



**Universiteit Utrecht**

Masters Thesis

# **Develop a competencies framework for digital transformation in the banking industry**

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*Author:*  
**Panithan Phongphaew**

*Supervisor:*  
**Prof. dr. Johan Jeuring**  
*Second Supervisor:*  
**Dr. Nico Brand**

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## *Abstract*

Concerning the banking industry, the Organization for Economic Co-operation and Development (OECD) stated that digital technology might significantly impact increased competitiveness and contestability in financial markets. Because of this, banking will move to a platform-based, customer-centric model, which will require incumbents to change. Several technologies, such as social, mobile, and big data, play a part in driving changes in banking models, where technology has revolutionized the bank's operations. The banking industry must plan its organization ahead of time, and human capital is critical.

Organizations and people are being forced to change due to technological disruption. It has become commonplace for employees to need to learn new skills. Also, a company's training and development strategy should align with its business model to help employees get better skills for jobs in the 21st century. As a result, this study aims to understand and develop a digital competency framework for digital transformation in the banking industry. This thesis discusses the related theoretical framework for digital transformation, a skills and competencies framework, the method used to get the results, a discussion, and conclusions, including limitations and suggestions for more research.

Keywords: Digital competencies, Skill, Digital transformation, Banking

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# 1. Introduction

Many factors, such as a more efficient transportation system, better communication, or e-commerce business, have made doing business considerably more competitive in recent years. Levitt (1983) coined the term "globalization" to describe these shifts in the economic world. The globe, according to Levitt, will become increasingly interconnected. As a result, the key to competitive success is to keep improving products and services to meet the global standard. Other studies discovered that to be successful, businesses must design products and tactics that are tailored to each market's unique qualities.

In a competitive era, one of the buzzwords is innovation. According to studies (Schumpeter, 1934) innovation is defined as the combination of existing resources to create something new, such as a product idea or operational systems. These changes may prove to be more sustainable than price competition in terms of improving the company's business.

Aside from innovation, rapid technological growth has altered society and is still changing the way businesses operate. To stay in business, a company must embrace digitization (Garth et al., 2016). Transformation is essential on all levels, according to Lanzolla and Anderson (2008), to develop a modern organization capable of continuous change.

With respect to the banking industry, the OECD (2019) stated that digital technology might have a significant impact on increasing competitiveness and contestability in financial markets. Banking will shift to a platform-based, customer-centric paradigm, requiring incumbents to restructure.

According to Krstić and Tešić (2016), the banking industry has been one of the most disrupted industries in recent years. Previously, customers had to go to a bank on their own and need at least a bank branch to perform most transactions, but thanks to technological advancements, they can now do most transactions on their mobile phone, tablet, or personal computer. Several technologies, such as social technology, mobile technology, and big data, play a part in driving changes in banking models, where technology has revolutionized the bank's operation (Wewege & Thomsett, 2019). In conclusion, the advancement of information technology, as well as widespread use of computers, the internet, and mobile phones, has had a significant impact on the financial sector, resulting in the introduction of new companies, financial instruments, and products, as well as other industries.

To prepare for this situation, the banking industry must plan its organization ahead of time, and human capital is critical. To increase organizational competencies and the ability to innovate, a corporation must consider various things, according to Drucker (1999). It must take elements such as new management or an improved information management structure into account, as well as the productivity of labor, which is based on knowledge of and aptitude to work. Many aspects of organizations have been transformed by digital technology, and this change has created new circumstances in which many organizations are struggling to survive, such as the global market's diversity, rising customer expectations for product and service quality, and the impact of the internet on an organization's business (Markowitsch et al., 2002). Organizations and people are being forced to change as a result of technological disruption (OECD, 2019). It has become commonplace for employees to need to learn new skills. Furthermore, research shows that investing in employee training helps to retain them, resulting in a competitive advantage (Sousa & Rocha, 2019).

An organization's training and development strategy should be aligned with its business model to increase employee skills for 21st century employment. As a result, the purpose of this study is to understand and develop organizational training and development strategies, and a skills and competencies framework toward digital transformation in the IT-related departments. This thesis describes the related theoretical framework for digital transformation, a skills and competencies framework, the methodology to arrive at the findings, a discussion, and conclusions, including limitations and further research.

## 1.1 Thesis Composition

The remainder of this thesis is structured as follows:

Chapter 2 gives the theoretical foundation of this thesis. Here, relevant existing knowledge areas are explored and systematically analyzed following a rigorous review process. This is done by considering the most influential literature in the investigated research fields. This process resulted in a solid understanding of theory and provided the basis that guided the development of the digital competencies.

Chapter 3 gives a comprehensive account of the research methodology. This chapter includes the choice of research strategy and design that provide the structure to guide the research process. Next, the research methods, techniques, and tools deemed appropriate for data collection and analysis are presented.

Chapter 4 synthesizes and aggregates the findings from the systematic literature review (SLR) and survey. This chapter is structured into three main sections. The first section is the result of a systematic literature review. The second section provides statistical results from the survey. Section three concludes with a summary of the findings on how digital competencies influenced digital transformation. The primary focus of this chapter is to address the main research question.

Chapter 5 concludes by summarizing the research findings. The conclusions are about our research objectives and questions, as well as relevant business practices and academic fields. Finally, we suggest areas for further research and the study's limitations.

## 2. Theoretical background

### 2.1 The banking industry

The financial service industry has long strived to stay at the forefront of technological advancement. Commercial banks have historically been active in forming joint ventures, licensing agreements, and mergers and acquisitions (Pennings & Harianto, 1992). Then, information technology became a fundamental aspect of financial services operations and delivery. Commercial banks are beginning to draw parallels with other service-oriented industries like telecommunications and transportation. New business models emerged as a result of these connections, such as large-scale credit cards and automated teller machine (ATM) networks. The financial services sector is now confronted by a new challenge, as a result of different digital technologies, social media, cloud computing, data analytics, and process digitization (Wewege & Thomsett, 2019). Banks will surely be more efficient in the future, with technologically equipped bank branches and services, appropriate self-service machines, and computers focusing on the bank's primary purpose of serving customers. The primary goals that banks must achieve through digital transformation in the future are to adapt services and ways of servicing to new ways of doing business, as well as the introduction of services based on human experience. These problems have the potential to disrupt incumbent firms and reshape marketplaces for customers. Policymakers face new problems as the landscape shifts and they must ensure that what will almost certainly be a very different environment is safe, resilient, and runs in a way that promotes economic progress while also protecting the community. Furthermore, to preserve a stable financial system, regulators cannot afford to lag too far behind commercial reality.

Another issue is the role of human factors in banking. Human capital can play a positive or a negative role through the whole banking system (Posnaya et al., 2017). Recent research in the financial sector has generated insight into how risk is managed and produced concrete findings on the nature and consequence of human factors problems in financial trading (e.g. errors, skill gaps, resources) (Leaver & Reader, 2016). Therefore, lack of skilled human capital can turn out to be a disadvantage for the implementation of complex digital innovations and the general digital change in banks (Diener & Špaček, 2021). To gain and sustain a competitive advantage in the banking industry, it is crucial to improve the competence of the bank staff.

### 2.2 Digital transformation

#### 2.2.1 Digital transformation framework

Since new technologies are appearing in such a high volume and at such a rapid pace, the term "digital transformation" (DT) has become popular among organizations in recent years. Digital transformation is a holistic concept that includes technologies, as well as organizational and strategic changes (Matt et al., 2015). Digital transformation strategies can be described along four essential dimensions: use of technologies, changes in value creation, structural changes, and financial aspects (Matt et al., 2015). The four transformational dimensions and their dependencies can be integrated into one joint Digital Transformation Framework.

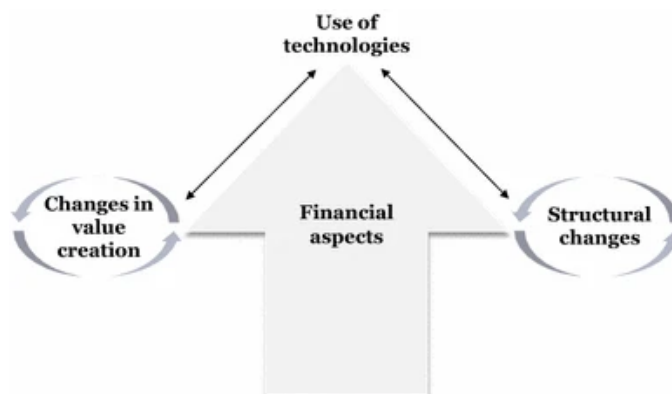


Figure 1 Digital transformation framework: balancing four transformational dimensions (Matt et al., 2015).

To ensure the successful rollout of a digital transformation strategy, all these four dimensions are considered as part of the framework, which will support firms in the assessment of their current abilities and the formulation of a digital transformation strategy.

DT has been a key strategy for improving an organization's operational performance (Hess et al., 2016; Matt et al., 2015). DT has the power to drive enterprises to more promising growth possibilities and increased profitability (Loonam et al., 2018). According to Westerman and Bonnet (2015), companies with strong digital strategies were 26 percent more lucrative than their industry peers, while traditional business earned 9 percent more income. Figure 1 shows a conceptual framework that aids in seeing and understanding the overall DT process (Vial, 2019).

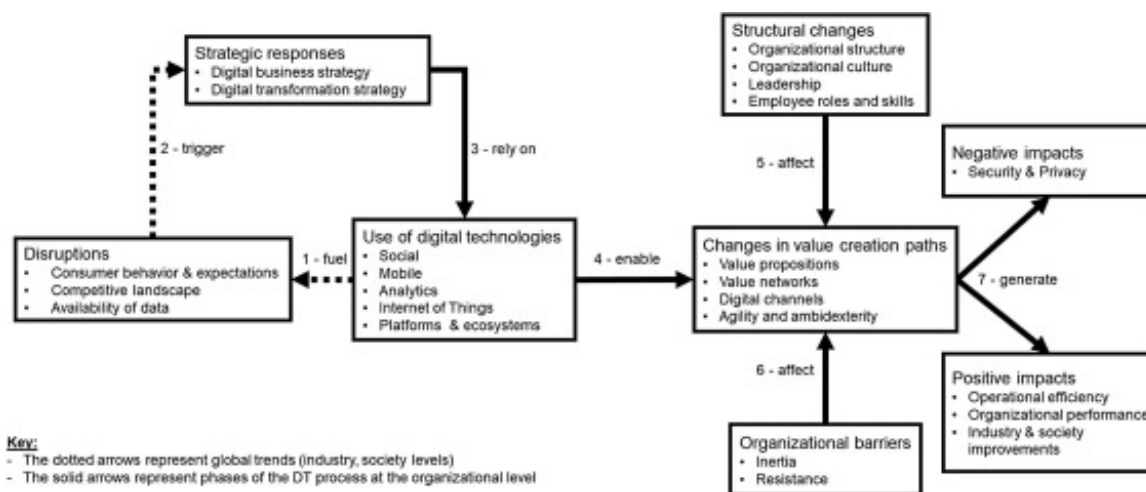


Figure 2 Building blocks of the DT process from Vial (2019).

DT has an impact on numerous parts of the organization, as indicated in Figure 1. Many aspects of DT, including employee roles and skills, necessitate structural modifications. The organization should prepare both employees and management with essential competencies required for the digital transformation strategy. Employee competencies are one of the most serious issues that organizations face when it comes to digital transformation. According to Kane (2019), technology evolves quicker than people can adapt to it. The actual problem is that these technologies are being assimilated at various speeds at different levels in the organization (Kane, 2019). As a result of technological disruptions, a company should comprehend the concept of technology adoption as it relates to the diffusion of innovation theory. In the diffusion of innovation model, Rogers (2003) classified innovation adopters into innovators, early adopters, early majority, late majority, and laggards based on varied rates and phases, as illustrated in figure 2. Adoption refers to the difference between the rate at which technology evolves and how people integrate those changes into their everyday work routine (Rogers, 2003). The model's output is a logistic function of cumulative adoption, in which innovation happens quickly as early and late majorities adopt. People embrace a new idea, behavior, or product as a result of this adoption.

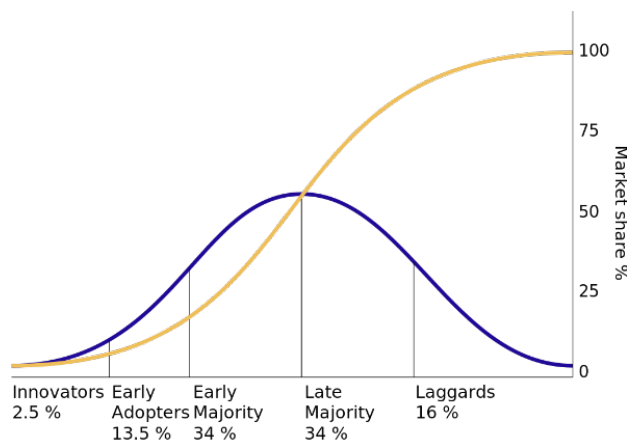


Figure 3 Diffusion of innovation model from Rogers (2003).



Because early adopters are the most eager to devote time and resources to test the innovation, they might be considered a strategic sector of the innovators (Valdani & Arbore, 2013). Because early adopters are not innovators, they can assist in motivating the public by reducing the amount of uncertainty surrounding the idea by implementing it (Momani et al., 2018). Early adopters can be thought of as people who can lead an organization's transformation since they are primed for change and eager to acquire and implement new ideas. Therefore, an appropriate training program is required during the digital adoption process. The training should help employees and managers learn new ideas and support digital adoption. (Varshney, 2020).

In conclusion, organizations use DT to alter the value creation paths they have previously relied upon to remain competitive. To that end, they must implement structural changes and overcome barriers that hinder their transformation effort (Vial, 2019).

### 2.2.2 Digital transformation in the banking sector

The financial sector, particularly the banking sector, is a fast-paced industry with fierce product and service rivalry. As a result, banks are working hard to expand, adapt, and restructure to avoid falling behind their competitors. The role of the financial industry in economic growth elevates the relevance of financial innovations, which can be defined as new entities that reduce risks, costs, or provide a product/service/instrument that better meets the demands of the parties involved than before (Frame & White, 2004). The digitalization of the banking industry uses a number of different technologies. One crucial drive to increase industry competition is the development of digital banking systems, which allow services to be provided through digital channels (Machkour & Abriane, 2020). As a result of the advancement of digital transformation, Fintech (Financial Technology) projects have emerged as one of the most important developments in the financial industry. Fintech (Financial Technology) projects have emerged as one of the most significant developments in the financial industry. Fintech uses digital, mobile, AI, and other technologies to improve financial and banking services' speed, cost, and efficiency. Many technologies also provide services in the following areas: Banking APIs, Artificial Intelligence, Personal Finance, Retail Investments, Corporate Investments, P2P (peer-to-peer) lending, Mass Finance, Asset Management, Money Transfer, Critical Data and Analysis, Financial Platforms, Regulatory Technologies, Blockchain and Cryptocurrency Technology, Robo Assistants, and Next Generation Banking (Machkour & Abriane, 2020). Despite the numerous benefits of digital transformation, it is recognized that it adds to a more complicated, fast changing, and disruptive business environment.

From a business perspective, the use of new technologies often implies changes in value creation in DT. With different forms of value creation, structural changes are often needed to provide an adequate basis for the new operations. Structural changes refer to variations in a firm's organizational setup including organizational structure, organizational culture, leadership, employee roles and skills. To accommodate the change, companies are establishing an additional position at top management level: the chief digital officer (CDO). CDOs are employed to make digital transformation a strategic priority in their companies (Matt et al., 2015). CDOs have a wider role and should have cross-department authority for digital initiatives and aim to transform the company as a whole. Matt et al. (2015) defines the scope of DT in the Financial Services industry as proceeding with great caution or "carefully innovative" due to the important concerns about security and confidentiality. As a result, the current focus of the digital transformation is on providing fundamental digital tools and devices and changing internal mindsets and skills. CDOs might thus provide their expertise about the industry's technological standpoint.

## 2.3 Skills and competencies

To further comprehend the concept and application of skills and competencies, a literature review was conducted. Rychen & Salganik (2003) describe competence as more than just knowledge or skills. It involves the ability to meet complex demands by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context. For example, the ability to communicate effectively is a competence that may draw on an individual's knowledge of the language, practical IT skills and attitudes towards those with whom he or she is communicating. Furthermore, Ananiadou et al. (2009) defines a skill as follows: the ability to perform tasks and solve problems, while a competence is the ability to apply learning outcomes adequately in a defined context (education, work, personal or professional development). In conclusion, we would like to describe competency and skills in the following manner:

*Competency* is the knowledge, behaviors, attitudes, and even skills that lead to the ability to perform a task successfully or efficiently. For example, a competency would be the ability to make business decisions.

*Skill* is a set of acquired, practical abilities that allow one to execute or perform something while utilizing knowledge. Based on the same example of business decisions, people need to keep certain skills to perform business decision tasks well: budgeting, market research, and competitive strategy.

However, the above definitions only define skills and competence concepts that are still not focused on digital. Therefore, we found that the Council of the European Union (2006) defines *digital competence* as the ability to use information and communication technology (ICT) with confidence, critical thinking, and creativity to achieve goals related to employment, employability, learning, leisure, inclusion, and participation in society. Digital competencies include using computers to find, analyze, save, create, display, and exchange information, as well as to interact and work together in networks through the Internet. To make digital competence easier to understand, Punie et al. (2014) describe that it is the set of knowledge, attitudes, and skills needed to be active in digital environments and get the most out of technology in everyday life.

In the next step, existing and established frameworks for skills and competencies were reviewed in this study to adapt the framework to apply it in the banking industry. This study contributes to developing a digital skills and competencies framework for organizations in the banking sector to use in identifying their specific digital transformation needs.

### 2.3.1 Digital competency framework (DCF)

To accomplish digital transformation, employees must have basic skills as well as industry-specific skills. The concept of digital literacy has provided Internet newbies users with the fundamental thinking abilities and core competencies they will need to survive in an interactive environment that is fundamentally different from passive media like television or print (Gilster, 1997).

Digital competence is regarded as one of the most important skills for a European citizen to face new challenges. The European Commission conducts research on digital competence and has established the “Digital Competence (DIGCOMP)” benchmark for EU citizens.

Based on the Communication of the Directorates General for Education and Culture (DG EAC), the European Parliament and Council of the European Union (2006) treated digital skills and competences from a lifelong learning perspective, designating Digital Competence as one of the 8 Key Competencies for European citizens.

Individuals should be able to use tools to produce, present, and understand complicated information, as well as access, search, and utilise internet-based services, to gain digital competency. Individuals should be able to use IST to help them think critically, creatively, and innovatively.

The European Commission set out in 2013 to find comprehensive conceptual descriptors of Digital Competence. The Joint Research Centre (JRC), the European Commission's scientific and knowledge service centre, created DIGCOMP as a scientific project with extensive stakeholder input, first on behalf of the DG EAC and Employment, Social Affairs and Inclusion (DG EMPL) (Ferrari, 2013).

JRC published DIGCOMP 2.0 in June 2016, upgrading the conceptual model of DIGCOMP and demonstrating its implementation at the European, national, and regional levels. DIGCOMP 2.1 is the most recent version. It expands the description of proficiency levels and offers application examples for each level. Its goal is to assist stakeholders with DIGCOMP's further implementation (Carretero et al., 2017).

There are five domains of digital competency in the DIGCOMP framework 2.1. The competencies are divided into four degrees of proficiency. The framework is laid down in a table format. It is a matrix with multiple dimensions that can be shown in a variety of ways. There are examples of knowledge, abilities, and attitudes in DIGCOMP 2.1, as well as instances of how competence can be applied to reach various goals.

There are five aspects of digital competence that can be summarized as follows:

1. Information: determining the relevance and purpose of digital information by locating, retrieving, storing, organizing, and analyzing it.

2. Communication: to communicate in digital environments, to exchange resources via online tools, to connect with others and cooperate via digital technologies, to interact with and participate in communities and networks, and to be conscious of cultural differences.

3. Content-creation: creating and editing new content (from word processing to photos and video); integrating and re-elaborating previous knowledge and content; producing creative expressions, media outputs, and programming; dealing with and applying intellectual property rights and licenses.

4. Safety: personal safety, data security, digital identity security, security measures, and safe and long-term use.

5. Problem-solving: identify digital needs and resources, make educated decisions on the most appropriate digital tools based on the purpose or need, solve conceptual problems using digital means, use technology creatively, address technical problems, and update own and others' competence.

Table 1 depicts an example of a competency area with a full explanation, whereas Table 2 depicts a description of each level in the DIGCOMP framework 2.1.

Competence area	Description	Level
1: Information and data literacy	1.1 Browsing, searching, filtering data, information, and digital content 1.2 Evaluating data, information, and digital content 1.3 Managing data, information, and digital content	1.Foundation 2.Intermediate 3.Advanced 4. Highly Specialized
2: Communication and collaboration	2.1 Interacting through digital technologies 2.2 Sharing thought digital technologies 2.3 Engaging in citizenship through digital technologies 2.4 Collaborating through digital technologies 2.5 Netiquette 2.6 Managing digital identity	
3: Digital content creation	3.1 Developing digital content. 3.2 Integrating and re-elaborating digital content 3.3 Copyright and licenses 3.4 Programming	
4: Safety	4.1 Protecting devices 4.2 Protecting personal data and privacy 4.3 Protecting health and well-being 4.4 Protecting the environment	
5: Problem solving	5.1 Solving technical problems 5.2 Identifying needs and technological responses 5.3 Creatively using digital technologies 5.4 Identifying digital competence gaps	

Table 1. Digital Competence framework 2.1 (Carretero et al., 2017)

Level	Description	Task
1: Foundation	1.1 At basic level and with guidance, I can: 1.2 At basic level and with autonomy and appropriate guidance where needed, I can:	<ul style="list-style-type: none"> <li>recognise simple appropriate digital technologies to share data, information, and digital content.</li> <li>identify simple referencing and attribution practices.</li> </ul>
2: Intermediate	2.1 On my own and solving straightforward problems, I can: 2.2 Independently, according to my own needs, and solving well-defined and non-routine problems, I can:	<ul style="list-style-type: none"> <li>explain where my digital competence needs to be improved or updated,</li> <li>indicate where to seek well-defined opportunities for self-developments and to keep up-to-date with the digital evolution</li> </ul>
3: Advanced	3.1 As well as guiding others, I can: 3.2 At advanced level, according to my own needs and those of others, and in complex contexts, I can:	<ul style="list-style-type: none"> <li>demonstrate where my own digital competence needs to be improved or updated,</li> <li>illustrate different ways to support others in the development of their digital competence.</li> <li>propose different opportunities found for self-development and to keep up-to-date with the digital evolution.</li> </ul>
4: Highly Specialized	4.1 At highly specialised level, I can: 4.2 At the most advanced and specialised level, I can:	<ul style="list-style-type: none"> <li>create solutions to complex problems with limited definition that are related to improving digital competence, and to find opportunities for self-development and to keep up-to-date with new developments.</li> <li>integrate my knowledge to contribute to professional practice and knowledge and to guide others in identifying digital competence gaps.</li> </ul>

Table 2. Proficiency levels (Carretero et al., 2017)

The digital competency framework may vary depending on the sort of employment. We will look at the capabilities of a group working on digital transformation in the banking industry. As a result, we will identify specific skill demands that drives an organization in the banking industry's digital transformation.

### 2.3.2 Technical competency framework

Apart from digital skills, technical skills are also considered an important need to push digital transformation in the organization. For example, the banking industry needs employees who have data science skills to deal with big data, and who should be able to make smart decisions for the business. We found research studies on digital skills focusing on the skills required for digital banking as summarized in Table 3.

Authors	Methodology	Result	Targeted skills
Pinzone et al.(2017)	literature review, focus groups and in-depth interviews	Sets of technical skills for Industry 4.0	<ul style="list-style-type: none"> <li>- Design and implementation of Big Data architectures and software platforms</li> <li>- Design of data and workflow models</li> <li>- Big Data analytics</li> <li>- Infographics for intuitive and engaging interpretation of data analytics</li> <li>- User experience design</li> </ul>
Mikalef and Krogstie (2019)	literature review, focus groups and in-depth interviews	Technical Skills (Skills ranked in order of importance)	<ul style="list-style-type: none"> <li>- Data science skills (10 Skills ranked in order of importance)</li> <li>Exploratory data analysis</li> <li>Data visualization</li> <li>Machine learning techniques</li> <li>Data mining</li> <li>Data modeling</li> <li>Data cleansing/preparation</li> <li>Research methods and empirical validation</li> <li>Data processing</li> <li>Statistical analysis</li> <li>Data integration</li> </ul>
		Soft Skills (Skills ranked in order of importance)	<ul style="list-style-type: none"> <li>- Identifying situations requiring participative group problem solving and to utilize the proper degree and type of participation</li> <li>- Cross-disciplinary collaboration</li> <li>- Recognizing obstacles of collaborative group problem solving and implement appropriate corrective actions</li> <li>- Plan and execute work in a collective environment</li> <li>- Communication</li> <li>- Presentation skills to different disciplines</li> <li>- Work with international partners and co-workers</li> <li>- Ability to present ideas in a clear and concise manner</li> <li>- Writing clear, concise, and effective memos, reports, and documentation</li> <li>- Listen non-evaluatively and to appropriately use active listening techniques</li> </ul>
Van Laar et al. (2018)	literature review, interviews, pilot survey, full survey	21st-century digital skills	<ul style="list-style-type: none"> <li>- Technical skills</li> <li>- Information skills</li> <li>- Communication skills</li> <li>- Collaboration skills</li> <li>- Critical-thinking skills</li> <li>- Creative skills</li> <li>- Problem-solving skills</li> </ul>

Table 3. The authors, methodology and results for digital skills theory background

Table 3 shows digital skills that we can use in our research to identify the required skills for the banking industry. There are some similarities in competencies when comparing DIGCOMP with the results from the literature review. DIGCOMP, for example, includes information and data literacy skills. Mikalef and Krogstie (2019) state that data skills are also important, and those skills should be at a level higher than the DIGCOMP model. To create a more comprehensive competency framework, it is necessary to identify the competencies that are absent from the DIGCOMP framework.

## 2.4 Digital competency framework for banking industry

Digital transformations will often accompany shifting skill sets required for the actual change and ongoing operations. The current employees might not have the technical aptitude to

change and have a less digitally knowledgeable mindset (Matt et al., 2015). This thesis could assist businesses by directing the evaluation of their employees' digital capabilities and advising on the design of training programs for both current workers and new hires. This research found that a DIGCOMP framework can be used to observe the required level of digital skills. However, no explicit technical skill frameworks supporting the organization's digital transformation could be identified. Therefore, we need to develop a framework for digital competencies that includes the technical and digital skills required to promote digital transformation in the banking industry.

### 3. Research Methodology

The research approach used for this study is described in this chapter. This thesis aims to investigate the relationship between human capital and digital transformation, as well as the banking industry's digital competency framework. To achieve this, we have performed a systematic literature review based on the original guidelines (Kitchenham, 2007). Based on the findings of our systematic literature review, we can create a preliminary definition of the digital competencies framework required to support digital transformation. To increase confidence about the framework's applicability and relative importance, we surveyed experts in the banking industry. The survey results improved the banking industry's digital competencies framework.

The overview of research process is illustrated below.

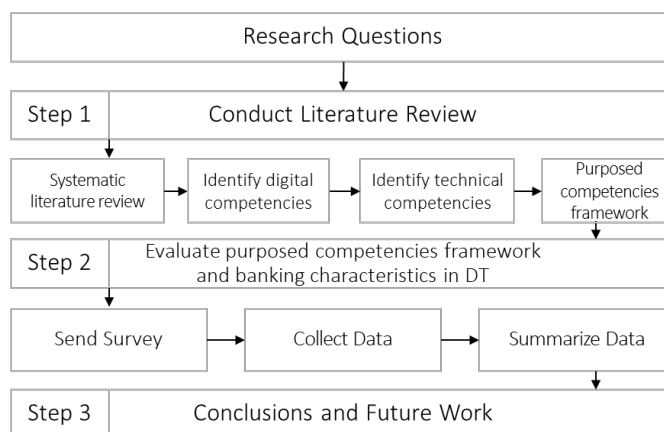


Figure 4. The overview of research process.

#### 3.1 Research objectives

- To explore the current state-of-the-art of competencies frameworks for digital transformation.
- To develop a competencies framework that facilitates structural change within the banking industry.
- To identify the characteristic of competencies that support the digital transformation process in banking industry.

#### 3.2 Research question

**(RQ<sub>1</sub>)** What do (Chief) Digital Officers in banking industry perceive as the most important digital and technical skills for the banking industry?

**Explanation:** This RQ aims to identify the digital competencies from the perspective of the CDO in the banking industry. In addition to digital skills, we would like to observe technical skills that are needed to support DT. The theoretical background demonstrates a connection between digital competencies and digital transformation. If employees have a digital skill set, they can provide better support DT activities and be ready for the change that may be caused by a DT. Based on the above explanation, we can develop sub-RQs as follow.

- (Sub RQ 1.1) What digital skills drive DT in the banking industry?
- (Sub RQ 1.2) What level is necessary for these digital skills?
- (Sub RQ 1.3) What technical skills drive DT in the banking industry?
- (Sub RQ 1.4) What level is necessary for these technical skills?

Once we have identified these skills, we can develop a proper digital competencies framework for the banking industry. However, we would like to investigate how the framework can support structural change in RQ2.

(RQ2) What is the most critical business unit that should use the digital competencies framework to support structural change?

**Explanation:** This RQ aims to locate the business unit in the banking industry that needs to prepare for technological change (e.g., Fintech, Cryptocurrency). The result from this RQ could support firms by assessing their existing employee capabilities and providing guidance on the design of training procedures for current employees and new hires.

(RQ3) What is the most important structural change for a successful digital transformation?

**Explanation:** This RQ explores the most important structural change that affects a successful transformation. Structural changes involve four main parts: organizational structure, organizational culture, leadership, employee roles and skill. We expect to find the importance of each structural part that has a high impact on digital transformation in the organization from a CDO perspective.

### 3.3 Research methodology

Table 4 shows the various research methods used to answer the research questions. Each research method is described in the paragraphs below.

RESEARCH QUESTION	RESEARCH METHOD
RQ1	Literature review, Survey
RQ2	Literature review, Survey
RQ3	Literature review, Survey

Table 4. Summary of research methods

#### 3.3.1 Literature review

The three main steps of a successful review are preparing, conducting, and reporting the review (Kitchenham, 2007; Xiao & Watson, 2019).

Researchers assess the need for a review, define research questions, and develop a review process during the planning stage. The researchers perform the review by identifying and selecting main studies and extracting, analyzing, and synthesizing data. Then the researchers write the review report to share their findings from the literature review. Despite differences in approach, all forms of literature reviews may be conducted using the similar eight procedures: (1) formulate the research problem; (2) develop and validate the review process; (3) search the literature; (4) screen for inclusion; (5) assess quality; (6) extract data; (7) analyze and synthesize data; and (8) report the findings (Figure 5).

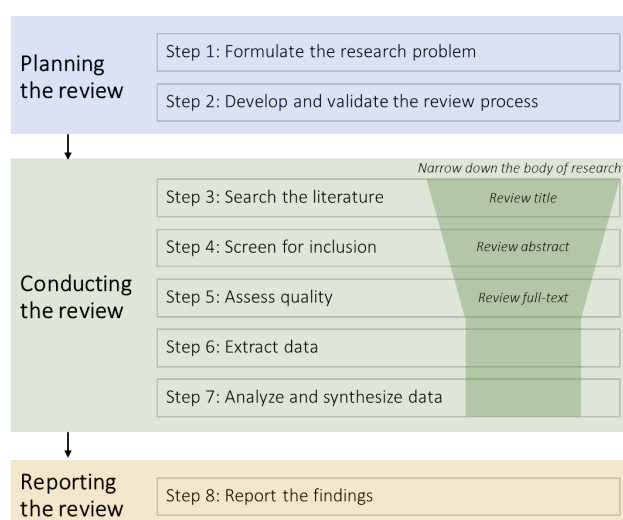


Figure 5 Protocol of systematic literature review (Xiao & Watson, 2019).

To minimize potential bias, both quantitative and qualitative analyses were used in this study. The focus of a qualitative approach is the content of the literature. A quantitative approach is

based on a bibliometric review using "publish or perish". It uses the Scopus database to present the following statistics: Total number of papers, Total number of quotes, Average number of citations per paper, Average number of citations per author, Average number of papers per author, Average number of citations per year. Citations are a common way of judging the most influential work in different fields. The most cited articles often provide new insights, open a new avenue of research, or provide a significant summary of the state-of-the-art in an area (Wohlin, 2007).

(1) Planning stage: A systematic review approach is adopted to achieve this thesis's objectives. As the first step, we specified a problem and reformulated a goal into a clear, structured, and unambiguous question before starting as the protocol indicated. Particularly interesting topics include the framework for digital skills, digital transformation, and the effects on the financial sector.

(2) Conducting stage: The search method used in our thesis is called a Boolean search (AND/OR). We combine different terms using the OR and AND logic operators. The literature search has focused on scientific articles published in English between 2000 and 2022. A set of relevant keywords were selected through previous articles and papers in the same field or with similar scope, and the final terms used can be seen in table x. The different compositions of terms were searched for in keywords, abstracts, and titles. The search string used is: [("Digital transformation" OR "Digitalization" OR "Industry 4.0" OR "Chief Digital Officer") AND ("Competency" OR "Digital competency" OR "Digital skill" OR "Technical skill" OR "Framework" OR "Competency framework") AND ("Bank" OR "Banking industry" OR "Central bank" OR "Retail bank" OR "Commercial bank" OR "Fintech")]

DT Context "OR"	AND	Competency Context "OR"	AND	Industry Context "OR"
Digital transformation Digitalization Industry 4.0 Chief Digital Officer		Competency Digital competency Digital skill Technical skill Competency framework		Bank Banking industry Central bank Retail bank Fintech

Table 5. Search terms and keywords

The initial selection from the database was not limited and included papers from other research fields (including other sectors, not only banking and financial sectors). Because this thesis aims to provide an overview of the research fields that concentrate on issues regarding the framework for digital competencies and contexts for digital transformation and explore their impact on the banking industry, we narrowed the search results based on quality measures. We established the selection criteria determining which studies are included and excluded. The abstracts, and titles were first manually reviewed for content.

Inclusion criteria:

- The review should be related to DT and competency and must relate to the research question.
- The publication must have a clear methodology that outlines the steps and approaches to its research data and findings.
- The research must come from trusted resources and journals (i.e., Scopus and ScienceDirect).
- The paper's publication year must be between 2000 and 2022.
- The paper is written in English.

Exclusion criteria:

- Studies are presenting non-peer reviewed material.
- Studies not presented in English.
- Studies not accessible in full-text.
- Books and gray literature.

(3) Reporting stage: For literature reviews to be reliable and independently repeatable, the process of systematic literature review must be reported in sufficient detail (Okoli & Schabram, 2012). This will allow other researchers to follow the same steps described and arrive at the same results. Once the data extraction process is complete, the reviewer will organize the data according to their chosen review. The research finding section will show the number and the reason for included and excluded articles in each stage, as shown in figure 6.



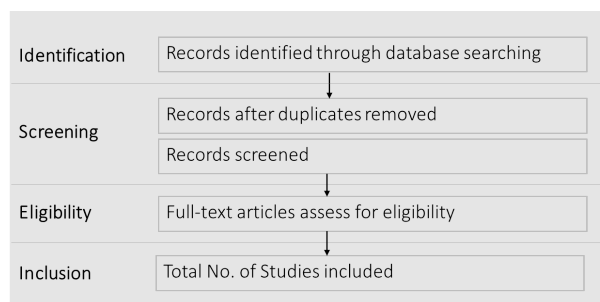


Figure 6 Example of literature search and evaluation for inclusion.

### 3.3.2 Survey

We conduct a survey based on the result of the ideal skill and competency framework from the literature review. We use purposive sampling to select experts who have worked in the banking industry and have experience with digital transformation activities to answer the research questions. A purposive sample, referred to as a judgmental or expert sample, is a nonprobability sample. The main objective of a purposive sample is to produce a sample that can be logically assumed to be representative of the population (Robinson, 2014). The target group is a CDO or person in the group of digital officers related to DT in the organization. The literature review results suggest that this group is involved in the organization's digital transformation activities. The expected number of respondents in total is around 30. We want to rely on CDO/digital office advice to determine the suitable competencies and skill sets for the banking industry. Participants are asked to respond to questions about each competency area's description using a five-point Likert scale. Youn et al. (2017) suggests that a five-point scale allows respondents to express their true neutral or indifferent opinion; respondents are not forced to agree or disagree. This type of survey is suitable for respondents who are familiar with the topic and should be allowed to express a neutral opinion. A five-point Likert scale also has the advantage that it can be used for statistical analysis purposes.

Part	Question	Answer	Type of question
Part 1	Questions about digital skills	RQ1	- Rating scale question - Open ended question
Part 2	Questions about technical skills	RQ1	
Part 3	Questions about the characteristics of digital transformations in banking industry	RQ2, RQ3	
Part 4	Contact information	-	- Open ended question

Table 6. Survey structure

The complete survey is provided in an appendix. We use Qualtrics to present the survey to participants.

## 4. Findings

### 4.1 Search strategy

The Scopus database, a platform that combines a comprehensive, expertly curated abstract and citation database with enriched data and linked scholarly literature across various fields, was the main resource used for early keyword searches. In the subsequent screening phases (Tab. I), full texts and abstracts were extracted using additional electronic databases. For example, some papers cannot be downloaded directly from Scopus, so Scopus offers a link to the official source, such as ScienceDirect, where the paper can be downloaded.

The screening process applied consists of four phases (Figure 6). All results from the first three search and screening phases were saved and retained in the Scopus Library. The final included studies were documented in a separate overview reflecting the characteristics of included studies and reports on the digital competencies framework in the banking industry, along with the results from screening the reference lists of included studies. The complete search strategy step is described in section 3.3.1.

#### I: Identification

Data source	Search process documentation
Scopus	<ul style="list-style-type: none"> <li>• Date of search: 15 - 31 July 2022</li> <li>• Preliminary search by using defined keywords (Tab. II)</li> <li>• First hit results sorted by relevance based on Scopus algorithms (i.e., keyword frequency and keywords in the title).</li> <li>• All screening and search results are saved and retained in Scopus Library</li> </ul>
ResearchGate, IEEE, Semantic Scholar, ScienceDirect, Emerald	<ul style="list-style-type: none"> <li>• Retrieve and review abstracts in accordance with inclusion criteria (Primary screening).</li> <li>• Retrieve and read the full text in accordance with inclusion criteria (Secondary screening).</li> <li>• Documentation of the completed set of studies</li> </ul>
Reference lists	<ul style="list-style-type: none"> <li>• Reviewing reference lists of previously included papers (backwards snowballing)</li> <li>• Locate and retrieve identified papers (Google)</li> <li>• Evaluate selected papers using inclusion criteria (section 3.3.1).</li> <li>• Documentation of the final set of included studies</li> </ul>

#### II: Search queries used in order (Primary Screening)

Search Query	Research String	Description	Records
1	TITLE-ABS-KEY("digital transformation" or "Digitalization" or "Industry 4.0" or "Chief Digital Officer") AND TITLE-ABS-KEY("competency" or "skill" or "Framework" or "Competency framework" or "Technical skill" or "Digital skill" or "Digital competency") AND TITLE-ABS-KEY("bank" or "Fintech" or "Banking industry" or "Retail bank" or "Central bank" or "Commercial bank") AND PUBYEAR > 2000	First Query	156
2	TITLE-ABS-KEY("digital transformation" or "Digitalization" or "Industry 4.0" or "Chief Digital Officer") AND TITLE-ABS-KEY("competency" or "skill" or "Framework" or "Competency framework" or "Technical skill" or "Digital skill" or "Digital competency") AND TITLE-ABS-KEY("bank" or "Fintech" or "Banking industry" or "Retail bank" or "Central bank" or "Commercial bank") AND PUBYEAR > 2000 AND ( LIMIT-TO ( DOCTYPE,"ar" ) OR LIMIT-TO ( DOCTYPE,"cp" ) ) AND ( EXCLUDE ( SRCTYPE,"k" ) )	Excluded records that are not journals or conference papers.	127
3	TITLE-ABS-KEY("digital transformation" or "Digitalization" or "Industry 4.0" or "Chief Digital Officer") AND TITLE-ABS-KEY("competency" or "skill" or "Framework" or "Competency framework" or "Technical skill" or "Digital skill" or "Digital competency") AND TITLE-ABS-KEY("bank" or "Fintech" or "Banking industry" or "Retail bank" or "Central bank" or "Commercial bank") AND PUBYEAR > 2000 AND ( EXCLUDE ( SRCTYPE,"k" ) ) AND ( LIMIT-TO ( DOCTYPE,"ar" ) OR LIMIT-TO ( DOCTYPE,"cp" ) ) AND ( LIMIT-TO ( LANGUAGE,"English" ) )	Limit the record to English only.	117
4	TITLE-ABS-KEY("digital transformation" or "Digitalization" or "Industry 4.0" or "Chief Digital Officer") AND TITLE-ABS-KEY("competency" or "skill" or "Framework" or "Competency	Exclude industries	90

<pre>framework" or "Technical skill" or "Digital skill" or "Digital competency") AND TITLE-ABS-KEY("bank" or "Fintech" or "Banking industry" or "Retail bank" or "Central bank" or "Commercial bank") AND PUBYEAR &gt; 2000 AND ( EXCLUDE ( SRCTYPE,"k" ) ) AND ( LIMIT- TO ( DOCTYPE,"ar" ) OR LIMIT-TO ( DOCTYPE,"cp" ) ) AND ( LIMIT-TO ( LANGUAGE,"English" ) ) AND ( EXCLUDE ( SUBJAREA,"ENER" ) OR EXCLUDE ( SUBJAREA,"ENVI" ) OR EXCLUDE ( SUBJAREA,"MEDI" ) OR EXCLUDE ( SUBJAREA,"MATH" ) OR EXCLUDE ( SUBJAREA,"AGRI" ) OR EXCLUDE ( SUBJAREA,"BIOC" ) OR EXCLUDE ( SUBJAREA,"EART" ) OR EXCLUDE ( SUBJAREA,"IMMU" ) OR EXCLUDE ( SUBJAREA,"PHYS" ) OR EXCLUDE ( SUBJAREA,"HEAL" ) OR EXCLUDE ( SUBJAREA,"NURS" ) OR EXCLUDE ( SUBJAREA,"PHAR" ) )</pre>	that are irrelevant.
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This search strategy returned 156 first results after the initial search. Section 3.3.1 shows the criteria for deciding which articles would be included in the final list. Then, the results were assessed by determining whether all employed keywords were identified in the displayed title or text of the search result. After the initial screening process, 90 studies remained. In the second step of screening, the abstracts and keywords of the remaining papers were looked at to see how well they fit with the idea of digital competencies and digital transformation in the banking sector. Full texts for the remaining 33 papers were obtained, thoroughly read, and checked again for matching inclusion requirements. In conclusion, 14 studies were found to be eligible. A secondary search was conducted to improve the systematic literature review's reliability and prevent missing important material discussing digital transformation and digital skills concepts. In addition, the reference lists of the 14 publications included in the study were searched, revealing ten further publications describing digital competencies in the banking sector. Finally, 24 studies were suitable for data extraction and had data that could be extracted (Tab. I). Figure 8 depicts the entire screening procedure and the results of the search strategy.

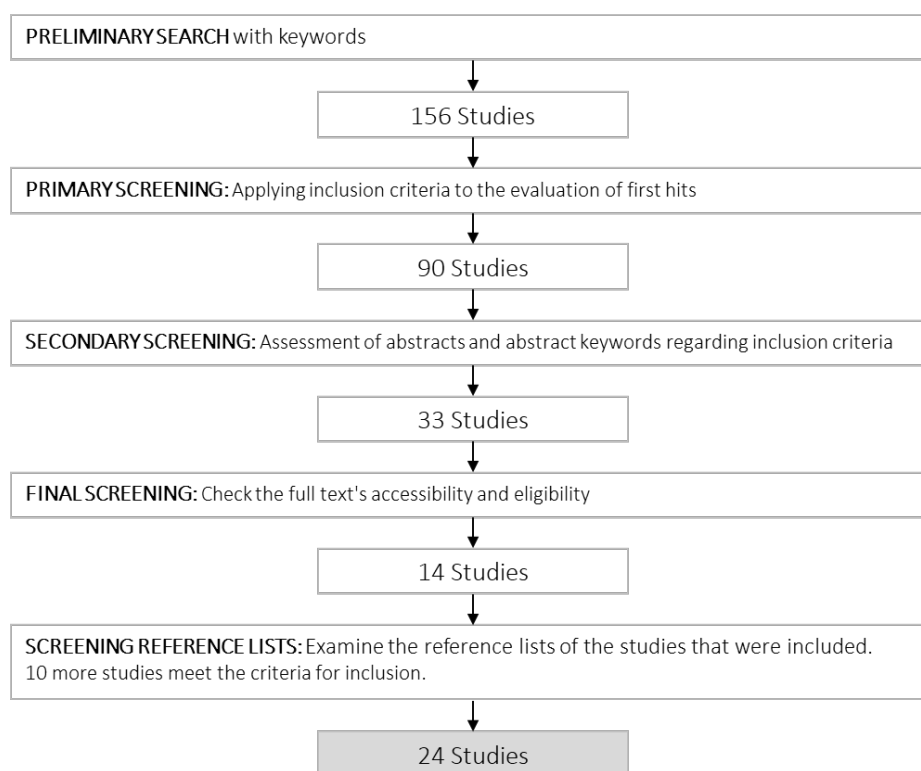


Figure 7 Overview of search process

## 4.2 Data extraction

All studies from the primary screening were used in the data extraction section to gain insight into the studies about digital transformation and digital competencies over time.

## I: Analysis of Keyword Networks

An analysis of the keywords was executed to identify new trends in the field network. We identify trends after primary screening because we have adequate data to see trends for the keyword that we selected. For further investigation, “. RIS” and “. CVS” files were exported from the Scopus database for further analysis. The identified keywords were investigated using the tool VOS viewer to detect their interconnections (van Eck & Waltman, 2010). We study how the topic appears in publications over the years and observe the development of the topic and derive new perspectives. The result can be seen in Figure 8.

The system of linked keywords is represented as a network. The colors point to the clusters in which most of the group's keywords occur together. The size of the node shows the connection degree of the keywords. The 14 keywords included 3 clusters. As can be seen, the most occurring keyword is "fintech." This keyword is also the most related keyword in its cluster, along with the terms "digital transformation," "banking", "financial innovation", "financial service", and "blockchain." The second largest node is the keyword "digitalization." The third most occurring keyword is "industry 4.0". The first cluster shows that the research focus of fintech is related to digital transformation, banking, and financial services (red cluster). The second cluster reveals that customer value and service quality are related to aspects of digitalization in banking (blue cluster). The third cluster focuses on the digital economy, technologies, and digitalization (green cluster).

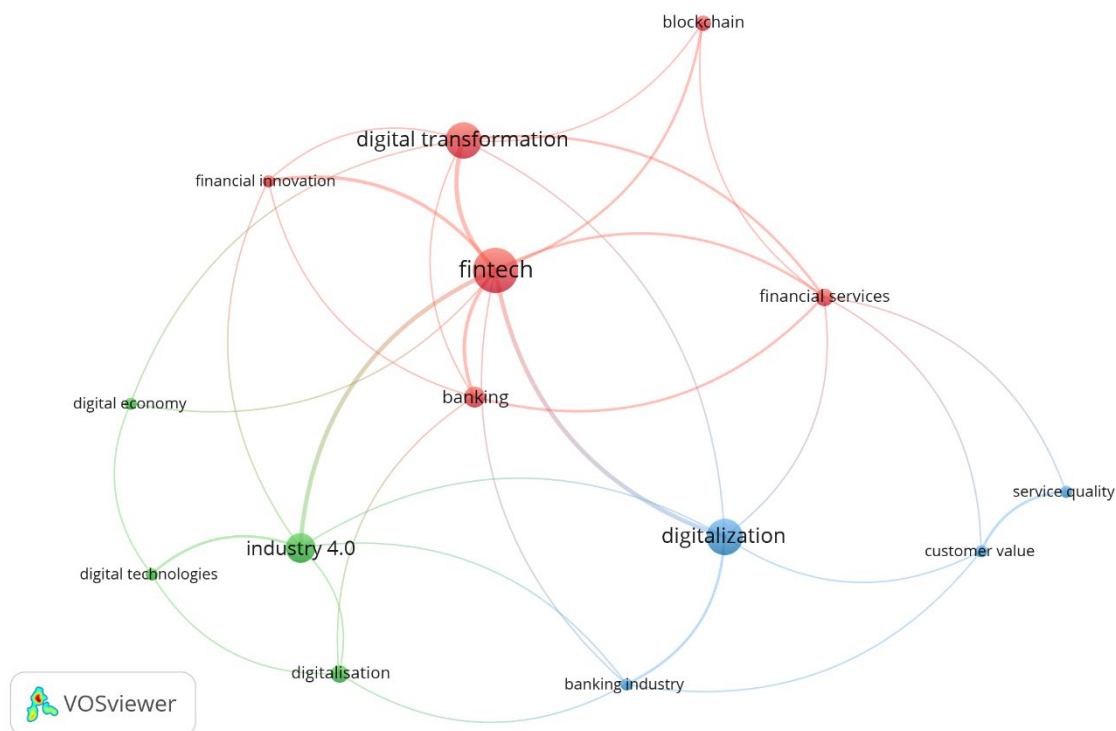


Figure 8 VOS viewer network analysis of keywords (source: created by authors)

According to the keyword analysis, the banking industry is associated with fintech and digital transformation. Therefore, we will discuss fintech-related skills and competencies in the qualitative analysis section.

## II: The occurrence of articles by year of publication

From 2015 through 2022, many articles on digital transformation were published each year. In 2018, the number of papers published on digital transformation and competencies increased, with more than three publications released yearly. The linear trendline is also still going up, which shows that digital transformation in banking is becoming more critical. Conference proceedings account for 29% of all papers and journal articles (Fig. 9). The graph (Fig. 10) depicting the articles published over the years shows the field's emergence. According to Figure 10, the largest number of published papers is

6 in 2021, while the lowest is 1 in 2015–2017. In 2022, 4 articles were published, and since this year has not ended yet, the number of papers that will be out by the end of the year is likely to go up.

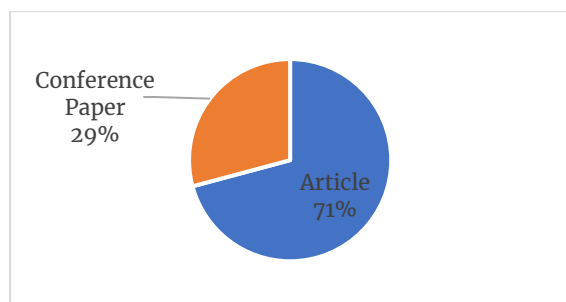


Figure 9 Documents by type (n=24)

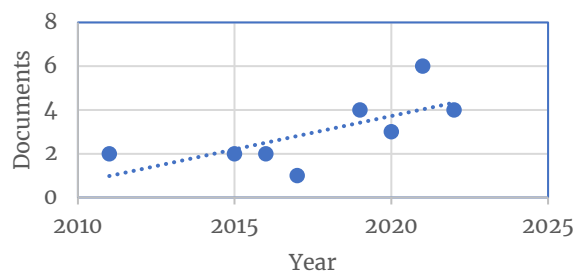


Figure 10 Documents by year (n=24)

### III: Distribution of papers by country of publication

Furthermore, we list the countries with the largest number of contributions to the topic (Fig. 11 and 12). The United States has contributed the most papers (17%). The United Kingdom, Russia, and Germany are second with 8% each. These countries are heavily affected by digital banking and fintech growth. They also have a robust educational and research system and a supportive regulatory environment for fintech. Even if the interests in digital transformation and digital competencies are less evident in the United Kingdom, Russia, and Germany, they have a strong infrastructure.

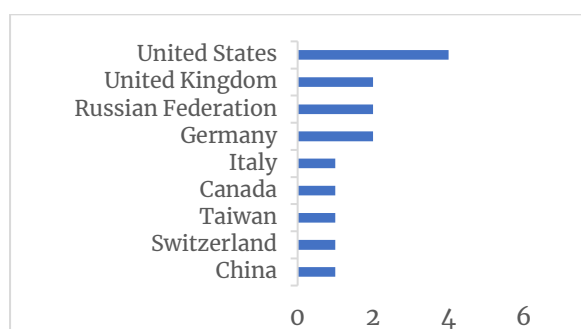


Figure 11 Documents by country (n=24)

Countries	Contribution (%)
United States	17%
United Kingdom	8%
Russian	8%
Germany	8%

Figure 12 Country classification (n=24)

### III: Top five authors on the field by citation number

We also extracted the top five authors in the field based on their citation counts (Table 7). Specifically, the "Publish or Perish" software displays Scopus database results in order of overall influence and impact. It considers a variety of metrics, including the total number of citations. The most influential papers concentrated on digital transformation strategy. They attempted to provide practitioners with guidelines for dealing with the challenge of digital transformation and how to improve employee digital competencies in the banking industry.

Authors	Publication	Cites	Cites/year
Matt et al. (2015)	Business and information systems Engineering	767	109.57
Hess et al. (2016)	MIS Quarterly Executive	520	86.67
Chanas et al. (2019)	Strategic Information Systems	152	50.67
Liu et al. (2011)	Management Decision	101	9.18
Zavolokina et al. (2016)	International Conference on Information Systems	52	8.67

Table 7. Top 5 authors on the field

## 4.3 Data synthesis and Qualitative analysis

Based on the keyword network analysis in section 4.2, we discovered a link between three important keywords: Fintech, digital transformation, and banking. Based on these connections, we can see that "Fintech" is a keyword always associated with digital transformation, as we discovered earlier in the literature review. In this part, we will provide summaries of how each term is related to the other terms

and extract information that can provide an answer to each research question. First, we focus on characteristics of digital transformation to find information to answer RQ2 and RQ3. Second, we focus on finding the skills related to Fintech and possible skills that should be included in a DCF for the banking industry to answer RQ1.

#### 4.3.1 Digital transformation in the banking industry

To understand more about the characteristics of digital transformation in the banking business, we look for the difference between traditional and digital banking. We found that traditional banking faces an existential threat, such as adapting to new technology or losing customers to faster and more agile FinTech competitors. The bank's major business segments in the past have been retail banking, wholesale banking, and wealth management. Furthermore, some larger banks have business lines other than the typical three, such as treasury services or insurance. In order to understand how technology disrupts traditional banks, Temelkov (2020) shares differences between traditional and digital banks based on each model's focus, distribution channels, and utilization of technology, see Table 8.

<b>Traditional bank model</b> <b>Product-centric</b>	<b>Digital Bank model</b> <b>Platform-centric</b>
<b>Branches</b> High verticalization of products No strong communities around the brand/product Services are only offered through the branch network High customer acquisition cost	<b>Marketplace community</b> High community engagement with the product Horizontalization of products with best-in-class apps Open banking through APIS Mobile only (low customer acquisition cost)
<b>Technology infrastructure</b> Outsourced technology Rigid legacy platforms of 1970s–1980s Non-modular architecture with limited scalability Hard to integrate data from 3rd party providers	<b>Technology infrastructure</b> Open architecture technology stack Ability to 'plug and play' best-in-class tools/services Low dependency on 3rd party providers Open ecosystem allowing access to external developers
<b>Product-Centric business</b> Banking data divided into silos Mix of paper-based and online data Difficulties in reconciling, monitoring data Hard to integrate data from 3rd party providers	<b>Data-Driven business</b> Real-time data integration and management Current accounts generate key data for 3rd parties Data powers business model through 3rd party affiliation fees
<b>Organizational design</b> Product-centric organizational design Products and verticals drive organization structure	<b>Organizational design</b> Customer-centric organizational design Customer needs drive data architecture

Table 8. Main differences between traditional bank model and digital bank model (Temelkov, 2020)

Traditional banking models incur considerable expenses due to maintaining an extensive network of branches, as seen by the features presented in the preceding table. On the other hand, the digital bank model is an online banking model that eliminates the need for costly maintenance and labor expenditures. Furthermore, traditional banking models have higher customer acquisition costs than digital banking models. Another distinction is the system enabled by each model. While digital banks use cutting-edge technology, traditional banks may use obsolete technology or even outsource their technology. Other significant differences include how each model and organizational architecture uses data. Digital banks position themselves as customer-centric banks because they use data to better understand client desires and modify or create new goods and services to meet those needs. On the other hand, traditional banks lack the ability to examine their data. They are product-driven to achieve economies of scale and fully leverage their expensive infrastructure and capacities. Aside from the differences indicated above, there are more that should be noted between traditional banking models and the other two broad models. For example, traditional banks' credit scoring models are gradually becoming obsolete due to changes in certain carefully stated factors. In addition, the development of new data collection and processing tools, among other things, allows for a comprehensive understanding of client behavior. As a result, technologically advanced banks, such as digital banks, may take advantage of this technology and tailor their offerings to the demands of their consumers. Based on the differences in bank business models, digital banks clearly give considerable benefits over traditional bank business models. This is also one of the reasons why the bank is becoming digital: old business models cannot compete with new ones.

The banking industry has been significantly disrupted by the fintech industry, which uses technological developments to provide financial services that traditional banks previously provided. The interesting aspect is that emerging technology enables institutions to provide financial services

with greater efficiency and flexibility. Y. Wang et al. (2021) summarize the fintech into 9 dimensions, see Table 9. This table gives an overview of fintech in each dimension.

<b>Payment dimension</b>	Online payment Mobile payment Third party payment QR code payment Network payment
<b>Resource allocation dimension</b>	Internet loan Internet lending Network investment Online lending P2P loan
<b>Risk management dimension</b>	Internet insurance Internet financing Network financing Online financing Network insurance
<b>Network channel dimension</b>	Mobile banking Online Banking Service Internet Banking E-bank
<b>Big data dimension</b>	Big data Data mining Big data analysis Big data application
<b>AI dimension</b>	Artificial intelligence Intelligent robot Natural language processing Machine learning
<b>Distributed technology dimension</b>	Cloud computing Cloud platform Digital currency Bitcoin Blockchain Technology
<b>Internet technology dimension</b>	Internet of things Vehicle interconnection Mobile Internet 5G Mobile communication
<b>Security technology dimension</b>	Biometrics Fingerprint identification Iris Recognition Face recognition Voice recognition

Table 9. Fintech dimensions (Y. Wang et al., 2021)

Even though FinTech offers so many chances to provide new services that traditional financial intermediaries do not, there are still numerous issues to investigate and overcome. The FinTech challenge in Table 10 that derive from Suryono et al. (2020) assists in understanding how FinTech transforms the business model of the banking sector, as well as the digital and technological capabilities necessary to support this transition.

Challenges	Issues
Framework and Model	Developing a practical and systematic framework for fintech (Haddad & Hornuf, 2019)
Financial literacy	Financial literacy should be technology oriented (Hatammimi & Krisnawati, 2018)
Personal data protection	The use of big data and new technologies raises significant data protection issues (Anugerah & Indriani, 2018)
Collaboration	Banks need to consider fintech and strategic partnerships (Mehrotra, 2019)
Security	Developing a trust-based financial system, including comprehensive and measurable security mechanisms (Kim & Hong, 2016)
Infrastructure	Improve and develop cost efficient infrastructure (cloud computing) (Kumari & Kumar Sharma, 2017)
Payment systems	Standard definitions of mobile payments (including mobile banking, mobile money, mobile wallets, mobile commerce, and mobile finance) are required (Iman, 2018)

Blockchain	The blockchain concept (including blockchain structures and payment transactions on the blockchain) (Milian et al., 2019)
Technology	<ul style="list-style-type: none"> <li>- Rapid developments in artificial intelligence (ai), machine learning, and blockchain (Cao et al., 2021)</li> <li>- Development of an optimization algorithm model and asset allocation to predict trends (Brownsword, 2019)</li> <li>- Develop integrated knowledge-based and generative models for the ai conversational robot advisor (Day et al., 2018)</li> <li>- Need to ensure the quality of the software system at fintech (Jin et al., 2019)</li> <li>- Technology integration (Lee &amp; Shin, 2018)</li> <li>- Alternative credit scoring based on non-traditional data (Leong et al., 2017)</li> <li>- Open Application Programming Interfaces (APIs) (Sybirianska et al., 2018)</li> <li>- Digital identification and biometrics (Sybirianska et al., 2018)</li> <li>- The design of big data-based lending markets (Tao et al., 2017)</li> <li>- Information collection for fraud detection (H. Wang et al., 2019)</li> </ul>
Robo-Advisor	Banks and other companies in the financial industry must design Robo-advisors (Belanche et al., 2019)

Table 10. FinTech challenges based on Suryono et al. (2020)

We can see from the above tab that several technologies are connected in FinTech (Big Data, Blockchain, AI). In the next section, we will learn more about this technology to determine what digital and technical skills are needed to support DT in the banking industry and to answer the first research question.

#### 4.3.2 Digital and technical skills for the banking industry

Identifying the digital capabilities that support DT in the banking industry is a relatively new concept. According to Moro et al. (2015), employees are one of the main groups that aid banks in transformation. Moro et al. (2015) further emphasize that, to assist DT, the banking industry should focus on developing digital skills and enhancing staff's fintech technical expertise. As a result, we want to see which skills get the most attention in the banking and FinTech industries. Therefore, table 11 include this industry's digital and technical skill descriptions.

##### Overview of digital skills

Scientific sources	Description
Mazurchenko et al. (2022)	<ul style="list-style-type: none"> <li>-Problem solving in a digital environment.</li> <li>-Advanced analytical and mathematical skills</li> <li>-Database management skill</li> <li>-Software development skill</li> </ul>
Santoso et al. (2020)	<ul style="list-style-type: none"> <li>-Basic digital skills</li> <li>-Technological skill competency requires various skills, such as modeling, big data analysis, statistics, and programming.</li> </ul>
Goumeh & Barforoush (2021)	Digital skills, expertise, experience, and interest; personnel dedicated to I4.0, ICT competencies of employees, data empowered decision making, openness to new technologies, employees have access to digital skills/expertise as needed.
Sia et al. (2021)	Digital skills include agile, data analytics, digital business models, digital communication, digital technologies, journey thinking, and risk and control.
Radović-Marković et al. (2019)	IT competencies

Table 11. Overview of digital skills

The overview of digital skills shows that it might be hard to tell digital skills from technical skills because some scientific sources group all related IT skills into digital skills, and there is no clear structure to separate digital skills from technical skills. As a result of the literature study, we adopted the DIGCOMP framework as a baseline for digital skills. However, we discovered some technical skills that go beyond the DCF in the banking industry. Those technical skills are related to data science skills. Melnychenko et al. (2020) share that big data, artificial intelligence, biometrics, and blockchain are digital technologies now widely used in digital banking. Previously, financial technology tools at the bank were primarily used as software for maintaining accounts, transactions, and client databases; now, they can be used in virtually all banking processes (Table 12).



Area of application	Artificial intelligence	Big data	Blockchain
Analysis of customer behavior	X	X	
Transaction monitoring	X	X	X
Customer segmentation	X	X	
Customer identification			X
Fraud management	X	X	X
Personalization of banking services	X	X	
Risk assessment and regulatory compliance	X	X	
Customer response analysis	X	X	
Process automation	X		
Providing financial advice	X	X	
Investment decision-making	X	X	X
Trade facilitation			X
Syndicated loan services			X
P2P transfers			X

Table 12. Use of financial technology in digital banking (Melnychenko et al., 2020)

Based on the table, we want to validate whether each technology is relevant to the FinTech industry. To accomplish this, we broaden our search criteria to ensure that each technology is relevant to FinTech. We use the same search method. The search string used is: [("Artificial intelligence" OR "Big data" OR "Blockchain" OR "Chief Digital Officer")] AND ("Bank" OR "Banking industry" OR "Fintech"). We look for indications of using technical skills in the banking industry by evaluating the title and abstract of each item of literature. As a result, we discovered 32 pieces of literature mentioning these technical skills and their application in the banking industry. Table 13 summarizes all papers we found that support each technical skill and application area in the banking and fintech industries.

Literature	Technical skills	Year
- Futures of artificial intelligence through technology readiness levels (Martínez-Plumed et al., 2021) - A Review of Credit Card Fraud Detection Using Machine Learning Techniques (Boutaher et al., 2020) - Loan approval system through customer segmentation using big data analytics and machine learning (Vijayalakshmi et al., 2020) - Towards an Efficient Real-time Approach to Loan Credit Approval Using Deep Learning (Abakarim et al., 2018)	Artificial intelligence	2021 2020 2020 2018
- Big Data in Asian Central Banks (Cornelli et al., 2022) - Structure optimization of big data financial industry based on 5g network processor and embedded system (L. Wang & Chen, 2021) - Recent applications of big data in finance (Tekaya et al., 2020) - The Effect of Big Data Analytics on Firm Decision Making: The Case of the Lebanese Banking Sector (Shouman & Chehade, 2020) - Big Data Skills Required for Successful Application Implementation in the Banking Sector (Al-Hakimi, 2017) - Technology road mapping architecture based on technological learning: Case study of social banking in Iran (Ghazinoory et al., 2017) - Expert systems in finance: Smart financial applications in big data environments (Metawa et al., 2019) - Big data and IoT: A prime opportunity for banking industry (Boumlik & Bahaj, 2018) - Big Data Innovation and the Application of Systems Thinking and Standards for Business Resiliency in the Banking Sector (Herron & Cloete-Hopkins, 2019)	Big data	2022 2021 2020 2020 2017 2017 2019 2018 2018
- Measuring the perceived benefits of implementing blockchain technology in the banking sector (Garg et al., 2021) - Blockchain technology and trust relationships in trade finance (Kowalski et al., 2021) - Blockchain Technology: Opportunities and Challenges for Small and Large Banks during COVID-19 (Dicuonzo et al., 2021) - Blockchain for banking systems: Opportunities and challenges (Shorman et al., 2020) - Corporate banking—risk management, regulatory and reporting framework in India: a Blockchain application (Dashottar & Srivastava, 2020) - How Blockchain can impact financial services – The overview, challenges and recommendations from expert interviewees (Chang et al., 2020) - Digital transformation of the banking system of Russia with the introduction of blockchain (Afolalu et al., 2020) - Blockchain technology in financial services: a comprehensive review of the literature (Milian et al., 2019) - Blockchain application and outlook in the banking industry (Guo & Liang, 2016)	Blockchain	2021 2021 2021 2020 2020 2020 2020 2020 2020 2016

- An effective security assessment approach for Internet banking services via deep analysis of multimedia data (Khattak et al., 2020)	Data science	2020
- Identifying suspicious money laundering transaction based on collaborative relational data screening model using decision classifier in transactional database (Krishnapriya, 2020)		2020
- Financial Technology: Evidence in the European Banking System (Campanella et al., 2020)		2020
- Predicting the daily number of payment transactions in the largest bank in the Netherlands: Application to Banking Data (Corstjens et al., 2019)		2019
- Credit scoring through data mining approach: A case study of mortgage loan in Indonesia (Aji & Dhini, 2019)		2019
- Data, Innovation and Competition in Finance: The Case of the Access to Account Rule (Colangelo & Borgogno, 2019)		2019
- Marketing relations and communication infrastructure development in the banking sector based on big data mining (Ivanchenko et al., 2019)		2019
- Development of a master data consolidation system model (on the example of the banking sector) (Prokhorov & Kolesnik, 2018)		2018
- Technical Efficiency Assessment Using Data Envelopment Analysis: An Application to the Banking Sector (Yannick et al., 2016)		2016
- Business intelligence in banking: a literature analysis from 2002 to 2013 using text mining and latent Dirichlet allocation (Moro et al., 2015)		2015

Table 13 List of literature related to the banking and fintech industries.

Moreover, we investigate the description of each financial technology that may aid in finding description of technical skills that are appropriate for banking employees.

1) Artificial intelligence (AI): AI refers to a group of technologies that, without additional programming, can replicate human actions in previously learned technological systems. Machine learning (ML), a related technological idea, is a set of algorithms that can predict new scenarios when used with the previously mentioned methods (Buchak et al., 2018; Chakraborty & Joseph, 2017). The most common uses of AI in banks are customer information support, which involves directing customers to the right source of information and making the job of bank employees easier; collecting customer data; using chatbots to handle individual banking transactions, such as opening or closing an account; providing services based on consumer behavior, which is analyzed by smart programs; and providing services based on the needs of customers (Melnychenko et al., 2020).

2) Big data: big data technologies in digital banking can solve the issues of business process optimization and automation, allowing banks to save resources while reducing operational risks (Melnychenko et al., 2020). Big Data analytics refers to the application of analytical methods to large amounts of data sets. According to Alexopoulos et al. (2022), big data analytics is progressively being incorporated into numerous bank departments. They mention that the employees who deal with the massive amounts of data acquired by CaixaBank from various sources and channels may be classified into the following groups.

- IT and Big Data expert users: employees and third-party consultants with excellent programming skills and Big Data analytics knowledge.
- Intermediate users: People with some notion of data analytics that are used to working with some Big Data tools, especially for visualization and Big Data visual analysis (such as QlikSense/QlikView). They are not skilled programmers, although they are capable of programming simple algorithms or functions with Python or R.
- Non-IT users: People with excellent knowledge of the field and sector could interpret the data but lack programming skills or Big Data analytics knowledge.

Another example from the Development Bank of Singapore Limited (DBS) also shares that bank-wide upskilling programs are three-fold, namely, to enhance employees' ability to:

- Use data to address business challenges in a highly structured fashion,
- Use data analytics to identify business opportunities better, and
- Facilitate closer collaboration with the bank's data scientists and technology teams to create more intuitive customer products and services.

Paul Cobban, Chief Data and Transformation Officer, DBS Bank, stated that Technology is advancing rapidly, and we need to ensure our staff have the knowledge, skills, and tools to adapt to change and build communities with their peers to create a cycle of learning. In addition, empowering our staff with new technical and soft skills makes them more efficient and productive at work (DBS Newsroom n.d.).

3) Blockchain: Blockchain is a digital system that enables recording transactions in a decentralized distributed ledger. It is decentralized since no authority or institution regulates it. Blockchain technology has the potential to minimize operational and transaction costs as well as financial inefficiencies. Additionally, established financial institutions are beginning to use this

technology in their operations. Furthermore, blockchain technology may be employed in other areas of the financial sector with some additional uses outside of this sector (Crosby Nachiappan Pradan Pattanayak Sanjeev Verma & Kalyanaraman, 2016).

4) Data science: Data science is disrupting the banking sector. Banks have vast amounts of data and leveraging the amounts of data is assisting banks in a variety of ways, including process automation, process improvements, the exploration of new delivery models and the introduction of new services. The following examples demonstrate how data science is used in the banking industry. Corstjens et al. (2019) show that the clearing system's processing time is improved by using the time series technique to anticipate the daily number of payment transactions. As another example, Aji & Dhini (2019) show that Support Vector Machines (SVMs) can improve data mining and help evaluate an applicant's credit score.

In conclusion, these are examples of technical skills in the industry. Most of the time, Big Data, AI, and Blockchain are linked to FinTech and skills like programming, data analytics, machine learning, and distributed ledgers. These should be considered as additional skills that banking industry employees need to learn to support DT.

## 4.4 Survey

### 4.4.1 Data collection

A purposive sample was used to select survey participants (Robinson, 2014). The survey was distributed to people who have work related to DT in the banking industry. The survey was sent out to 30 participants. The survey was open for 30 days, from August 5 to September 5, 2022. During the survey period, the system sends reminders to each participant if they do not complete the survey. As a result, 10 responses came from different countries (Figure 14) and two types of companies (Figure 15). An example of question 15 is shown below, and the complete survey question is included in the appendix.

Q15 3.2 What aspects of your organization need to change for a successful digital transformation?

*Based on the literature review, the scope of digital transformation in banking currently focuses on changing or improving the internal structure. Therefore, we would like to investigate what area in your organization structure is important and impacts the success of digital transformation the most.*



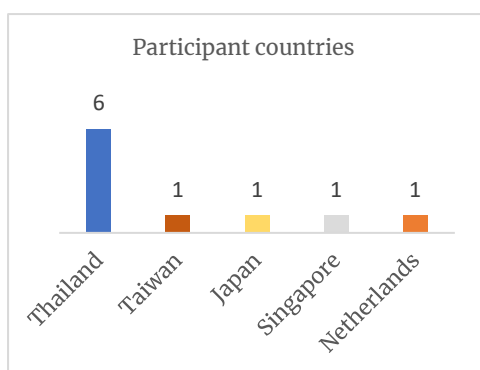


Figure 13 Participant countries

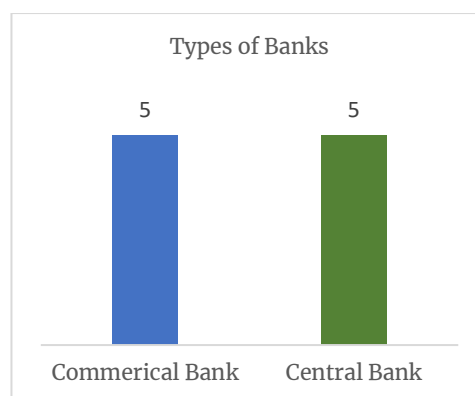


Figure 14 Types of Banks

#### 4.4.2 Data analysis

The first question of the survey is a question related to digital competencies. Table 14 displays digital competence results by mean and level in each competence area. The first column shows the average mean for each skill, while the third column shows the mean for each competency detail (1: not important to 5: most important). The fourth column shows the raw score of each level, and the last column shows the definition of the score range (0–1 is foundation, 1–2 is intermediate, 2–3 is advanced, and 3–4 is very specialized). The second question of the survey is question related to technical competencies.

Competence area	Description	Mean	Level (score)	Level
<b>1: Information and data literacy</b> (Mean: 4.03)	1.1 Browsing, searching, filtering data, information, and digital content	3.90	2.50	Advanced
	1.2 Evaluating data, information, and digital content	4.40	2.90	Advanced
	1.3 Managing data, information, and digital content	4.00	2.80	Advanced
<b>2: Communication and collaboration</b> (Mean: 4.15)	2.1 Interacting through digital technologies	4.20	2.60	Advanced
	2.2 Sharing thought digital technologies	4.10	2.80	Advanced
	2.3 Engaging in citizenship through digital technologies	3.90	2.50	Advanced
	2.4 Collaborating through digital technologies	4.00	2.70	Advanced
	2.5 Netiquette	4.40	2.70	Advanced
	2.6 Managing digital identity	4.30	2.70	Advanced
<b>3: Digital content creation</b> (Mean: 3.43)	3.1 Developing digital content.	3.40	2.50	Advanced
	3.2 Integrating and re-elaborating digital content	3.30	2.40	Advanced
	3.3 Copyright and licenses	3.60	2.70	Advanced
	3.4 Programming	3.40	2.30	Advanced
<b>4: Safety</b> (Mean:4.30)	4.1 Protecting devices	4.50	3.00	Specialized
	4.2 Protecting personal data and privacy	4.40	3.30	Specialized
	4.3 Protecting health and well-being	4.40	2.60	Advanced
	4.4 Protecting the environment	4.20	2.60	Advanced
<b>5: Problem solving</b> (Mean:3.58)	5.1 Solving technical problems	3.40	2.80	Advanced
	5.2 Identifying needs and technological responses	3.50	2.80	Advanced
	5.3 Creatively using digital technologies	3.70	2.80	Advanced
	5.4 Identifying digital competence gaps	3.70	2.70	Advanced

Table 14: Digital competencies

Competence area	Rank	Description	Mean
<b>Data Science</b>	1	Data visualization	4.00
	2	Exploratory data analysis	3.90
	3	Data cleansing/preparation	3.80
	4	Data processing	3.80
	5	Data integration	3.70
	6	Data modeling	3.70
	7	Statistical analysis	3.70
	8	Research methods and empirical validation	3.50
	9	Machine learning techniques	3.50
	10	Data mining	3.40

Table 15: Technical competencies

Table 13 shows the top three important digital competencies: safety has a mean of 4.30 with an advanced level, communication and collaboration has a mean of 4.15 with an advanced level, and information and data literacy has a mean of 4.03 with an advanced level. Protecting devices and personal data have the highest mean of 4.50 and 4.40 in the safety competencies, respectively. Netiquette, managing digital identity, and interacting through digital technologies are the top three highest means of communication and collaboration, with 4.40, 4.30, and 4.20. Finally, the highest mean in information and data literacy is 4.40 for evaluating data. Table 15 displays the rank of technical competencies, and the top four are data science skills: data visualization, exploratory data analysis, and data cleansing and processing, with 4.00, 3.90, and 3.80, respectively.

The following section is about identifying the preferred business unit in the banking industry that should have digital competencies and be able to assist an organization's digital transformation. Three units came out of this question: data analysis (6 answers), IT (3 answers), and corporate service (1 answer).

The last section is the question of the most important structural change for a successful digital transformation. Table 16 shows the type of structural change and mean. In conclusion, the highest to the lowest mean rank is as follows: Employee roles and skills, organizational structure, leadership, and organizational culture each have a score of 4.50, 4.20, 4.10, and 4.00.

Type of structural changes	Mean
1. Organizational structure	4.20
2. Organizational culture	4.00
3. Leadership	4.10
4. Employee roles and skills	4.50

*Table 16: Type of structural changes*

## 5. Discussion

The findings from this research are discussed in this chapter. The chapter describes how the sub-questions are answered using the results of this research. Furthermore, it describes how, using the answers to the sub-questions, the main research question can be answered. Moreover, it lays out the limitations of this research and potential threats to its validity. Finally, it discusses opportunities for future research.

### 5.1 Results

This section discusses all the research findings. First, it explains how the study approaches/analyzes the sub-questions. Second, the answers to the sub-questions are combined to answer to the main research question.

#### 5.1.1 Digital and Technical Skills

First, RQ1 contains a sub-question that aims to identify the digital and technical competencies in the banking industry and develop a DCF. The DCF is created in two parts of the process. The first part is a literature review. In this part, a researcher gathers different definitions of digital and technical competencies from the academic literature and subsequently uses those definitions to review the digital competencies framework from the DIGCOMP model. Next, in the second part of the process, each skill is ranked in a survey, where participants have feedback on how important each skill is and what knowledge level is required in the banking industry. The outcomes of these two processes resulted in developing a proposed DCF for the banking industry, which aids in answering RQ1.

The recommended DCF includes three DIGCOMP competence areas (“Safety,” “Communication and collaboration,” and “Information and data literacy”), each with a mean greater than 4. The other 2 competence areas are from the literature review results in chapter 4, which are “Data Science” and “FinTech”. We chose these competence areas because the literature review shows that digital transformation in banking is mostly related to these two competencies. The Data Sciences competence area contains three primary competencies: “Data visualization,” “Exploratory data analysis,” and “Data cleansing and preparation,” which are the top four results from the survey. The FinTech competence area contains three primary competencies: “Artificial intelligence,” “Big Data,” and “Blockchain,” which are the keywords that are related to digital transformation in banking. Based on the DIGCOMP framework (Carretero et al., 2017) and the literature review results, we describe each competence in detail and give an example of skill in Table 17. As “Data science” and “FinTech” details are not available in the DIGCOMP framework, we provide the detail of each competency based on the literature review result in section 4.3.2.

Competence area	Description	Competence	Example of skills
<i>Safety</i>	To protect devices, content, personal data, and privacy in digital environments.	<ul style="list-style-type: none"> <li>- Protecting devices</li> <li>- Protecting personal data and privacy</li> </ul>	<ul style="list-style-type: none"> <li>- Knows how to adopt a proper cyber-hygiene strategy regarding passwords (e.g., selecting strong ones that are difficult to guess) and managing them securely (e.g., using a password manager).</li> <li>- Knows how to activate two-factor authentication when it is available (e.g., using one-time passwords, One Time Password, or codes along with access credentials).</li> <li>- Knows how to detect suspicious email messages that contain malware or attempt to obtain sensitive information (e.g., personal data, banking identification).</li> <li>- Can respond appropriately to a security breach (i.e., an incident that results in unauthorized access to digital data, applications, networks, or devices, or the leaking of personal data such as logins or passwords)</li> </ul>
<i>Communication and collaboration</i>	To interact, communicate, and collaborate through digital technologies.	<ul style="list-style-type: none"> <li>- Netiquette</li> <li>- Managing digital identity</li> <li>- Interacting and sharing through digital technologies</li> </ul>	<ul style="list-style-type: none"> <li>- Knows how to stop receiving unwanted disturbing messages or emails.</li> <li>- Knows how to recognize hostile or derogatory messages or activities online that attack certain individuals or groups of individuals (e.g., hate speech).</li> <li>- Knows how to modify user configurations (e.g., in apps, software, or digital platforms) to enable, prevent, or</li> </ul>

		<p>moderate the AI system that is tracking, collecting, or analyzing data (e.g., not allowing a mobile phone to track the user's location).</p> <ul style="list-style-type: none"> <li>- Knows how to use a variety of videoconferencing features (e.g., moderating a session, recording audio and video).</li> <li>- Able to achieve effective communication in an asynchronous (non-simultaneous) mode using digital tools (e.g., for reporting and briefing, sharing ideas, giving feedback and advice, scheduling meetings, and communicating milestones).</li> <li>- Knows how to flag or report disinformation and misinformation to fact-checking organizations and social media platforms to stop it from spreading.</li> </ul>
<i>Information and data literacy</i>	<p>To articulate information needs and locate and retrieve digital data, information, and content.</p>	<ul style="list-style-type: none"> <li>- Evaluating and managing data, information, and digital content</li> </ul> <ul style="list-style-type: none"> <li>- Carefully considers the top/first search results in both text-based and audio searches, as they may reflect commercial and other interests rather than be the most appropriate results for the query.</li> <li>- Knows how to collect digital data using basic tools such as online forms and present them in an accessible way (e.g., using headers in tables).</li> <li>- Can apply basic statistical procedures to data in a structured environment (e.g., spreadsheets) to produce graphs and other visualizations (e.g., histograms, bar charts, and pie charts).</li> <li>- Knows how to interact with dynamic data visualization and manipulate dynamic graphs of interest (e.g., those provided by Eurostat and that appear on government websites).</li> <li>- Can use data tools (e.g., databases, data mining, and analysis software) designed to manage and organize complex information to support decision-making and solve problems.</li> </ul>
<i>Data sciences</i>	<p>To understand how to find information in large, raw, or structured data sets to identify patterns and gain new insights.</p>	<ul style="list-style-type: none"> <li>- Data visualization</li> <li>- Exploratory data analysis</li> <li>- Data cleansing/preparation</li> <li>- Data processing</li> </ul> <ul style="list-style-type: none"> <li>- Knows how to develop new approaches to risk analysis or figure out how to automate the risk management process (risk management).</li> <li>- Can create and implement high-performance identity verification applications capable of withstanding aggressive fraud attacks (fraud detection).</li> <li>- Can analyze how customers use products and behave so that recommendations to improve the customer experience can be made across all business units (customer data).</li> <li>- Knows how to personalize different offers in a way that matches the needs and preferences of the customer (customer segmentation).</li> <li>- Understands how to use data science tools and techniques to analyze data (e.g., Tableau, Hadoop, time series, R, and Python)</li> </ul>
<i>FinTech</i>	<p>To fundamentally understand software, mobile applications, and other technologies designed to improve and automate traditional forms of business finance.</p>	<ul style="list-style-type: none"> <li>- Artificial intelligence</li> <li>- Big data</li> <li>- Blockchain</li> </ul> <ul style="list-style-type: none"> <li>- Understands how AI can provide businesses with valuable insights into consumer behavior and spending habits.</li> <li>- Learns how big data analytics can help companies predict changes in the market and create new, data-driven business strategies.</li> <li>- Understands how blockchain technology enables decentralized transactions without the involvement of a third party; can use a network of blockchain participants to monitor potential changes or additions to encrypted data.</li> </ul>

Table 17: Recommended digital competencies framework for the banking industry.

### 5.1.2 Structural Changes in the Banking Industry

The second and third research questions explore the structural changes and organizational units that are involved in the process of digital transformation. This research focuses on structural changes in the banking industry that are influenced by digital transformation. A structural change is one that involves a change to a company's organizational structure, particularly the placement of new digital activities inside corporate structures. This assessment is also crucial in determining whether the changes primarily affect products, procedures, or skills. For example, suppose that the structural changes in a particular situation are relatively minor. In that case, it may be more appropriate to integrate the new operations resulting from the change within existing corporate structures. In contrast, where the changes are more significant, it may be appropriate to establish a separate subsidiary inside the organization. There are four dimensions that define structural changes: organizational structure, organizational culture, leadership and employee roles, and skills. These dimensions will aid businesses in assessing their current capabilities and developing a digital transformation strategy. The result of RQ3 is intended to provide an overview of structural change. At an absolute minimum, an organization's digital transformation strategy should be able to consider these four factors.

This paper creates and validates an overview of type of structural changes in three steps. The first step is a literature review of papers that offer a definition of the concept of structural change and examine its dimensions. This definition of structural change is the starting point for the second step. During this step, each dimension is ranked by participants in the survey. Based on these rankings and the second literature review, a final rank for each dimension was created in table 18. The definition of structural change is based on research from Vial (2019).

Dimension	Description
1. Employee roles and skills	Digital transformations are often accompanied by changes in skill sets required for a transformation and subsequent routine operations. While present employees may have a different, less tech-savvy perspective and may lack the technological capabilities to deal with future changes, new, highly skilled, and focused people may be challenging to find. As a result, an employee should evaluate their present digital skills and procedures to weigh their current skills and drive the design of training procedures for current employees and new hires.
2. Organizational structure	Structures and operations in digital banks should be reorganized around the consumer. In doing so, banks can quickly react to digital innovations while managing organizational transformation. Change in an organization begins at the top, and support for customer-focused digital banking must be pervasive, reinforced, and monitored.
3. Leadership	Digital transformation is a continuous, complex endeavor that has the potential to influence an organization and its operations significantly. As a result, it is critical to assign proper and clear roles for developing and implementing a digital transformation strategy. If a digital transformation strategy is poorly planned, businesses may lose their scope and face operational challenges. As a result, businesses should ensure that the individual who is operationally accountable for the digital transformation strategy has appropriate experience in transformative projects and that their incentives are directly aligned with the strategy's aims and progress. There is no simple answer to who should be in control of a digital transformation strategy. Potential candidates include dedicated business transformation managers or individuals who hold the relatively new job of chief digital officer (CDO), in addition to chief information officers (CIOs) and CEOs. In any event, because many transformative processes unfold over an extended period, it would be ideal if this person remained the same throughout that process.
4. Organizational culture	Culture is always a factor in large transformation programs, and digital ones are no exception. Nevertheless, it is well worth the effort; successfully navigating digital cultural shifts is a competitive differentiator for banks. Competitors find it challenging to replicate other businesses' strong customer focus and to develop new ideas and act quickly.

Table 18: Rank of structural changes for the banking industry.

### 5.1.3 Answering the Main Question

Throughout these questions, the digital competencies framework (DCF) has been introduced. The primary research question is: "What do (Chief) Digital Officers in banking industry perceive as the most important digital and technical skills for the banking industry?" The existing DIGCOMP framework partially answers this question. The remaining research questions support tailoring the



framework to the characteristics of the banking industry. According to the SLR and the survey results, digital competencies are important for the banking industry to prepare for digital transformation.

## 5.2 Validity

There are potential challenges with respect to the validity of this research. To analyze validity, the author used the model from Wohlin et al. (2012). To summarize, this book discusses four types of validity: construct validity, internal validity, external validity, and conclusion validity. Each type of validity has issues that could impair the research's validity. This section discusses this study's potential validity threats. Figure 15 depicts an overview of each validity threat and identifies where it appears in the research. The specifics of each threat type are discussed in the following paragraphs in this section.

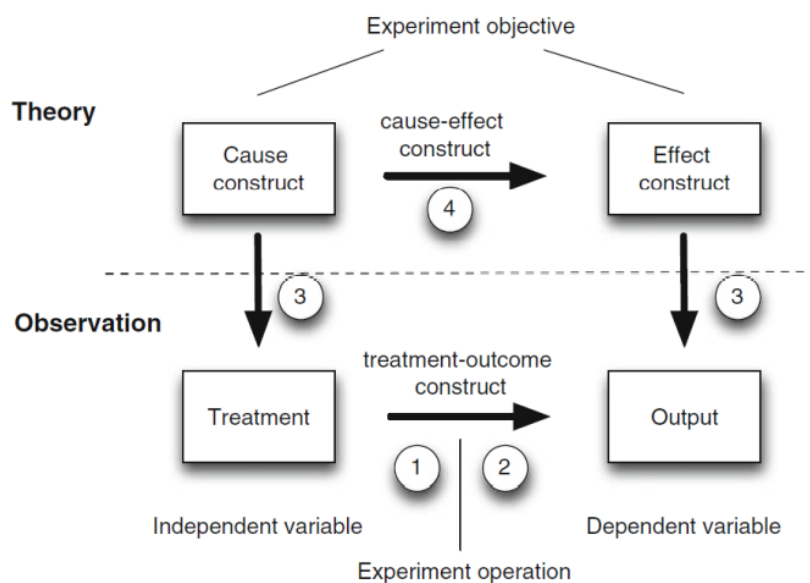


Figure 15: Validity Threats (Wohlin et al., 2012)

### 5.2.1 Internal Validity

To improve the internal validity of this study, we used method triangulation. Thyer (2019) notes that methods triangulation uses diverse research methods to examine the data (i.e., combining quantitative and qualitative methods in a single study). Triangulation is also helpful for enhancing credibility and validity. The intention is to decrease the deficiencies and biases of any single method. In this study, triangulation helps you get a complete understanding of your research problem, as we use a literature review and a survey to help us understand the research problem.

The threat to internal validity is a lack of completeness in the literature review. As Brereton et al. (Brereton et al., 2007) note, one of the most common validity threats with respect to literature reviews is the use of incomplete or inappropriate search terms. This threat is present in this research as the author is not an expert on the topic, and the literature review was conducted during the initial phases of the research, which could have resulted in the use of inaccurate search terms. In addition, it is possible that the list of search terms was incomplete. Therefore, despite being conducted systematically, the literature review may not be exhaustive. During the search of the literature, the author reviewed preliminary publications on the topic to develop an understanding of the terminology, which assisted in establishing relevant search terms for the literature review. Furthermore, the search terms were adjusted during the study.

### 5.2.2 External Validity

The second validity threat described by Wohlin et al. (2012) is to a study's external validity. This threat is concerned specifically with the generalizability of the research. For example, one threat could be having a sample group of interviewees that is not representative of the overall population. The main threat is the representative sampling that may occur during a survey. In sample-based research, in making statistical inferences about and interpreting the results, one typically needs to go

beyond the sample to the study population (i.e., the population described by the sampling frame). According to Andrade (2021), generalization is possible only among those in the population from which the sample was drawn and those in the population who possess the characteristics of the sample under study. To reduce the threat of this problem, the author selected a study group whose members were familiar with the banking industry and involved in digital transformation. The participants in the study group hailed from commercial and central banks and had more than five years of experience and involvement in managerial roles. However, this does not completely obviate the threat stemming from representative sampling because the study group members did not come from all regions of the world. Consequently, the study group may not be representative of the entire industry.

### 5.2.3 Construct Validity

A third validity threat is construct validity (Wohlin et al., 2012), which relates to how well-defined the research is. For example, for construct validity to be present, research must include clear definitions and be capable of unambiguous application. A lack of construct validity can harm the repeatability of the research, as unclear definitions can lead to different outcomes when applied by different researchers. In this research, if a participant misunderstood the definition of the term 'digital competencies', that participant's score was not considered. According to Wieringa, there is a potential for construct validity threats during the literature review regarding the definition of the term "digital competencies" (Wieringa, 2014). In this research, we clearly define terms related to digital transformation, competencies, and skills in the survey. This definition can help the participant understand each term before answering the survey. In the information sheet, we also provide guidelines for the survey and recommend that participants understand the terms before taking the survey.

With respect to the definitions of technical skills, there are many such definitions that need to be clearly defined and described for future research. During the literature review, the author found clear definitions in each skill and application area used in FinTech industries. The results from literature review reduced the threat that the definition of each technical skill would be misunderstood. However, this did not entirely remove the threat. Not all the skills in the research have precise definitions. This means that the author constructed definitions for these skills. Because the inputs for these definitions were sometimes limited, this could have resulted in the creation of inaccurate or partial definitions. Due to the limited availability of resources to address this threat, it had to be accepted.

## 5.3 Limitations

This study has a number of limitations. Although these constraints do not inherently reduce the quality of the research, there are aspects of the study that, in hindsight, could have been done better or more efficiently.

The first limitation affects many researchers. This study would have benefited from the participation of more specialists in digital transformation in the banking industry. Seven of the respondents in this study can be considered digital transformation specialists. The other responses were from subject matter experts (i.e., individuals who are familiar with digital competencies). The small number of respondents made it difficult to broaden the range of digital skills or units that are relevant to DCF. However, due to the limited availability of DCF in general and the time allotted for this research, a greater number of participants could not be recruited.

A second limitation pertains to the structural change topic. It would have been beneficial to conduct interviews with CDOs in the industry. This would have provided further evidence or more validity to a recommendation that organization should follow as well as provided an example of how they can develop strategies for that purpose. Therefore, the generalizability of the results of this research are limited.

A third limitation is the lack of exposure to the actual value of implementing DCF in the banking industry. As a result, the specific research topic for this study focuses on the concept of DCF rather than how to implement it in the organization. However, the framework should be used as a starting point for traditional banks to construct DCFs that are appropriate for their business and their stage in the digital transformation process.

## 5.4 Future studies

While this paper has developed the fundamental aspects of the digital competencies framework, there are at least three possible areas for additional research.

### 5.4.1 Digital Competencies Framework

The review of digital skills presented earlier in this paper took technical skills into account. However, some technical skills may not be included in the DCF due to other FinTech technologies still developing and may require additional technical skills to facilitate the technologies. As a result, researchers should continue investigating the FinTech challenge and related skills to aid in the development of the DCF over time. Another thing to consider for future research is that the survey used in this study specifically sampled people who were directly involved in digital transformation and worked in a commercial or central bank. People who work in FinTech or who are support employees, such as office managers and finance leads, were omitted from the participant pool. By using a larger sample group in future studies, scholars may identify additional skills that are currently absent from the framework and should be included. In future research, DCF could be used to measure the current level of digital and technical skills in the banking industry.

### 5.4.2 Digital Transformation Strategies

Structural change describes the fundamental aspects of a digital transformation using four dimensions. Future research should identify other common aspects of digital transformation that are linked to these four dimensions. Empirical insights could aid in comparing digital transformation plans across firms to analyze similarities and differences and thus improve success rates.

### 5.4.3 Training and Development Strategies

Finally, researchers might use a DCF to create organizational training and development initiatives. According to our findings, there is little research on practical strategies that assist businesses in acquiring digital and technical skills and ensuring they have the capabilities required to enable a digital transformation. So, a researcher could look into training strategies that use a DCF as a framework for employee development and how to use these strategies in an organization to help employees develop skill sets based on a DCF.

## 6. Conclusion

This research intends to describe a theoretical framework for digital transformation and develop a DCF that is suitable for the banking industry. The research has resulted in several conclusions about DCF. These findings are summarized in this chapter with reference to the research questions.

The goal of this research was to answer three main questions:

1. What do (Chief) Digital Officers in banking industry perceive as the most important digital and technical skills for the banking industry?

This study aimed to answer this broad question by developing a framework that explains each skill. The sub-questions explored different aspects of digital and technical skills. An extensive systematic literature review was used to find suitable skills for a DCF. These skills were then ranked through surveys by participants who work in fields that are involved in digital transformation processes in banks. As a result, we created a DCF, as shown in 5.1.1. The DCF can be used to determine which skills a bank should prioritize to prepare for digital transformation. These surveys yielded a set of skills that were added to the framework. Finally, we present our research findings in the form of figures. Figure 16 illustrates DCF's five key digital competencies for the banking industry.

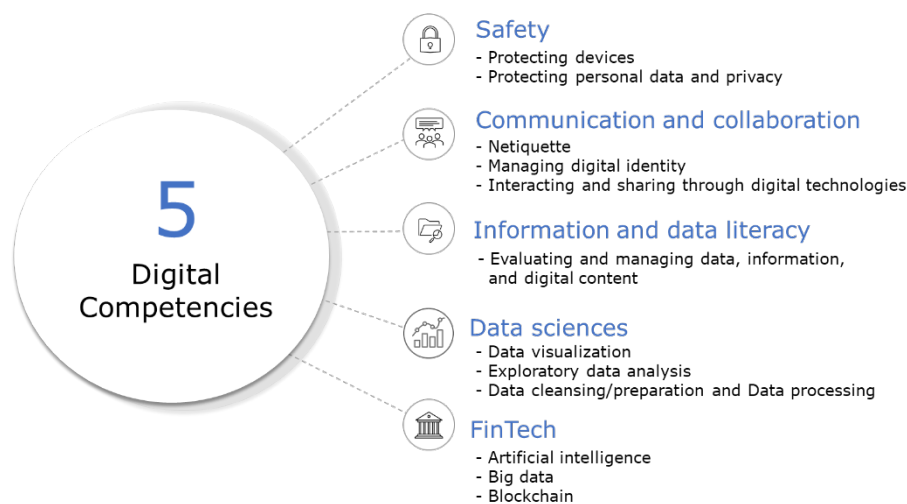


Figure 16 DCF's five key digital competencies for the banking industry (source: created by authors)

2. What is the most critical business unit that should use the digital competencies framework to support structural change?

According to the findings of this study, one should use the DCF to focus on three main units: the data analytics unit, the IT unit, and the corporate services unit. The literature review showed that transformation events in digital banks or FinTech are typically associated with new technologies. These new technologies are data science-related and used to engage with data analytics or IT units, depending on the organizational structure. As a result, the business unit survey participants mentioned most frequently in their responses was the data analytics unit, which comports with the findings from the literature review. However, because the organizational structures of different organizations may differ, this business unit may not be the only one that should be prioritized.

3. What structural change is most important to ensure that a digital transformation is successful?

According to this study's findings, the most significant structural changes are the employee roles and skills dimension. As demonstrated by the literature review, digital transformations in the banking industry have altered several aspects of the industry. The literature review usually mentions two dimensions, technology, and data, which change how traditional businesses operate. On the other hand, employees may lack the technological capabilities to deal with these changes. As a result, one of the critical elements that organizations must consider to ensure a successful transformation is employees.

In conclusion, we proposed a digital competencies framework that should support the banking industry during digital transformation. In addition, this framework could be used to measure professionals' digital and technical skills and to analyze the effectiveness of employee development strategies regarding digital skills. Furthermore, the business unit related to data is the critical business unit that an organization should focus on to improve the digital competencies of the employees in the unit. Finally, the FinTech organization consistently invests in new financial technologies to improve overall business performance. However, our findings suggest that the FinTech organization should consider organizational structure before investing in new technologies. An organization must ensure that its employees have the knowledge, skills, and tools to adapt to changes in a new business process that may affect new technologies.

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## Appendix

### Appendix A: Survey

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#### Start of Block: Consent form

#### Consent form INFORMATION SHEET FOR PARTICIPATION IN RESEARCH STUDY Develop a competencies framework for digital transformation in the banking industry.

Panithan Phongphaew, student in the Master of Business Informatics (University Utrecht)  
Version August 2022

#### What is the purpose of this research?

We are conducting a research study because we are trying to explore the current state of competency frameworks for digital transformation and how digital competencies affect the digital transformation in the banking industry.

#### What do I have to do when I participate in this research?

If you accept to participate in this study, you will be required to complete a three-part questionnaire. The first and second sections are concerned with identifying critical competencies that can aid in digital transformation operations. The third section focuses on identifying digital transformation features in the banking industry. Most of the questions are rating questions, while others require short words. An overview of the questionnaire is shown as follows.

1. Digital competencies
2. Technical competencies
3. Characteristic of digital transformation organization in the banking industry
4. Contact information

#### How long does it take to participate in the research?

The study should take about 30 minutes to complete.

#### Are there any risks involved in my participation in the research?

Your participation is voluntary, which means you can choose not to participate. There will be no negative consequences if you decide not to participate or change your mind later after you begin the study. You can withdraw your participation at any time prior to submitting your survey. If you change your mind later while answering the survey, you may simply exit the survey. Once you submit your responses online, I will be unable to remove your data later from the study because all submissions are anonymous, and I will not know which survey response belongs to you.

#### Is the information about me and my participation in this research confidential?

Research data collected from you will be anonymous. Since your information is collected online in an anonymous way, we will not be able to link your responses back to you. So, your responses will remain confidential. The files in which the results are stored are accessible to Panithan Phongphaew (Master student at Utrecht University) and Johan Jeuring (Professor at Utrecht University). Any publications based on this research do not contain any information with which you can be identified. The project's research records may be reviewed by Utrecht University departments responsible for regulatory and research supervision.

#### What are my rights when I participate in this research?

Your participation in this research is voluntary. You are not paid to participate. You can choose not to participate. If you agree to participate, you can withdraw your participation at any time without incurring any consequences. In that case, your answers to the questionnaires will no longer be included in the study.

#### How do I obtain information about the results of the research?

If you want to obtain information about the results of this research, you can send an email to Panithan Phongphaew ([p.phongphaew@students.uu.nl](mailto:p.phongphaew@students.uu.nl)). Since we do not store any information about participants, we cannot send this to all participants, unless they make themselves known to us.

#### Whom can I contact if I have questions about this research?

If you have any questions or remarks about this research, or if you are concerned about particular aspects about the research, you can contact Panithan Phongphaew ([p.phongphaew@students.uu.nl](mailto:p.phongphaew@students.uu.nl))

Do you have any privacy-related complaints or questions as a result of this research? Then you can send an email to the data protection officer of Utrecht University ([privacy@uu.nl](mailto:privacy@uu.nl)).

- I consent (1)
- I do not consent (2)

End of Block: Consent form

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Start of Block: Framework introduction

#### Part 1 :Introduction Part 1: Digital skill

Based on the below competency table, please rate the importance of each skill in part 1 that is crucial for supporting digital transformation.

For example, we are starting to witness a post-COVID boom in digital solutions, platforms, products and services, which further amplifies the need for digital business processes and a digitally skilled workforce. People's digital skills can be broadly categorized as basic, intermediate, and advanced. Basic digital skills relate to basic manipulation of digital devices, email communication, web search and online transactions; while intermediate skills relate to professional use of business software and data management. Advanced skills relate to data analysis, software development and high-level computing competences in the range of emerging technologies such as artificial intelligence and machine learning.

More information: [DigComp framework](#)

End of Block: Framework introduction

---

Start of Block: Competence 1: Information and data literacy

#### Q1 1. Information and data literacy

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
	1	2	3	4	5
1.1 Browsing, searching, filtering data, information, and digital content ()					
1.2 Evaluating data, information, and digital content ()					
1.3 Managing data, information, and digital content ()					

#### Q2 What level should employees have for this skill?

Foundational	Intermediate	Advanced	Highly Specialized
1	2	3	4

1.1 Browsing, searching, filtering data, information, and digital content ()	
1.2 Evaluating data, information, and digital content ()	
1.3 Managing data, information, and digital content ()	

End of Block: Competence 1: Information and data literacy

Start of Block: Competence 2: Communication and collaboration

Q3 2. Communication and collaboration

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
	1	2	3	4	5
2.1 Interacting through digital technologies ()					
2.2 Sharing through digital technologies ()					
2.3 Engaging in citizenship through digital technologies ()					
2.4 Collaborating through digital technologies ()					
2.5 Netiquette ()					
2.6 Managing digital identity ()					

Q4 What level should employees have for this skill?

	Foundational	Intermediate	Advanced	Highly Specialized
	1	2	3	4
2.1 Interacting through digital technologies ()				
2.2 Sharing through digital technologies ()				
2.3 Engaging in citizenship through digital technologies ()				
2.4 Collaborating through digital technologies ()				
2.5 Netiquette ()				
2.6 Managing digital identity ()				

End of Block: Competence 2: Communication and collaboration

Start of Block: Competence 3: Digital content creation

Q5 3. Digital content creation

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
	1	2	3	4	5
3.1 Developing digital content ()					
3.2 Integrating and re-elaborating digital content ()					
3.3 Copyright and licenses ()					
3.4 Programming ()					

Q6 What level should employees have for this skill?

	Foundational	Intermediate	Advanced	Highly Specialized
	1	2	3	4
3.1 Developing digital content ()				
3.2 Integrating and re-elaborating digital content ()				
3.3 Copyright and licenses ()				
3.4 Programming ()				

End of Block: Competence 3: Digital content creation

Start of Block: Competence 4: Safety

Q7 4. Safety

Not at all important	Slightly important	Moderately important	Very important	Extremely important
1	2	3	4	5



4.1 Protecting devices ()	
4.2 Protecting personal data and privacy ()	
4.3 Protecting health and well-being ()	
4.4 Protecting the environment ()	

Q8 What level should employees have for this skill?

	Foundational	Intermediate	Advanced	Highly Specialized
	1	2	3	4
4.1 Protecting devices ()				
4.2 Protecting personal data and privacy ()				
4.3 Protecting health and well-being ()				
4.4 Protecting the environment ()				

End of Block: Competence 4: Safety

Start of Block: Competence 5: Problem solving

Q9 5. Problem solving

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
	1	2	3	4	5
5.1 Solving technical problems ()					
5.2 Identifying needs and technological responses ()					
5.3 Creatively using digital technologies ()					
5.4 Identifying digital competence gaps ()					

Q10 What level should employees have for this skill?

	Foundational	Intermediate	Advanced	Highly Specialized
	1	2	3	4

5.1 Solving technical problems ( )	
5.2 Identifying needs and technological responses ( )	
5.3 Creatively using digital technologies ( )	
5.4 Identifying digital competence gaps ( )	

End of Block: Competence 5: Problem solving

Start of Block: Part 2

Q11 Part 2: Technical skill

What are important technical skills for banking industry?

*This part plans to find the essential data science skill required to support digital transformation in the industry. Based on the literature review, the researcher found the ten most important technical skills to support digital transformation. Therefore, we would like to see the level of importance in each skill and example of related work or task.*

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
	1	2	3	4	5
1. Exploratory data analysis ( )					
2. Data visualization ( )					
3. Machine learning techniques ( )					
4. Data mining ( )					
5. Data cleansing/preparation ( )					
6. Research methods and empirical validation ( )					
7. Data processing ( )					
8. Statistical analysis ( )					
9. Data integration ( )					
10. Data modeling ( )					

Q12 (Optional) Please provide an example of a task for this skill.

`Q11/ChoiceGroup/ChoiceWithHighestValue` (1)

Q13 3.1 What business unit is required to practice the digital competencies framework to cope with structural changes arising from digital transformation?

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Q14 Please rank the relevance level of this business unit toward digital transformation.

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
	1	2	3	4	5
<div style="border: 1px solid #ccc; padding: 5px; width: fit-content;">                     {{Q13/EnteredText}} ()                 </div>					

Q15 3.2 What aspects of your organization need to change for a successful digital transformation?

*Based on the literature review, the scope of digital transformation in banking currently focuses on changing or improving the internal structure. Therefore, we would like to investigate what area in your organization structure is important and impacts the success of digital transformation the most.*

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
	1	2	3	4	5
1. Organizational structure ()					
2. Organizational culture ()					
3. Leadership ()					
4. Employee roles and skills ()					

Q16 (Optional) Please describe the reason why you give this score.

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Start of Block: Contact information

Q19 Please provide your information

Name: (1) \_\_\_\_\_

Organization: (2) \_\_\_\_\_

Position: (3) \_\_\_\_\_

Country: (4) \_\_\_\_\_

-----  
Q20 (Optional) Please provide your contact information

Contact information (1)  
\_\_\_\_\_

End of Block: Contact information  
\_\_\_\_\_