthermore, we observed an inverse relationship between digital literacy and change management. This means that a higher level of digital literacy is linked to lower effectiveness in managing change, reflecting challenges in adapting to technological changes. This negative relationship could stem from factors like resistance to new processes, difficulties in integrating new technologies within existing structures, or limited flexibility for rapid change.

2. LITERATURE REVIEW

The impact of digitalization on the labor market is reshaping working conditions, job dynamics, and the knowledge and skills required (Bejaković & Mrnjavac, 2020). Digital transformation involves fundamentally changing a company's entire business model, as exemplified by Facebook, Skype, Tesla, and Airbnb, which have revolutionized the diverse industries (Ilcus, 2018). Industrialized labor is on the decline with numerous routine positions gradually giving way to automation through numerical machines and electronic processors and so, manufacturing sector workers face the need to acquire digital skills to improve work efficiency and productivity (Sartika et al. 2023). Concerns are rising among both workers and employers regarding the potential replacement of human jobs by robots and computers, as documented by Wike et al. (2018). Due to COVID-19, the gig economy has expanded, representing a grey area between self-employment and standard employment. This concept may reflect what might be the future of work — flexible. However, this gig economy trend also evokes mixed feelings. For some it represents an extra income through short-term jobs due to the increase of digital and flexible jobs and, for others, it means a decline in the employment quality in terms of payment and working conditions (Montgomery & Baglioni, 2021). Supporting these concerns, an empirical study reveals that about 5% of occupations could have close to 100% of tasks automated, and almost 60% of occupations could have 30% of tasks already automated (Lund et al. 2021). In the same study, the author highlights skills and training as a serious challenge attached to the future of work landscape. This reflects the opposite effects digitalization creates in the labor market: job creation on one side, by generating new business models, products, and machines, and on the other side, the potential destruction of jobs and tasks (Alhloul & Kiss, 2022). McKinsey believes that COVID-19 has accelerated the major trends (e-commerce, remote work, and automation) that may reshape work in a post-pandemic period (Lund et al. 2021). However, not all tasks in the service industry can be automated because AI and automation struggle to replicate human intuition and empathy and these qualities are crucial in many service roles. Furthermore, humans are good at adapting to different situations, something AI still struggles with. As a result, certain tasks, especially those requiring empathy and understanding, remain best performed by humans (Ekaningrum et al. 2023).

Therefore, digital literacy has become a fundamental key qualification. The Information and Communication Technology (ICT) revolution and the digital era, characterized by rapid technological advancements, have reshaped work and employment (Wallace, 2004; Shepherd, 2004). In a study about the future of work in the UK, focusing on ICT development and the era of big data, Punkt (2014) underlines the significant influence of digital devices' capabilities and the potential to gather and utilize massive amounts of data in shaping the future of work in the UK. In fact, ICT has several implications for jobs, which will continue to be replaced by technologies and their developments. In addition, research emphasizes the importance of defining the skills citizens will need in the future world of work, with digital

literacy as a fundamental skill to thrive in an automated and digitalized labor market (Dondi et al. 2021). Technology brought challenges but also the opportunity to improve our ability to adapt to changes, the capacity to do it will determine our success in shaping the future of work for the better. Economic reports highlight the need for workers to tolerate changes, adapt to new working methods and environments, and have the capacity to continually update their skills and career paths using sophisticated learning tools driven by ICT (Billett et al. 2018), as an example research about foodservice industry underlines the importance for employees to gain technological skills to mitigate job disruptions and build resilience to face the changes seen in the hospitality sector (Klöpper & Köhne, 2023).

Over the literatures is expressed the importance for the majority of workers to acquire new skills due to digitalization and the need of organizations to ensure new capabilities to respond to external challenges (Leopold et al. 2016).

2.1 DIGITAL LITERACY STUDIES

Although many recognize the importance of digital skills, there is non-universal or official definition for the term of digital literacy. Diverse terms and explanations describe what digital competence includes, along with the related knowledge, skills, and abilities (Bejaković & Mrnjavac, 2020).

The concept of digital literacy is multifaceted, viewed through various means and perspectives. Initially, definitions were contradictory, emerging from different viewpoints and contexts (Nguyen & Habók, 2023). The concept of DL was first introduced by Gilster, (1997) in his book, defining it as "*the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers"* (Bawden, 2008, p.4). This definition highlighted the importance of using and evaluating digital resources for lifelong learning but did not specify the necessary skills for digital literacy (Nguyen & Habók, 2022).

Digital literacy and competencies extend beyond the use of technological tools (Demchenko et al. 2023). Curtarelli et al. (2016) identified three categories of digital competences used to measure and develop digital competence - Basic digital literacy competences and skills, work-related digital competences, and digital competences for ICT professions. The former enables individuals to become digitally literate and thus included in the digital society and the world of work. Work-related competences include both basic competences and those needed to fulfil specific job requirements. Finally, digital competences for ICT-related professions, which comprise the competences of the two previous categories plus the components of creativity and innovation, as they are competences related to the development of new digital solutions, products, or services.

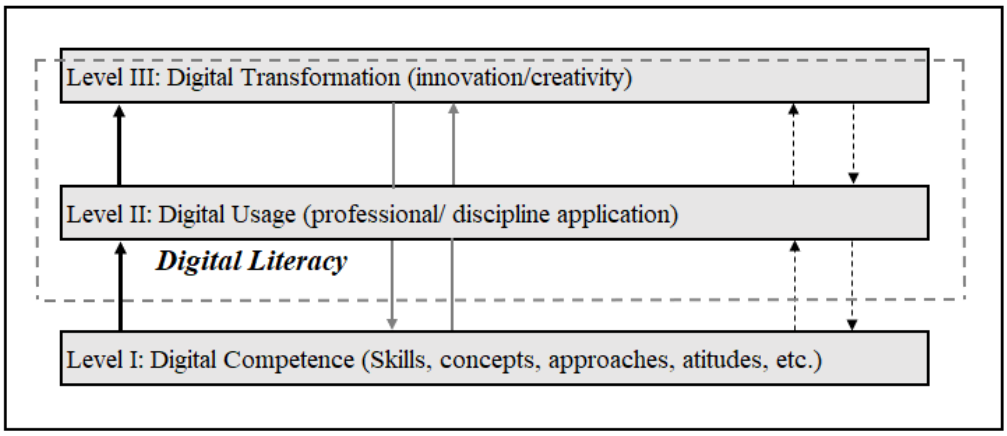

Figure 1 – Martin and Grudziecki (2006), Levels of Digital Literacy

Allan Martin argues in his study on "Digital Literacy and the Digital Society", that digital literacy revealed itself at levels II or III because, although Digital Competence (DC) is a requirement and the pioneer of digital literacy, it cannot be described as digital literacy (Martin & Grudziecki, 2006). According to their perspective, DC is a component of DL, or DL forms the foundation for DC, as DC represents the initial step toward an individual achieving full DL (Nguyen & Habók, 2022). Right at the opposite, Ferrari et al. (2013) consider DL as a necessary skill to aim DC.

Ilomäki et al. (2011) note that the term 'digital competence' has recently emerged as a concept summarizing skills related to technology use. Other terms, such as *"ICT skills", "technology skills", "information technology skills", "21st-century skills", "information literacy", "digital literacy",* and *"digital skills"*, have also been used to describe similar competencies. Academic studies sometimes use these terms interchangeably, exemplified by the interchangeable use of 'digital competence' and 'digital literacy' in certain contexts. The concept of digital literacy is seen as being a pluralistic character, lacking a singular, clear definition. Most researchers see this literacy as a " *continuum, with progressive stages where the basic abilities are only the first step"* (Shopova, 2014, p.27). For Martin & Grudziecki, (2006) digital literacy is about knowing how to use digital tools, while digital competence is about using those tools effectively to communicate, collaborate, create, and problem-solve in the modern digital world. Together, they form a comprehensive skill set that enables individuals to thrive in the digital age.

In the context of the current study, the terms DL and DC will be used interchangeably. The study does not make distinctions based on their meanings or origins; therefore, DL will be the chosen term. For this reason, DL and DC are considered synonymous throughout the research.

2.2 Main drivers for Digital Literacy and the Future of Work

Digital innovation is reshaping the future of work, disrupting traditional structures, introducing new job roles, and impacting society profoundly (Tabares, 2019). It requires

workers to adapt to evolving skill requirements (Goos et al. 2019) leading to the rise of highly qualified professional profiles and the decline of low-skilled jobs (Kateryna et al., 2020).
This evolution demands the acquisition of new abilities, with digital literacy playing a crucial role in this transformative process (Khan et al. 2022). It empowers individuals to develop skills like critical thinking, collaboration, and the capacity to learn and adapt to new technologies (Arntz et al. 2019). Digital literacy, communication skills, and problem-solving abilities are essential for success in the future of work (Nešić Tomašević, 2023) Research by Putra & Syahrul, (2023) reveals the positive influence of digital literacy on employee performance and innovative work behavior. Furthermore, digital literacy plays a crucial role in ensuring equal societal participation for vulnerable groups, such as the elderly and persons with disabilities, reducing the risk of social isolation (Pavić-Rogošić et al. 2022).
Adapting to the current labor panorama extends beyond employees, companies must change to survive (Phillips & Klein, 2023). The correlation between individual and organizational performance poses a significant challenge for leaders amid ongoing disruptions in technology and innovation (Dhir, 2019). Therefore, given the situation of today's job market, knowing how to manage information is a crucial skill (Ummatqul Qizi, 2020) and employers value individuals who can proficiently handle information within a company. In the context of AI technology integration, several key factors influence change management. These factors include the need for upskilling and reskilling the workforce to embrace AI capabilities effectively, fostering a culture of continuous learning and adaptability, and establishing clear communication channels to manage employee concerns and expectations during AI implementation (Manyika et al. 2017). Strong information management skills not only enhance a company's performance and competitiveness but also facilitate smooth adaptation to changes (Devece-Carañana et al. 2015).
Change management is a central concern in the future of work, involving technological transitions and the evolving nature of work (Barcellini, 2022). Defined, change management encompasses a series of models and strategies that ‘help employees accept new organizational developments’ (Phillips & Klein, 2023, p.189). Effective change management involves implementing strategies and techniques to facilitate organizational change (Litzcke & Nolte, 2023). In other words, it comprises a set of activities designed to achieve comprehensive transformations within an organization, including structural changes such as: mission, vision, strategies, structures, systems, processes, and behaviours (Rawson & Davis, 2023). The success of the initiatives has an immediate consequence: they bring greater organizational efficiency and effectiveness due to increased innovation in institutions. For this reason, Payne et al. (2023) stress the importance of understanding and implementing dynamic change management models so that organizations can face the challenges of transformation with confidence and achieve significant and sustainable results. As such, it is also extremely important to have good leadership in the digital field to support employee performance, so that they can develop digital competences and bring more innovation to companies (Turyadi et al. 2023). There are various models for managing change, including Kotter's eight-step

model, Levin's business transformation model, the ADKAR model and McKinsey's seven-step model (Havlovska et al. 2023) that can guide an organization to successful transformations.
Ademola (2024) highlights success stories of change management in the AI era, focusing on IBM and General Electric (GE). Both companies effectively integrated AI technologies, with IBM enhancing customer experiences and productivity through strategic AI implementation, while GE saw operational efficiency gains and new revenue streams by embedding AI and machine learning into its industrial offerings. These cases underscore the significance of proactive change management and organizational readiness in utilizing AI to foster innovation and gain a competitive edge in the modern workplace. Additionally, research about digital literacy among library professionals highlights the synergy between digital literacy and change management into the library ecosystem – while "*librarians should invest in continuous training and professional development programs focused on digital marketing, e-commerce, and content creation; (…); libraries can implement change management strategies to address resistance to digital transformation and foster a culture of innovation"* (Diseiye et al. 2023, p.6).

3. THEORETICAL MODEL PROPOSAL

After the literature review, it was possible to identify the following constructs: Problem solving; Communication Skills; Information Management Skills; Change Management; Digital Innovation - that can explain the relationship between digital literacy and the future of work and identify the impacts of the increasingly intensive use of ICT and change management.
The research model proposed is shown in the Table 1.

Table 1 – Model Dimensions

Construct	Conceptual definition	Reference
Change management (CM)	How organizations handle frequent, intense changes like restructuring or new technologies, both externally and internally, to ensure adaptability and resilience.	(Raineri, 2011)
Communication skills (CS)	The capability to use to ICT to transmit information to other, making sure that the meaning is expressed effectively.	(Siddiq & Scherer, 2016)
Digital Innovation (DI)	The transformative process that serves as a bridge between a company's resources and its business performance, aiming to enhance overall operational effectiveness and outcomes.	(Hidayat et al. 2022)
Digital Literacy (DL)	A combination of various skills and practices, including conceptual understanding, positive attitudes, practical procedures, and ethical considerations, which empower both individuals and groups to effectively participate and communicate in society.	(Marín & Castañeda, 2023)
FoW	Future of Work is all about the way technology is creating flexible workplaces and job markets, making work less predictable. To succeed in this changing environment, businesses need people who can keep learning and adapting to new things	(Pasha, 2019)
Information management (IM)	The skills to effectively utilize ICTS for tasks like searching selecting, and organization information, enabling informed decision-making about the most appropriate information task.	(Van Laar et al. 2017)
Problem – Solving (PS)	The skills to employ ICT for comprehending and analyzing complex problems, coupled with the active application of knowledge to develop solutions.	(Medina et al. 2019)

In his study, Schwartz et al. (2019) predicts a significant increase in the use of machines and data in future jobs compared to the past. But then, there is also a strong prospect that they will require human skills, such as problem-solving and communication skills. The FoW is about merging technology with human skills and advanced understanding and service skills. As so, it is possible to observe the direct and positive relationship between problem solving and communication skills and FoW (Schwartz et al. 2019). A study about "*Exploring Digital Literacy Skills in Social Sciences and Humanities Students*" highlights a strong link between communication digital skills and DL, particularly in economics and social sciences students. Information skills, vital for navigating the digital age, are more dominant among humanities students. Additionally, problem-solving skills, crucial for effective use of digital technologies, show higher proficiency in economics and social sciences students. These skills collectively contribute to digital literacy, enhancing activities like banking operations and civic participation (Vodă et al. 2022). As seen on the literature review problem solving skills are considered essential for the future of work. Various studies have examined the impact of problem-solving models and programs on different groups. The Piil Pesenggiri Team Work Learning (PPTWL) model was found to be effective in improving collaborative problem solving skills in science classes (Oppert et al. 2022). The Future Problem Solving Program International (FPSPI) targets to promote creative and critical thinking through a futurist approach to problems, and it has shown positive effects on creative skills (Karla et al. 2022). Also, the construction industry, which has been greatly affected by the pandemic, requires future skills in digitalization and problem-solving to overcome challenges (Odacı et al. 2023). To enhance problem solving skills in the workforce, it is necessary to provide education and training opportunities, improve communication and cooperation at work, and establish a skill-friendly labour market structure (Odacı et al. 2023).

H1.a: Communication Skills are directly related to the Digital Literacy.

H1.b: Information Management skills are directly related to the Digital Literacy.

H1.c: Problem Solving skills are directly related to Digital Literacy.

H1.d: Problem Solving skills have a positive impact in FoW.

Change management is a fundamental piece in successfully implementing e-learning technologies, particularly within educational institutions and organizations (Çulhaoğlu Uludağ, 2023) and the resistance of users to change presents a significant challenge in this context (Parlakkılıç, 2014; Kanitz & Gonzalez, 2021). Studies reveal that employees' digital literacy significantly influences their readiness for organizational change (RFOC), with resistance to change (RTC) serving as a mediating factor (Çulhaoğlu Uludağ, 2023). In the realm of e-learning, enhancing users' digital literacy is crucial for overcoming resistance to change and ensuring the effective integration of new technologies (Parlakkilic, 2013). Moreover, the contemporary societal mandate for perpetual change focuses the necessity for proactive change management strategies, where digital literacy emerges as a fundamental component

for adapting to technological advancements within educational institutions (Dimitrovski et al. 2019). The prove that DL is crucial to CM is the fact that as Perides et al. (2020) studied, organizations have a superior need for acceptance of innovative process and behaviours due to the cultural shifts and the adoption of new work methodologies. Their study indicates that organizations undergoing digital transformations require the acceptance of innovative processes and behaviours due to cultural shifts and the adoption of new work methodologies. Additionally, in the healthcare sector, digital health literacy is indispensable for nurses to deliver superior health services and education, highlighting the imperative of technological literacy in improving patient outcomes and disease management (Temür & Aksoy, 2022). Digital literacy is also crucial for the future of work, shaping how individuals navigate the evolving job market. As technology advances and transforms industries, continuous skill enhancement through lifelong learning is essential (Nešić Tomašević, 2023). Society's digital shift necessitates increased digital competences, encompassing computer literacy, collaboration, problem-solving, and understanding social relationships in a digital context (Leimeister & Blohm, 2022). Additionally, it has revolutionized access and engagement with English literature, fostering reader communities through digital platforms (Thapliyal, 2020). In the professional realm, digital literacy empowers individuals to create, share digital content, and effectively communicate, fostering self-realization in education, work, and social contexts (Kateryna et al., 2020). These findings underscore the critical role of digital literacy in adapting to work's changing landscape and leveraging digital technologies for future success.

H2.a Digital Literacy has a positive impact on Change Management

H2.b: Digital Literacy has a positive impact on the FoW.

The future of work is linked with the necessity for organizations to adapt to radical changes brought about by globalization, digitalization, and demographic shifts, as said before in this essay and by Malone (2005). By the year of 2025, the move towards more decentralized and electronically connected work setups could promote a smoother and more inclusive way of managing organizational changes. This means there would be a stronger focus on continuous adaptation and involving all parties affected by the changes (CFA Institute, 2022). Understanding the technological impact and implementing effective change management principles will be crucial for organizations to navigate these evolving work landscapes (Carstea & Sabau, 2013). Additionally, managing work transformations requires a holistic view that integrates social, organizational, and technological projects to shape the future of work successfully, ensuring safe, healthy, and productive working conditions. The FoW is being sculpted by digital innovation and technological advancements which are leading to the digitalization of jobs and the potential automation of up to 32% of today's jobs (Johnson et al. 2020). Companies are adopting new work arrangements, including remote work and gig economy positions, which are facilitated by digital workplace technology and virtual collaboration platforms (Wagner et al. 2019). The impact of digitalization on the workplace of the future requires companies to develop adequate individuals' development strategies and

implement additional measures for the change process (Melián-González, 2019). The future of knowledge work will involve increased use of AI and robotics, as well as distance work and virtual teams (Jevnaker & Olaisen, 2022). Overall, the future of work will be characterized by increased digitalization, flexibility, and the need for a diverse set of skills to navigate the changing landscape.

H3.a: FoW has a positive impact on Change Management.

H3.b: Digital Innovation has a positive impact on FoW

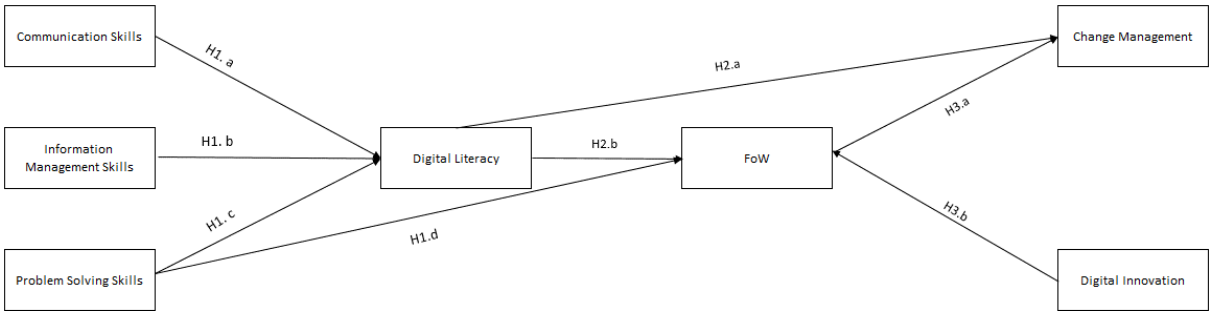

Figure 2 – Research Model of Change Management

4. EMPIRICAL STUDY OF THE THEORETICAL MODEL

4.1 MODEL OPERATIONALIZATION

The research model has been confirmed as valid through a quantitative approach using established scales known to effectively measure each aspect under study, thereby enhancing the credibility of the research. Instruments for measurement were adapted from prior studies with a demonstrated effectiveness. A questionnaire was developed, comprising two sections: the first section focused on gathering demographic information, while the second section utilized a five-point Likert-type (ranging from 1 for "completely disagree" to 5 for "strongly agree") to scale respondents' perceptions. The survey used established measurement tools and was approved by the Ethics Commission before being published. Data collection took place between January 13th and March 9th. The final measurement instruments used to test the structural model are provided in Appendix B. The sampling strategy involved randomly selecting participants from a voluntary target population. The questionnaire was distributed electronically via platform (Qualtrics, 2024). The study enlisted 192 participants who provided insights into their digital skills and their perceptions of the future of work.
In terms of gender distribution, approximately fifty-two percent of respondents identified as female, forty-seven percent as male, and one person identified as "other". Furthermore, 115 respondents were aged 30 or younger, as summarized in Table 2.

Table 2 – Sample characteristics

Sample characteristics	**(n=192)**	**%**
Gender		
Female	100	52,1%
Male	91	47,4%
Other	1	0,5%
Age		
<=30	115	59,9%
>30	77	40,1%

To explore the connections and causal effects within our proposed model, the Structural Equation Modeling (SEM) with Partial Least Squares (PLS) analysis was employed (Hair et al. 2011; Ringle et al. 2005). PLS is believed suitable for testing and validating the causality of a structural model. It effectively minimizes residual variances in endogenous dimensions and is recognized in the literature as appropriate for validating models with non-normally distributed samples (Hair et al. 2011). Additionally, SEM/PLS is well-suited for our sample size, which follows the guideline, recommending at least ten times the number of constructs for empirical validation (Cohen, 1992). This method utilizes bootstrapping with a minimum of 5000 subsamples to test hypotheses effectively.

4.2. MEASUREMENT MODEL RESULTS

Table 3 demonstrates that the reliability of the items exceeds 0.70 (Hair et al. 2011). This means that all measurement items are reliable and dependable, as detailed in Appendix B. At the same table the convergent and discriminant validity can be confirmed and the findings reveal that all items converge and share a significant portion of variance. The results expose that all items converge and share a significant proportion of variance. Commonality analysis demonstrates that the outer loadings of the dimensions exhibit substantial overlap when measuring latent variables (LVs). Results from the discriminant validity test indicate that each dimension is different from the others. From Table 3, we deduce that each indicator is associated exclusively with one dimension analysis of cross-loadings Appendix C suggests that the outer loadings of the indicators surpass all loadings in other dimensions (Gefen et al. 2005). As crossloadings serve as a liberal criterion for discriminant validity, a more conservative approach to evaluation was also considered.

Table 3 – Measurement model results

Construct	Item	Outer Loading	Cronbach's Alpha	Composite reliability (rho_A)	AVE
CM	CM1	0,811	0,880	0,889	0,675
	CM2	0,812			
	CM3	0,867			
	CM4	0,831			
	CM5	0,782			
CS	CS1	0,717	0,717	0,741	0,638
	CS2	0,791			
	CS3	0,816			
DI	DI1	0,819	0,865	0,869	0,650
	DI2	0,783			
	DI3	0,851			
	DI4	0,813			
	DI5	0,763			
DL	DL1	0,704	0,704	0,723	0,630
	DL2	0,693			
	DL3	0,871			
FOW	FOW1	0,739	0,766	0,769	0,588
	FOW2	0,763			
	FOW3	0,757			
	FOW4	0,760			
IMS	IMS1	0,807	0,732	0,823	0,782
	IMS2	0,765			
PS	PS1	0,720	0,755	0,759	0,575
	PS2	0,737			
	PS3	0,738			
	PS4	0,781			

The test for internal consistency reliability using Dijkstra-Henseler's rho (ρA) demonstrated that all latent variables met the required standards (Dijkstra & Henseler, 2015). The lowest recorded value among the latent variables was 0.704, while the highest was 0.871, as detailed in Table 3. Nine items were removed from the analysis due to their low factor loadings (<0.70): CS1&5, DL4&5, FOW5, IMS3,4&5 and PS3. Additionally, the study confirmed convergent validity, indicating that the constructs effectively explain their respective items. This was evidenced by examining the Average Variance Extracted (AVE), which all surpassed the threshold of 0.5 (Fornell & Larcker, 1981). To study the discriminant validity, it was used two criteria: the Fornell-Larcker criterion and the Heterotrait-Monotrait ratio of correlations, HTMT (Henseler et al. 2015). The Fornell-Larcker criterion compares how close each survey question is to the main concept in the study. So, a question can be considered as effective as it is more closely related to the main concept (Fornell & Larcker, 1981; Hair et al.2011). Through the model analysis, it can be said that the results indicate the survey measures what we intended because each question of the survey was mainly related to the main concept. Similarly, the HTMT analysis examines how distinct questions about different concepts are from each other. If questions about different concepts are more different from each other than questions about the same concept, it suggests good measurement (Gold et al. 2001). Our HTMT results also showed that questions about different concepts were indeed more distinct from each other, which is desirable. Consequently, there is substantial evidence indicating strong evidence that the survey accurately measures the intended concepts.

Table 4 – Discriminant validity (Fornell-Larcker criterion)

	CM	CS	DI	DL	FoW	IMS	PS
CM	**0,821**						
CS	0,183	**0,799**					
DI	0,643	0,192	**0,806**				
DL	-0,044	0,459	0,118	**0,794**			
FoW	0,451	0,411	0,381	0,283	**0,767**		
IMS	0,215	0,247	0,247	0,269	0,368	**0,884**	
PS	0,27	0,395	0,316	0,325	0,527	0,209	**0,758**

*Bold values indicate square root of AVE in the diagonal.

Table 5 – Discriminant validity (HTMT)

	CM	CS	DI	DL	FoW	IMS	PS
CM	0,239						
CS	0,742	0,250					
DI	0,107	0,635	0,162				
DL	0,534	0,568	0,463	0,380			
FoW	0,273	0,335	0,312	0,365	0,497		
IMS	0,329	0,527	0,389	0,426	0,690	0,262	
PS	0,239	0,250	0,162	0,380	0,497	0,262	

4.3. RESULTS

The second part of the assessment involves the structural model, which is applied following a satisfactory evaluation of the measurement model (Hair et al. 2019). According to their framework, four key criteria are used to assess the structural model in PLS-SEM: relevance of the path coefficients, coefficient of determination (R^2), effect size (F^2), and statistical significance. It is crucial to first examine collinearity before proceeding with the assessment of structural relationships (Sarstedt et al. 2021). The variance inflation factors (VIF) were scrutinized, and the results, as displayed in Table 6, indicated the absence of collinearity issues among the predictor constructs, as all VIF values were below the threshold of 5 (Hair et al. 2019).

Table 6 – Inner VIF

	CM	CS	DI	DL	FoW	IMS	PS
CM							
CS				1,226			
DI					1,111		
DL	1,087				1,119		
FoW	1,087						
IMS				1,082			
PS				1,204	1,225		

The Structural Equation Modeling (SEM) or Partial Least Squares (PLS) method is employed to evaluate structural paths once the validity of the measurement model has been established. In this study, digital Literacy ($\hat{\beta}$ = -0.186, p < 0.001) and future of work ($\hat{\beta}$= 0.504, p < 0.001) collectively account for 23.5% of the variance in change management. Moreover, problem solving ($\hat{\beta}$ = 0.413, p < 0.001) and digital Innovation ($\hat{\beta}$ = 0.413, p < 0.001) together explain approximately 34% of the variability in the future of work. Furthermore, Digital Literacy is significantly influenced by communication skills ($\hat{\beta}$ = 0.363, p < 0.05). Regarding digital literacy, information management skills ($\hat{\beta}$ = 0.148, p < 0.001), and problem solving ($\hat{\beta}$ = 0.151, p < 0.05), explain 25.6% of its variance. However, it's notable that only Digital Literacy ($\hat{\beta}$ = -0.186, p < 0.001) does not significantly contribute to explaining Future of Work, indicating an insignificant relationship in between. Overall, the model supports all paths with at least a small predictive impact, as depicted in Figure 2. The coefficients of determination (R^2) for Change Management (CM) with R^2 = 0.235, Future of Work (FoW) with R^2 = 0.342, and Digital Literacy (DL) with R^2 = 0.256 indicate substantial explanatory power for these variables.

At this point, all hypotheses are both theoretically and empirically supported. The F^2 statistic assesses the contribution of exogenous variables to endogenous variables, where intervals

indicating effect size are categorized as large, medium, and small effect. A summary of these results is presented in Table 7.

Table 7 – Hypothesis test results

Hypotheses| Independ. Var	→ Depend. variable		Findings	Conclusion
H1.a	→ Communication Skills (CS)	Digital Literacy (DL)	Positively & statistically Significant *** ($\hat{\beta}$ = 0.363, p < 0.001)	Supported with large effect
H1.b	→Information Management Skills (IMS)	Digital Literacy (DL)	Positively & statistically Significant * $\hat{\beta}$= 0.148, p < 0.05)	Supported with small effect
H1.c	→Problem Solving Skills (PS)	Digital Literacy (DL)	Positively & statistically Significant * ($\hat{\beta}$ = 0.151, p < 0.05)	Supported with medium effect
H1.d	→ Problem Solving (PS)	Future of Work (FOW)	Positively & statistically Significant *** ($\hat{\beta}$ = 0.413, p < 0.001)	Supported with large effect
H2.a	→ Digital Literacy (DL)	Change Management (CM)	Negatively & statistically Significant ** ($\hat{\beta}$ = - 0.186, p < 0.01)	Supported with small effect
H2.b	→ Digital Literacy (DL)	Future of Work (FOW)	Positively & statistically not Significant ($\hat{\beta}$ = 0.121)	Not significant
H3.a	→ Future of Work (FOW)	Change Management (CM)	Positively & statistically Significant *** ($\hat{\beta}$ = 0.504, p < 0.001)	Supported with large effect
H3.b	→Digital Innovation (DI)	Future of Work (FOW)	Positively & statistically Significant *** ($\widehat{\beta}$ = 0.236, p < 0.001)	Supported with medium effect

Legend: **Path Coefficient $\widehat{\boldsymbol{\beta}}$** : NS not significant; * significant at p < 0.10.; ** significant at p < 0.05.; *** significant at p < 0.01. **Effect size**: large effect ($F^2 > 0.350$), medium effect ($0.350 > F^2 > 0.150$), and small effect ($0.150 > F^2 > 0.020$). (Chin, 2015; Cohen, 1988)

The findings reveal that hypotheses 2a and 2b have contrasting effects. Specifically, the association between digital literacy and future of work (hypothesis 2b) is found to be statistically insignificant, suggesting that digital literacy does not account for variations in future work outcomes. Additionally, there exists a negative relationship between digital literacy and change management. Conversely, all other hypotheses demonstrate statistically significant positive relationships. Communication skills exhibit a highly significant impact on digital literacy (p < 0.001) and exert a substantial effect in explaining this relationship ($F^2 > 0.350$). Similarly, the relationships posited in hypotheses 1d and 2a – between problem solving and future of work, and between future of work and change management, respectively – are also highly significant, with substantial explanatory effects ($F^2 > 0.350$). Digital innovation (hypothesis 3.b) significantly influences future of work (p < 0.001), with a medium effect size

in explaining this relationship ($0.350 > F^2 > 0.150$). Hypotheses 1b and 1c exhibit the lowest influence on digital literacy ($p < 0.05$). However, the relationship between information management skills and digital literacy has a small explanatory effect ($0.150 > F^2 > 0.020$), while the effect in the relationship between problem-solving skills and digital literacy is moderate ($0.350 > F^2 > 0.150$).

In the SEM model, path coefficients represent standardized regression coefficients, indicating the relative importance of exogenous variables in predicting the dependent variable. These coefficients estimate the hypothesized relationships between variables, illustrated in Figure 3.

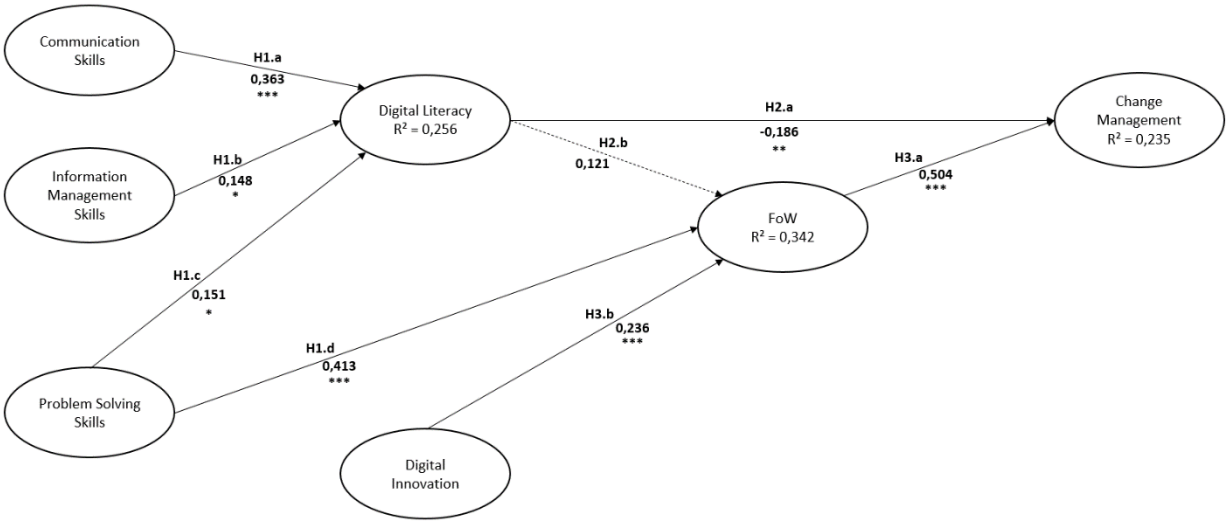

Figure 3 – Structural Model Results

Path *significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$

Summarizing, seven of the eight paths drawn from the list of hypotheses were significant at $p < 0.05$.

Future of work had the strongest impact on change management, followed by problem-solving on future of work. Communication skills had the greatest effect on digital literacy but the lowest effect on information management skills for digital literacy, and on digital literacy for change management. Problem-solving skills and digital innovation had moderately significant effects on digital literacy and change management, respectively. The explanatory power of research model as shown Figure 2 shows that the R^2 value of the quality dimensions, digital Literacy and future of work explain 23,5% of the change management. Also, a combination of problem solving, and digital innovation explain about 34% variance total future of work, but this variable can´t be explained trough digital literacy. The digital literacy is also 25,6% explained by communication skills, information management skills and problem solving.

5. DISCUSSION

The study initially expected a positive correlation between DL and the FoW, as suggested by (Kateryna et al., 2020). However, our findings indicate that digital literacy does not impact the future of work, diverging from prior studies such as Ilham & Rohmani, (2024) which found a significant but moderate correlation in opposition to the hypothesis 2b that was considered to be insignificant due to the p = 0.074, p > 0.05, although the ($\hat{\beta}$= 0.121).

Our model accused a negative relation between DL and CM. Path coefficient can be positive or negative depending on the relationship between variables and measures the strength of the relationship. Regarding this relation, our SEM analysis indicates that digital literacy has a negative (but significative) relation with CM ($\hat{\beta}$= - 0.186), but the relation is weak. These results were not excepted because the findings of Slavković et al. (2023) and Uludağ, (2023) and other literatures mentioned before underlines a positive relation. This finding suggests that companies need to adopt a more holistic and new approaches to talent development and organizational adaptation. In contrast, problem-solving and digital innovation exhibit strong significance and impact on the future of work, as evidenced by high significance levels ($p < 0.001$). This is in line with previous empirical studies by Oppert et al. (2022); Karla et al. (2022) and Odacı et al. (2023), which highlight the pivotal role of problem-solving skills in the labor market's future. Susanti et al. (2024) found a significant influence of problem-solving skills on work readiness too, even though slightly lower than our findings in H1d.

Besides that, our study reveals a positive impact of all three types of digital skills studied – communication, problem-solving, and information management – on digital literacy, coherent with existing theories and research from Vodă et al. (2022) and Schwartz et al. (2019). Communication skills have the largest effect ($\hat{\beta}$ = 0.363) and the strongest significance on DL $p < 0.001$), in contrast to findings by Qostal et al. (2024). If companies have the wise to invest in problem-solving skills and digital innovation, while promoting a culture of continuous learning and innovation, they can effectively adapt to the evolving market demands.

Plus, FoW shows a very positive impact on CM, consistent with prior research, with significant effects ($0.150 > F^2 > 0.020$) and a substantial relationship ($\hat{\beta}$ = 0.504, $p < 0.001$). Our results support previous findings that highlight this positive relation, along with the idea that increased work engagement can improve readiness for change (Meria et al. 2023). In summary, the future of work significantly impacts change management and if organizations effectively implement change management practices, they can adapt to the evolving work landscape and position themselves for success in the digital and constant change era. In the context provided, the most significant variable appears to be problem-solving skills, as indicated by their high significance level ($p < 0.001$) which emphasizes the importance of problem-solving skills for the labor market's future. In terms of explanatory power, communication skills seem to have the strongest impact on digital literacy compared to problem-solving and information management skills. This states that communication skills

have the greatest effect on digital literacy, contrary to the findings of Qostal et al. (2024). Therefore, while problem-solving skills is the most significant variable in relation to the future of work, communication skills have the strongest explanatory effect on digital literacy.

The absence of a significant impact of digital literacy on the future of work suggests that while digital literacy is crucial for individual skills and competencies, its direct influence on shaping the broader landscape of work may be limited. However, when considering digital literacy in relation to change management, the negative connection indicates that higher levels of digital literacy among employees may pose challenges to traditional change management processes. It's plausible that employees with advanced digital literacy may exhibit more resistance to change or perceive changes differently due to their digital skills and perspectives.

6. CONCLUSIONS AND FUTURE WORKS

Our model explains the future of work by focusing on digital literacy, including different digital skills and factors shaping changes in work. Based on a review of the literature, this model provides a strong theoretical basis.

First, this study pretends to investigate how digital literacy influences the future of work in the context of evolving technology and to identify key skills necessary to enhance digital literacy for individual employability. Secondly, understand if change management is impacted by the future of work. Through empirical research and the development of a theoretical model, our findings suggest that problem-solving skills and digital innovation explain 34% of the future of work and indicate that change management is explained by approximately 24% (23.5%) by the future of work and digital literacy. Furthermore, digital literacy is explained by 25.6% of the independent variables of the model – communication, information management, and problem-solving skills. Our essay reveals the significant impact of communication skills on digital literacy and highlights the importance of change management in shaping the future of work. Curiously and contrary to expectations, digital literacy does not affect the future of work but negatively affects change management. Problem-solving and digital innovation skills are paramount for organizations to stay competitive and adapt to the ever-changing environment. Investing in digital skills development programs, combined with effective communication skills training, can significantly boost the overall digital literacy levels within the workforce. In the current circumstances where technology is rapidly evolving, organizations must continuously reevaluate the role of digital literacy and its impact on their competitiveness. This means not only focusing on technical skills but also promoting a culture of adaptability and continuous learning. Change management becomes crucial in this context, as implementing new digital tools and processes can sometimes face resistance or pose challenges within an organization. Implementing strategies that consider employees' specific needs and concerns regarding digital literacy can help moderate these barriers and facilitate a smoother transition. Recognizing the importance of digital literacy and effectively managing change, are important measures that organizations should prioritize if they want to seize the opportunities presented by the evolving digital landscape and drive innovation and growth successfully.

This study has limitations too. Future works might expand the research scope to include additional variables relevant to the future of work that would help define and understand the broad concept of FoW. Then, focusing on specific aspects or topics within the future of work could refine the research and offer more targeted insights. Moreover, increasing the sample size in future research could enhance the statistical power of the findings and make stronger conclusions about the relationships between variables. Also, and as said before future research could focus studies on understanding the reasons why digital literacy no impact on the future of work has but has a negative impact on change management.

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APPENDIX A

Ethics Committee Report

This is to certify that
Project No.: **INFSYS2023-11-269494**
Project Title: **DIGITAL LYTERACY AND IMPACTS ON FUTURE OF WORK**
Principal Researcher: **Ângela Meneses**

according to the regulations of the Ethics Committee of NOVA IMS and MagIC Research Center this project was considered to meet the requirements of the NOVA IMS Internal Review Board, being considered **APPROVED** on 11/26/2023.

It is the Principal Researcher's responsibility to ensure that all researchers and stakeholders associated with this project are aware of the conditions of approval and which documents have been approved.

The Principal Researcher is required to notify the Ethics Committee, via amendment or progress report, of
- Any significant change to the project and the reason for that change;
- Any unforeseen events or unexpected developments that merit notification;
- The inability of the Principal Researcher to continue in that role or any other change in research personnel involved in the project.

Lisbon, 11/26/2023

NOVA IMS Ethics Committee
ethicscommittee@novaims.unl.pt

APPENDIX B

Measurement Model

Construct	Code	Indicator	Reference
Digital Literacy	DL1	*"I feel confident making payments online without any help."*	(Abdulkareem & Ramli, 2021)
	DL2	*"I can complete e-government tasks online without any help."*	
	DL3	*"I feel confident finding information using the search engine."*	Cronbach's alpha = 0,704
	DL4	*"I feel confident posting messages in a web bulletin board."*	
	DL5	*"I feel confident chatting on the internet."*	
Change Management	CM1	*"My company communicates with clarity individual and work unit objectives and challenges."*	(Raineri, 2011)
	CM2	*"My company changes program objectives have been clearly stated throughout the company."*	Cronbach's alpha = 0,88
	CM3	*"My company plans to pursue the change program were well known throughout the company."*	
	CM4	*"My company makes an effort to understand how employees understood its messages."*	
	CM5	*"My company makes frequent communication efforts to ensure understanding and support of the change program."*	
Problem Solving	PS1	*"After understanding the problem, I will identify what is unknown to solve the problem."*	(Medina et al. 2019)
	PS2	*"If I can't find a suitable answer, I seek help from knowledgeable people on how to solve it."*	Cronbach's alpha = 0,755
	PS3	*"After finding an answer using one method, I use another method to confirm my answer."*	
	PS4	*"I solve step-by-step so that I can look back and know what I am doing."*	
	PS5	*"I associate the given problem to the real world to come up with practical ways to solve the problem."*	
Information Management	IM1	*"I have the capacity to obtain information about the state and progress of science and relevant technologies through systems of intelligence and vigilance technology. "*	(Devece-Carañana et al. 2015)
	IM2	*"I have the availability and efficacy of systems to capture relevant, regular and up-to-date information about competitors through competitive intelligence systems."*	Cronbach's alpha = 0,732
	IM3	*"My firm has systems to codify explicit knowledge within the organisation."*	

	IM4	*"My company has the capability to ensure employees can swiftly and conveniently access the information and knowledge they require."*	
	IM5	*"In my company there exist mechanisms to incentivise organisational members to share information."*	
Communication skills	CS1	*"My write is clear and precise."*	(Cuic Tankovic et al. 2023) Cronbach's alpha = 0,717
	CS2	*"I feel confident using an effective business vocabulary."*	
	CS3	*"I can use spelling, grammar and punctuation correctly."*	
	CS4	*"I feel confident preparing documents that are concise, accurate, and supportive of the subject matter."*	
	CS5	*"I feel comfortable presenting ideas and information in a clear and logical sequence."*	
		"My company makes frequent communication efforts to ensure understanding and support of the change program."	
FoW	FoW1	*"My skills have been upgraded to keep pace with the current technique."*	(Pasha, 2019) Cronbach's alpha = 0,766
	FoW2	*"I explore trends in my field/industry and have identified various changes that are occurring."*	
	FoW3	*"The skills and abilities that I need to be employable are clear to me."*	
	FoW4	*"I welcome job and organizational changes."*	
	FoW5	*"Regularly, I try to identify the future direction of "My field by making personal contacts, reading or attending professional meetings."*	
Digital Innovation	DI1	*"My company always prepares products/services that are easy to use."*	(Hidayat et al. 2022) Cronbach's alpha = 0,865
	DI2	*"My company always creates products/services by involving customers to create a meaningful user experience."*	
	DI3	*"My company always performs the right customer segmentation."*	
	DI4	*"My company always performs the right product/service bundling."*	
	DI5	*"My company always pays attention to user behaviour that appears in market."*	

APPENDIX C

Crossloadings

	(CM)	(CS)	(DI)	(DL)	(FoW)	(IMS)	(PS)
CM1	**0,803**	0,118	0,598	-0,001	0,389	0,115	0,236
CM2	**0,811**	0,214	0,473	-0,003	0,399	0,150	0,251
CM3	**0,870**	0,187	0,531	-0,042	0,418	0,229	0,265
CM4	**0,833**	0,103	0,487	-0,090	0,352	0,219	0,169
CM5	**0,787**	0,118	0,577	-0,046	0,261	0,165	0,170
CS2	0,211	**0,702**	0,180	0,285	0,385	0,234	0,227
CS3	0,087	**0,824**	0,145	0,408	0,335	0,143	0,392
CS4	0,165	**0,862**	0,146	0,392	0,289	0,232	0,307
DI1	0,585	0,152	**0,819**	0,069	0,328	0,291	0,206
DI2	0,446	0,172	**0,783**	0,147	0,326	0,108	0,306
DI3	0,568	0,139	**0,851**	0,100	0,297	0,187	0,259
DI4	0,516	0,143	**0,813**	0,051	0,317	0,217	0,228
DI5	0,476	0,169	**0,763**	0,110	0,259	0,188	0,279
DL1	-0,077	0,328	0,079	**0,771**	0,151	0,228	0,233
DL2	0,042	0,355	0,107	**0,733**	0,253	0,202	0,174
DL3	-0,066	0,405	0,095	**0,871**	0,260	0,215	0,350
FoW1	0,360	0,297	0,334	0,252	**0,752**	0,313	0,376
FoW2	0,308	0,302	0,283	0,168	**0,762**	0,331	0,383
FoW3	0,428	0,321	0,304	0,183	**0,795**	0,259	0,403
FoW4	0,275	0,342	0,244	0,266	**0,757**	0,231	0,456
IM1	0,179	0,270	0,217	0,278	0,328	**0,932**	0,245
IM2	0,212	0,145	0,224	0,183	0,330	**0,833**	0,097
PS1	0,184	0,283	0,257	0,292	0,449	0,180	**0,766**
PS2	0,175	0,304	0,258	0,328	0,363	0,071	**0,769**
PS4	0,204	0,290	0,202	0,190	0,367	0,146	**0,737**
PS5	0,266	0,326	0,233	0,156	0,411	0,240	**0,759**

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