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Configurations of barriers to Digital Transformation in Portuguese SMEs and the effects of DT to the employees

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Master's in Human Resources Development Policies

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ISCTE

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CIÊNCIAS SOCIAIS
E HUMANAS

Department of Political Economy

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Resumo

A transformação digital (TD) está a mudar todas as empresas e a alterar fundamentalmente os processos, as competências relevantes, as fronteiras e as perspectivas da GRH. Embora reconhecida como um fator inevitável e benéfico para as empresas, a TD requer recursos e atitudes positivas conducentes à sua implementação. No entanto, também pode estar associada a ameaças, tais como impactos às dimensões quantitativas e qualitativas dos RH, que dificultam a vontade de a implementar. Este facto pode ser especialmente sentido nas PMEs devido à menor disponibilidade de recursos. Do mesmo modo, as barreiras à TD tendem a ser tratadas de forma isolada como um conjunto cumulativo de fatores que contribuem para um determinado nível de resistência à implementação da TD. Porém, é muito provável que estas barreiras co-ocorram como clusters, visto que estes operam como configurações, i.e. pode determinar a resistência dependendo das configurações de barreiras e não dos seus simples efeitos cumulativos. Este estudo foi concebido para testar em que medida as barreiras da TD estão presentes nas PMEs portuguesas, o quão estão associadas entre si, e que configurações estão associadas ao impacto esperado nas dimensões quantitativa e qualitativa dos RH. Com uma amostra de 30 gestores de PMEs, uma análise hierárquica de clusters revelou grupos de barreiras à TD, que após integração numa análise fsQCA, revelam quatro configurações de barreiras à TD que explicam impactos qualitativos nos RH. Sobre impactos quantitativos, a análise não produziu qualquer configuração, pois a grande maioria declarou não serem esperadas alterações a este nível.

Palavras-chave: Transformação Digital; PME; Portugal; Barreiras à Transformação Digital; fsQCA

Abstract

Digital transformation (DT) is sweeping all businesses, and fundamentally changing processes, relevant skills, frontiers, and outlook for HRM. Although universally recognised as an unavoidable and beneficial factor for business, DT requires resources and positive attitudes conducive to its implementation. However, it may also be associated with perceived threats, such as impacts as regards both HR quantitative and qualitative dimensions, that hamper the willingness to implement it. This may be especially felt in SMEs due to lower resource availability. Likewise, DT barriers tend to be treated as a cumulative set of factors that contribute each one to a certain level of resistance to DT implementation. Still, it is most likely that not only are these DT barriers working together as clusters (they tend to co-occur) as they may operate as bundles, i.e. they may determine the resistance as configurations of DT barriers and not as simple cumulative effects. This study was designed to test to which extend DT barriers are present in Portuguese SMEs, how much they are associated among each other, and what configurations are associated to the expected impact on both HR quantitative and qualitative. With a sample of 30 SMEs managers a hierarchical cluster analysis showed groups of DT barriers, which were integrated in a fsQCA analysis, to reveal four configurations of DT barriers that account for qualitative HR impacts. As per the quantitative impacts, the analysis did not yield any configuration as the vast majority stated no changes are expectable at this level.

Keywords: Digital Transformation; SME; Portugal; Digital Transformation Barriers; fsQCA

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CHAPTER 1

Introduction

With the evolution of work methods that revolve around digital technologies, enterprises have the choice of maintaining the current methods or investing in the more modern methods. In McKinsey Global Survey on digital strategy and investments, comprising 1331 respondents and with a diversified organisational sample, 90% of C-level and senior leaders report that their organisation has pursued one or more large-scale digital transformations between 2020 and February 2022 (McKinsey Consultants Survey, 2022). These changes target the organisation's activity using technology to improve the core business, and also implementing a digital business alongside the core business.

Being already identified large benefits of digitalisation: identifying and resolving problems faster (Markovitch & Willmott, 2014) and exponential growth with the maturation of digitalisation in the organisation (Sabbagh et al., 2012), it is important to question why, in certain cases, it is not realised nor there are plans to implement digitalisation and, in the future, digital transformation (DT). According to Gaglio et al. (2022) simple technologies incremental changes (such as a business mobile phone for employees or a stronger presence in social media) leads to more productivity in manufacturing MSEs located in Johannesburg. However, different locations have different obstacles and cultures, and different activity sectors may require more complex technologies to innovate and have a substantial impact. So, it is important to consider what is the best fit of new technologies an organisation that wants to apply DT should implement, since failing to do so will only add to the list of companies that have witnessed DT implementation failure.

The structure of business plays an important role in this matter. The management of Micro, Small, and Medium Enterprises (SMEs) differs from the management of larger enterprises, usually, by being less resilient, by having a smaller "safety net" regarding failed investments (Berrone et al., 2012; ICBS, 2023), having a smaller scope in general (workforce and clients), resulting in more difficulty in acquiring a loan (OECD, 2021) and having a stronger tie with the resources and ecosystem where the company operates (König et al., 2013). It is thus, not surprising that, with these unique challenges, literature reports that SMEs show a slower implementation of DT (Akpan et al., 2021). In the case of Portugal, in 2022, 99.9% of Portuguese enterprises are classified as SMEs (Table 1.1) which means that each company may not have the required resources to grasp the full extent of DT.

Table 1.1 – Portuguese company size distribution

	Micro	Small	Medium	Large
2022	96.1%	3.3%	0.6%	0.1%

Source: PORDATA (2023)

Notwithstanding this, family-owned companies have been reported to show more commitment and resolve, due to the relation between family success and business success (Berrone et al., 2012). In Portugal, SMEs are usually family owned (AEF, 2024) and sometimes there is help by the national or local government to create programs to leverage DT in these enterprises (Barros et al., 2023).

One of the flagship programs implemented by the Portuguese government via the Portuguese Institute for SMEs (IAPMEI), Industry 4.0, integrated in the Resilience and Recovery Plan (PRR). This program is intended to help overcoming the delay in the DT process identified in Portuguese companies and establishes one reform and six well-defined investments (IAPMEI, 2024).

Reform “TD-r31”, already completed in 2021, fostered the revision of the National Qualifications Catalogue so to be mindful of the skills that new technologies require from employees, and produced the juridical framework that regulates digital signatures, so to promote sustainability, cybersecurity and digital trust.

Investment “TD-C16-i01” was focused on digital skills of the working population and comprehends two programs: "Academia Portugal Digital" (Portugal Digital Academy) and "Emprego + Digital 2025" (Employment + Digital 2025). Portugal Digital Academy is an online platform where the population can test themselves about digital topics and have access to free training programs. Employment + Digital 2025 aims to provide more in-depth training regarding this topic but also find and fund partners that can provide these training programs.

Investment “TD-C16-i02” aims to leverage the transformation of business models of Portuguese SMEs by focusing on digitalisation, competitiveness, and resilience. Resulting from this line of investment, “Test Beds National Network” will provide companies with physical equipment, infrastructure or simulators to test and develop new products. A program regarding e-commerce with the main goal of digitalising micro enterprises is also part of this investment and three projects were defined: 1) “Accelerators of Digital Commerce” which consist of the creation of 25 entities that provide mentoring and financial support to SMEs; 2) “Digital Shopping Districts” which consist of the digitalisation of 75 shopping zones located in urban, suburban and rural areas with e-commerce and delivery platforms, focusing on internet connectivity and updating equipment; 3) “Internationalisation via e-commerce” which is intended to help companies implement methods to sell and ship internationally. Also, this line of investment makes available financial support to encourage

entrepreneurship in three ways: 1) “Start-up Voucher – New Green and Digital Products”) to encourage the development of sustainable and green business models; 2) “Strengthening the National Structure for Entrepreneurship – Startup Portugal”, to aid companies still in the early stages; and 3) “Incubator / Accelerator Voucher” to help the 25 entities mentioned in “Digital Commerce Accelerators” in their mission of finding and adopting new technologies and updating their knowledge.

Investment "TD-C16-i03" aims to reduce the reliance on paper through the dematerialisation of invoicing, but also to create a more secure and trustworthy digital business environment via certifications and reduce operational costs. Additionally, the investment will support the development of knowledge transfer mechanisms, encouraging the development of new technological products and services, while also enhancing the skills of professionals involved. The initiative is structured through three major programs: 1) the “Digital Innovation Hubs” are intended to facilitate the digital transition of companies by providing centralised services that focus on Artificial Intelligence (AI), high performance computing, and cybersecurity, with the goal of expanding the digital innovation hubs network to 126 additional hubs nationwide; 2) “Invoicing dematerialisation” program will automate the electronic signature process for invoices using the Electronic Invoice Signature Service (Portuguese acronym SAFE) from the Administrative Modernisation Agency (AMA) and promote the use of digital invoicing in both B2B and B2C environments. Finally, 3) the certification program will introduce four new certification platforms focused on cybersecurity, privacy, usability, and sustainability, with the goal of training conformity assessment bodies and technical laboratories.

Investment "TD-C16-i04" focuses on the industrial sector by supporting research, experimental development and innovation. It aims to aid 200 investments that implement at least one of the following topics: data storage, management and processing; AI; digital twins; additive layer manufacturing; augmented reality; collaborative robotics; IoT; cloud computing; and integration of innovative software.

Investment “TD-C16-i05 RAA” focuses on companies located in the Autonomous Region of Azores and develops a Digital Transition Incentive System, aimed to support the adaptation and integration of digital technologies of these companies. Projects to be eligible to these funds should have present at least one of the following goals: aid the company in the integration of technologies that improve productivity, boost innovation and reduce costs; provide consulting services that help implement methodologies that improve business processes and cybersecurity; promote the collaboration of companies located in this region regarding topics of sharing technological solutions, equipment, methods and experience.

Investment “TD-C16-i06 RAM” focuses on the Autonomous Region of Madeira, supporting the acquisition of machinery, equipment, software, or patents intending to reach 300 SMEs.

Overall, the Portuguese authorities are aware of the importance and barriers of DT and the Industry 4.0 is an expression of a comprehensive strategy intended to tackle barriers and expected future need of SMEs. However, the diversity and extension of DT barriers might easily go beyond the reach of this program.

Literature comprehends many recent studies about the subject of DT and barriers to DT, which served to better understand how this subject is studied in other countries (Rupeika-Apoga & Petrovska, 2022; Saleh & Manjunath, 2021) and how this subject is studied in a specific sector (Cichosz et al., 2020; Gkrimpizi et al., 2023).

Unfortunately, studies mainly regarding the barriers to DT present in Portugal are lacking. One of the most recent is Teles (2023) but it is based on secondary data from 2014-2020, which was collected from answers to the Survey on the Use of Information and Communication Technologies in Companies realised by INE, Portugal's national statistics institute. Among national companies, 21991 only answered once between 2014 and 2020 from the 28933 companies that answered. The full panel was answered only by 1092 companies (less than 4% the original panel) resulting in a need to collect new data to better grasp which DT barriers are currently experienced.

A study conducted by Ipsos Apeme (2022) gathered, between 26/10/2022 and 28/11/2022, information on this topic in Portugal. It was intended to understand how technologies are utilised and perceived and concludes that Lisbon Metropolitan Area is the most advanced and innovative region; enterprises with more than 50 employees are more likely to implement DT; one out of three enterprises currently do not prioritise DT. Regarding DT barriers this report states they are transversal to all sectors, and that the main DT barriers in Portugal concern the "difficulty in reconciling training with working time" and in "readjusting the business model to digital technologies".

Therefore, there is a research gap pertaining to the depth of DT barriers in SMEs in Portugal. This study is conducted to gather such data and systematically analyse it in search of the relative weight each DT barrier has in accounting for SMEs DT adoption and its expected impact on HRM.

For this purpose, the study is guided by the following first question: "What are the barriers to Digital Transformation experienced in Portuguese SMEs?". This question is relevant because each study regarding DT (e.g. Cichosz et al., 2020; Gkrimpizi et al., 2023; Rupeika-Apoga & Petrovska, 2022; Saleh & Manjunath, 2021) is conducted within a specific context, which has idiosyncrasies resulting in different barriers weights. While acknowledging this, considering the time available to conduct this study, we opted not to do sector comparison or single sector analysis.

A second research question, based on the first one, focuses on the HRM impact of DT: "What is the impact of DT in the number and function of employees in Portuguese SMEs?". The main objective of this question is to understand expected consequences of DT on the number and functions of employees in the aftermath of DT.

Therefore, this study is designed to identify the DT barriers experienced in Portuguese SMEs, relating these barriers to the estimated impact of DT in Portuguese SMEs as regards the number and functions of employees. This allows to identify the relative weight DT barriers have as a whole, in such domains (estimated quantitative and qualitative impact in HRM).

CHAPTER 2

Literature review

2.1 Digital transformation

Although the term "digital transformation" has become widespread and popularly used, its conceptual definition is not straightforward (Verina & Titko, 2019). According to OECD (2019, p. 16) digital transformation refers to "the economic and societal effects of digitisation and digitalisation". Two underlying constructs are therefore entailed in this definition: digitisation and digitalisation.

Digitisation refers to the encoding of analogue information into a digital format (Yoo et al., 2010). So, digitisation makes physical products programmable and traceable allowing them to be present in future data analysis (Yoo, 2010). Differently, digitalisation is a sociotechnical process of applying digitising techniques, resulting in digital technologies altering the company's infrastructure and having an impact on employees and the institutional context (Tilson et al., 2010), fundamentally altering how a company works.

Ismail et al. (2017) offer a broader view of digital transformation referring to it as the converging of the enterprise's business model, customer experience, operations, people, and networks to be connected via digital technologies. Therefore, these authors highlight digital technologies as the connecting dimension of all structures, processes and interactions within organisations and between these and their stakeholders.

Some examples of technologies implemented to achieve digital transformation include (Ebert & Duarte, 2018): AI, together with company's data to compute solutions to company's problems; open APIs, relevant to the company's wants and needs are a faster way to implement software already developed and common between several companies, such as shipping and product catalogues and IoT connected devices, introduction of devices that are able to connect with each other in order to complement each other and possibly technologies already present in the company's activity, relevant in a production line or storage to keep track of time and placement of specific products.

2.2 Consequences of digital transformation

It is important to understand why organisations should at least consider implementing digital transformation. In reviewing literature that reports consequences of digital transformation, Gertzen et al. (2022) stress empirical articles that brought to light some important findings. For example, DT

was found to result in better operational efficiency, customer experience and satisfaction (Gebayew et al., 2018) but DT also introduces new criteria for evaluating projects (Jiang & Klein, 1999). At a higher level, DT was reported as leading to new business models (Henriette et al., 2015) and fostering new organisational culture (Berghaus & Back, 2016).

Due to the data integration efficiency and the speed with which information can flow, DT has a leveraging potential to improve information transparency (W. Chen et al., 2022) and exchange (Kraus et al., 2021) which are key conditions for heightened organisational innovation. Indeed, by collecting data of over 15000 listed companies in Shanghai and Shenzhen stock markets about their level of innovation performance and the extent to which these companies' annual reports included terms closely related to DT, Niu et al. (2023) found DT (as indicated by this proxy) was positively predicting innovation performance, and that this association was stronger in high-tech companies.

Overall, the idea from literature on the effects of DT is that a well implemented DT pushes the organisations to change and unify the different dimensions of their activity, towards a simpler and more integrative way.

2.3 Digital transformation impact on HR

The highlights on DT literature are mostly placed on the technological advancements and the emerging AI in organisational management (e.g. Qiu, 2023; Wu et al., 2024) but the impact of DT on HRM is central for organisations and society. These effects can be distinguished in larger scale job market effects (Goulart et al., 2022) as well as within organisations effects (Guerra et al., 2023; Pedron, 2022).

The latter may benefit from distinguishing between qualitative impact (impact pertaining to the qualifications or any other non-quantitative dimension in HRM) and quantitative impact (any impact upon the number of employees, either decreasing or increasing).

2.3.1 Qualitative HR impact

The emergence of new work technology necessarily implies learning the skills to deal with such technology. Skills are obsolescent in the sense that their utility dissipates as work processes or technologies change and require novel skills or an adjustment in those skills employees already master (Allaart et al., 2002).

The impact on skills profile originating from the DT is so pervasive and wide that a substantial body of literature has been produced specifically targeting digital skills. This body of literature is not only

academic in origin (e.g. Van Laar et al., 2017) but also institutional as the main global governing bodies gave this topic a central place in designing public policy (OECD, 2022).

Although the obvious solution to improve digital skills lies in corporate training and upskilling, the alignment between training programs and employees' needs is not so guaranteed as Buvat et al. (2017) reported, based on a sample of 1250 worldwide, cross-sector respondents, that 42% of respondents believe that their organisation's training programs are useless and boring and 45% believe that the training programs are not helping them to gain new digital skills.

2.3.2 Quantitative HR impact

DT has the obvious consequence of helping processes to become automated, i.e. the flow of processes occurs without the need for human intervention. The logical outcome of such automation is the potential loss of jobs needed for a given company to operate. For example, Liu et al. (2022) analysed production departments in China and reported a reduced number of required employees due to more automation, and that employees with less education (i.e. high-school degrees) are substituted either by machine automation or employees that possess a higher qualification. In this same article, it is shown that employees with higher qualification are less likely to be dismissed due to having characteristics that are rare, valuable, costly to imitate and non-substitutable, i.e. due to offering a competitive advantage.

A similar conclusion is also mentioned by Brynjolfsson and McAfee (2014) who highlight the fact that the reorganisation of production due to DT is equally impactful for employees that are directly working with computers and those who are not dealing with technology. The tone in the literature suggests that the numbers related to employee exits may rise as a consequence of the ever-increasing usage of new work technologies.

However, being present in more digitalised world means a greater number of opportunities are within reach to the employees. These novel opportunities, e.g. for a designer to be offering work easily to any company located on the other side of the world without the traditional travelling or moving costs, may not be the rule for every single worker that could lose the job because those who work with simpler technology (e.g. receptionist, bank teller) will not be able to continue offering the same work to different employers across the world. Even if they are hired to work remotely using videoconference channels, their work conditions will not remain the same, and most likely will be downgraded.

Analysing data across 22 occupational categories, relating job displacement with AI and testing for the protective action of digital skills, N. Chen et al. (2022) found that 1) AI does have a substantial impact on job displacement, 2) that this displacement varies according to the specific occupational

category, and 3) that digital skills interact in the relationship between AI and job displacement in such a way that more digital skills, decrease the magnitude of this effect. Therefore, although the impact of AI upon job availability might be detrimental, digital skills can cushion this effect.

A benevolent view of the impact of DT on jobs, labels the changes not as "job loss" but rather as "job displacement" (e.g. N. Chen et al., 2022) highlighting the impact is manifested mostly in the need for reskilling and occupying new job responsibilities within or outside the organisation (e.g. via internal mobility strategy after retraining). As Villar and Khan (2021, p.83) stated in relation to the case study of Deutsche Bank's moving into DT "jobs will be lost despite retraining efforts and internal mobility strategy".

Overall, DT is expected to always exert impact on HR, both qualitative (pressing for higher digital skills acquisition) and quantitative (pressing for lower human resources needs and job displacement).

2.4 Barriers to digital transformation

Pirkkalainen and Pawlowski (2013, p. 5) define barriers as: "any challenge, risk, difficulty, obstacle, restriction or hindrance that might prevent a single person, a group or an organisation to reach an objective and success in a specific context when the challenge is related to acting or working in a collaborative cross border setting".

So, DT barriers can be taken as barriers that hinder how fast or well DT is implemented in the organisations. In the literature, several DT barriers have been identified and there are common classifications between studies. An important aspect in this literature review is the specificity of each study that addresses this topic regarding the sample studied.

2.4.1 Internal Barriers to DT

In general, internal barriers are related to aspects that the organisation is responsible for (Töytäri et al., 2017), i.e. the allocation of financial resources, training programs regularity and its contents, and the organisational culture itself. Our literature review allowed to identify 19 main barriers, which will be detailed below.

The first barrier, “lack of holistic vision and strategic planning towards Digital Transformation”, refers to the main aspect of well implemented DT: the understanding that it is a complex subject, and that it entails a large number of implications and change within the set of the company’s activity. All employees must understand why and how the future changes will happen, and the new expectations that they will be subjected to (Gkrimpizi et al., 2023). The shareholders and managers need to be aligned in their goals and expectations regarding this investment (Vogelsang et al., 2019) and if any party does not fully understand the change that they wish to implement, it may lead to failure and frustration (Syed et al., 2023), deterring future attempts to implement DT.

The second barrier, “lack of action plan and institutional policy”, complements the first. Not developing a detailed plan will make it more difficult to effectively realise DT since it will make it harder for employees to understand what goals should be achieved (Gkrimpizi et al., 2023). Additionally, if the internal policies in the organisation delay the implementation of matters related to DT (Verhoef et al., 2021) it may not be appealing to investors and this will halt the implementation of DT.

The third barrier, “insufficient elaboration of the regulatory framework in the field of information interaction in the enterprise”, still relates to the preparation needed for effective DT. New technologies may introduce more complex communication methods that, when well implemented, should be more secure and better for the company’s activity. Employees may not fully understand new communication methods inside the organisation, and those new communication methods towards outside agents may result in unwanted outcomes related to leaking confidential data or creating a sense of general uneasiness regarding communicating with the company, and also gather and store information (Borovkov et al., 2021).

The fourth barrier, “insufficient elaboration of the issue of transferring limited-access information through secure-access channels”, also relates to the company’s responsibility to prepare the employees while introducing the topic of IT skills inside the organisation. This barrier identified in Borovkov et al. (2021) refers to the lack of safety while only transferring information through electronic media. So, secure methods via physical hardware should be implemented while transferring confidential information. If this barrier is present, training programs will be needed to guarantee that the employees are qualified in matters of information security in the digital work environment, which may delay DT implementation and may introduce the notion of more security risks regarding this topic.

The fifth barrier, “low individual IT knowledge”, refers to the skills that each individual employee has regarding IT. This barrier may result in a much harder effort to introduce new technologies. It may delay the implementation of DT in a department or process depending on the current skill set and qualifications of specific employees (Gkrimpizi et al., 2023; Vogelsang et al., 2019). To remove this barrier, it would be needed a new selection criterion when recruiting new employees, requiring a better degree or certification regarding IT matters. Without resorting to firing current employees, relevant training programs are needed to upskill employees and make them better understand the technologies that will be introduced in the future.

The sixth barrier, “low individual IT literacy”, is similar to the fifth but differentiates by introducing the notion of how an employee might feel regarding working with new technologies, while the knowledge mentioned in the previous barrier regards only the efficiency and productivity of the employee with the new technology. Not being comfortable with more complex technologies may result in uneasiness while working and less qualified employees in this matter may show a lack of “know-how” in navigating software, creating a divide between employees that adapt more rapidly to new technologies and others that will still need a more basic training program to be comfortable and keep up. Separate simpler training programs may be needed for a select number of employees, while other employees can start with more complex training programs. This barrier was adapted from Gkrimpizi et al. (2023) to mainly include the confidence aspect that the barrier “Lack of Digital Literacy” presents.

The seventh barrier, “individuals fear and uneasiness regarding Digital Transformation”, regards how comfortable an employee is with DT. An apprehensive employee regarding this topic will need convincing or more time to understand all aspects of DT and how to safely navigate in the new environment. The downside of DT being a holist investment is that it introduces worries and the need to training programs regarding a multitude of topics: cybersecurity, data control, job loss, unwanted company data transparency (Vogelsang et al., 2019). The company that experiences this barrier needs to rigorously explain the predicted effects that DT will have in the number and function of the employees so to reduce employee’s uncertainty and clarify doubts regarding this topic.

The eight barrier, “aversion to change the culture and work methods”, may exist in tandem with the previous barrier, when employees do not fully trust DT. Bureaucratic cultures are slow in nature (Gkrimpizi et al., 2023) which halts any sort of dynamic changes enabled by DT, and Portugal has been described and recognised by many as having a culture of risk avoidance (Burton, 2015; Rego, 2004). However, the previous statement is based on a generalisation, and it is still needed to access how present this barrier is currently.

The ninth barrier, “lack/insufficiency of training, retraining, and advanced training programs for employees regarding Digital Transformation”, refers to the investment needed to accommodate all the new skills required because of DT (Borovkov et al., 2021). Companies may already have in practice some training programs regarding this topic, but to some companies, the cost of introducing and the time needed to have employees ready to work in the new digital environment may be less appealing, resulting in no changes being made.

The tenth barrier, “lack of time to train the employees in the new technologies and work methods”, completes the previous barrier. Companies that do not prioritise relevant topics in their training programs or allow their employees to learn the new topics will have a harder time implementing DT. Gkrimpizi et al. (2023) mention the workload of the employees in higher education institutions not allowing them to learn. It is important to identify which sector or sectors in Portugal experience this barrier.

The eleventh barrier, “lack of financial resources”, may reveal a lack of prioritisation to the example of the previous barrier, but it may also be a result of internal disputes to allocate financial resources for DT. Rupeika-Apoga and Petrovska (2022) found this is the main barrier in Latvian micro-enterprises as they had difficulty in obtaining public or private funding. This was corroborated in Cichosz et al. (2020) that found this barrier becomes less prevalent as the company size grows, and the smaller the company is, the less financial institutions are willing to fund risky projects. In the special case of public higher education institutions, Gkrimpizi et al. (2023) highlight they have a different budget depending on the subjects taught and country. In some cases, the budget does not allow for a risky investment and therefore, these institutions are dependent on the government decisions to allocate budget for investment purposes.

The twelfth barrier, “narrow view of ROI”, relates to the holistic nature of DT and difficulty of identifying improvements directly related to DT (Gkrimpizi et al., 2023). As mentioned, DT impacts several aspects of a company and there may be difficulty in quantifying the benefits of DT. Well planned DT and the introduction of metrics to evaluate work before and after DT may help calculate the ROI. Still, measuring the ROI of DT is not a straightforward task that is available to everyone.

The thirteenth barrier, “complexity of integrating new digital technologies with existing IT systems in the enterprise”, regards to the difficulty of introducing software and hardware that are compatible with previous methods of work, as lack of clarity in compatibility characteristics or lack of knowledge regarding this topic may halt DT implementation (Borovkov et al., 2021; Cichosz et al., 2020; Gkrimpizi et al., 2023). The existence of this barrier results in the need to totally overhaul the IT systems or the difficult exercise of creating a technological environment that integrates the old and new technologies. Both scenarios require some consideration to find the best fit to the company.

The fourteenth barrier, “data fragmentation”, refers to the dispersion of data across multiple systems, databases and applications (Gkrimpizi et al., 2023). As a result of DT, more data is produced from different sources and the need to be stored and shared internally may result in some problems if not properly accounted for. One issue of data fragmentation is harder interpretation of multiple data sources, for example Wei et al. (2012) researched data fragmentation in health clinics and found that when data came from a single clinic it led to misclassification of the patients in comparison when data came from both clinics used in the investigation. Applying the previous example in a company setting, the employees should have easy access to all information that they need to work, and that may be scattered by different software programs, resulting in different databases. This situation may render it difficult to interpret data. Scattered data in various levels of security (data that has different parameters for access requirements) may also become a problem that should be recognised before deploying DT, and methods to prevent security breaches should be applied: employee training; rigorous selection of what each employee should have access to and data encryption (Abdalla & Artoli, 2019).

The fifteenth barrier, “security and privacy risk”, should also be considered when addressing the previous barrier. Data fragmentation is only a part of the security issues that should be accounted for when addressing the topic of DT. In Rupeika-Apoga and Petrovska (2022), security issues were identified as a very important barrier to Latvian SMEs, which should be important to identify if Portuguese SMEs also have in mind this subject regarding DT. Companies that work with sensitive data may be especially hesitant to apply DT without proper guarantees that their data is secured (Cichosz et al., 2020; Gkrimpizi et al., 2023).

The sixteenth barrier, “unreadiness or lack of interest of the enterprise decision makers to implement Digital Transformation”, shows that the decision makers ultimately have the final word regarding implementation of DT (Borovkov et al., 2021). Employees that want the implementation of new work methods should be able to convince the decision makers by making the case of the benefits and a detailed plan of how to implement DT. However, decision makers may show unreadiness regarding this subject due to aversion to changing the culture or work methods or even due to previous failed attempts to DT. In any case, consideration of the topic should be done to maintain a level of competitiveness and to identify the best course of action.

The seventeenth barrier, “unreadiness of IT departments to implement and support Digital Transformation”, show that IT department may be unprepared to implement DT, either by complacency or by not having the necessary means (Borovkov et al., 2021). As mentioned, if the decision makers do not want DT, they will not expect the IT departments to investigate and innovate current technologies that would help the company activity, reducing the IT department to a “putting out fires” role.

The eighteenth barrier “inadequate internal IT support service”, refers to the quality of the IT personnel within the company. Lack of quality training programs or low standards of IT skills needed, in tandem with the fact that SMEs often have employees with IT responsibilities with a background that does not relate to this topic (Kratzer et al., 2024), result in an extra difficulty to keep IT competitive and the need to use outside resources and services to have a good IT infrastructure.

The nineteenth barrier "inadequate external IT support service”, occurs when companies recruit outside IT services, but the results remain lacking. Kratzer et al. (2024) exemplify this barrier by providing some scenarios where the need for external IT support may be present: lack of strategic alignment between IT infrastructure and business model, irregular IT investment (over budget or under invested), no in-house IT employees. This barrier is also present when the company employs server room services but has poor experience with these services. In conclusion, this barrier is present when outside IT agents are employed by the company, but their services are falling short, resulting in a need to reevaluate their output and if need be, replace them.

In the case of Portugal, based on 2014-2020 data from the Survey on the Use of Information and Communication Technologies in Companies conducted by INE, Teles (2023) reports that the DT barrier with the most impact is related to cybersecurity. Additionally, this author found that financial barriers are not truly deterring DT that much. Still, although there is some discrepancy in classifying DT barriers, due to the contexts studied in the different articles, it is possible to organise them around these 19 DT barriers that have just been reviewed. For a more comprehensive view on this topic, and for a specific understanding of such DT barriers in Portuguese context, Table 2.1 shows the internal DT barriers.

Table 2.1 - Internal DT barriers

Barrier's name	Description	Source
Lack of holistic vision and strategic planning towards Digital Transformation	Lack of comprehension on the subject and planning may lead to a failed digital transformation	Gkrimpizi et al., 2023; Syed et al., 2023; Vogelsang et al., 2019
Lack of action plan and institutional policy	Not developing an action plan on digital transformation may delay it	Gkrimpizi et al., 2023; Verhoef et al., 2021
Insufficient elaboration of the regulatory framework in the field of information interaction in the enterprise	Lack of comprehensive documents to explain and help guide the employees on how to use the technologies	Borovkov et al., 2021
Insufficient elaboration of the issue of transferring limited-access information through secure-access channels	Inability to identify the need and carry out data transfers through secure-access channels may lead to failure in digital transformation and the security of classified documents, which may slow down the plans for digital transformation	Borovkov et al., 2021
Individual IT knowledge	Knowledge on general IT	Gkrimpizi et al., 2023; Vogelsang et al., 2019
Individual IT literacy	Lack of "know-how" to complete everyday tasks without help	Gkrimpizi et al., 2023
Individuals fear and uneasiness regarding Digital Transformation	Individual emotions	Vogelsang et al., 2019
Aversion to change the culture and work methods	Current culture may slow down digital transformation due to current methods and how the employees expect and are expected to work	Burton, 2015; Gkrimpizi et al., 2023; Rego, 2004
Lack/insufficiency of training, retraining, and advanced training programs for employees regarding Digital Transformation	Overall quality of training programs is lacking	Borovkov et al., 2021

Table 2.1 (cont.) - Internal DT barriers

Lack of time to train the employees in the new technologies and work methods	Lack of time to learn and implement new software may reveal a lack of prioritisation in digital transformation	Gkrimpizi et al., 2023
Lack of financial resources	Lack of monetary resources may reveal that the enterprise is not able to implement digital transformation or that it doesn´t prioritise it; in addition, it may reveal lack of government support	Cichosz et al., 2020; Gkrimpizi et al., 2023; Rupeika-Apoga & Petrovska, 2022
Narrow view of ROI	Difficulty in attributing economic results to DT only	Gkrimpizi et al., 2023
Complexity of integrating new digital technologies with existing IT systems in the enterprise	Difficulties in identifying how to best proceed with the digital transformation	Borovkov et al., 2021; Cichosz et al., 2020; Gkrimpizi et al., 2023
Data fragmentation	Different departments may require special software unique to their activity. In addition to enterprise-wide software (employee accounts, client accounts) may result in difficulty in organising all the information	Abdalla & Artoli, 2019; Gkrimpizi et al., 2023; Wei et al., 2012
Security and privacy risk	Constant risk of attacks even with security measures may slow down digital transformation	Cichosz et al., 2020; Gkrimpizi et al., 2023; Rupeika-Apoga & Petrovska, 2022
Unreadiness or lack of interest of the enterprise decision makers to implement Digital Transformation	The decision makers make no effort to implement digital transformation	Borovkov et al., 2021
Unreadiness of IT departments to implement and support Digital Transformation	Overall quality of IT department is lacking	Borovkov et al., 2021
Inadequate internal IT Support Service	Inhouse employees cannot accomplish the task of implementing DT	Kratzer et al., 2024
Inadequate external IT Support Service	External services do not help enough with the implementation of DT	Kratzer et al., 2024

Considering the integrated view of the literature, we hypothesise that the more internal barriers a company experiences, the stronger the impact DT will have upon HR, both qualitatively and quantitatively. For short:

H1: Internal barriers are positively associated with HR impact

H1a: Internal barriers are positive associated with quantitative HR impact

H1b: Internal barriers are positively associated with qualitative HR impact

2.4.2 Contextual Barriers to DT

Contextual barriers are outside of the enterprise's reach but will affect the enterprise's decision regarding DT. Literature allow to identify some such barriers namely: 1) IT informational exchange incompatibility between industrial cooperation partners; 2) uncertainty about future digital standards and laws; 3) lack of adequate external IT infrastructure; 4) low availability of relevant software to the organisation; 5) lack of government support; and 6) shortage of specialists in the external labour market. Table 2.2 summarises the contextual barriers at study.

The first contextual barrier, "IT informational exchange incompatibility between industrial cooperation partners", is originally named as "Diverse IT maturity of production cooperation participants" (Borovkov et al., 2021) and it refers to different IT cooperation protocols between the organisation and other organisations, which may hamper information exchange and thus slow down the organisations' DT due to not wanting to misalign their IT protocols from those of their cooperating partners. This makes the adoption of new technologies less appealing because it would need partners to want and to be ready to implement compatible new technologies.

The second contextual barrier, "uncertainty about future digital standards and laws", refers to delays in identifying what may be the best course of action due to uncertainty. For example, a standard file format used within an organisations' activity may lead to choosing to implement different technologies and software (Rupeika-Apoga & Petrovska, 2022; Vogelsang et al., 2019). Clients or business partners may change their preference due to changes for the best or for the worst in the software produced by a third party. Similarly, future laws may change and dictate how a certain process should now be completed (Gkrimpizi et al., 2023). Using a recent topic, the EU Artificial Intelligence Act option for categorising algorithm implementation in HR as "high risk" (Regulation 2024/1689) may have critical implications in the recruiting process of new employees, and any company that could be developing that technology for such purposes may find it non-viable or requiring strong changes to be legally implemented after the 1st of August 2024.

The third contextual barrier, “lack of adequate external IT infrastructure”, refers to the local supply of electricity, internet and phone service that may influence how willing an organisation is to make investments and implement processes. If local electricity supply is unreliable, it may not be appealing to invest and change processes to be based on this external supply (Vogelsang et al., 2019). Gkrimpizi et al. (2023) mention that this barrier is less prevalent in Europe, but the aggregated data such as the one provided by the mobile connectivity index (GSMA, 2023) is unclear as to the true unique network coverage for the legal telecommunication operators and some specific locations inland can experience difficulties with infrastructural services. Likewise in power supply, the Portuguese regulator has evidence that technical quality of service is heterogeneous across the country (ERSE, 2024). Therefore, this barrier should be included in this study as the lack of reach on mobile data and reliable electric supply can hamper business across some locations.

The fourth contextual barrier, “low availability of relevant software to the organisation”, refers to the software products that are created by third parties. When a company states that there are few relevant products to their activity it may mean low knowledge about the offers available in the market, taking a more internal approach (Nagy et al., 2010). In this study, the barrier takes a more external meaning because it is the responsibility of the third parties to market their product and introduce themselves to the companies that would want to purchase their product. Companies that do not see advertisements about a product because it is only marketed to a certain area or activity sector become isolated and it results in less immediate access to the knowledge of the existence of a certain product. A market saturated with a plethora of different software makes it very difficult for companies to find the software that has the best fit to their wants and needs. In addition, if the best fit is not found there is a risk of failure in DT, rendering investments and efforts obsolete and deterring future attempts of DT.

The fifth barrier, “lack of government support”, refers to the grants or programs that incentivise the organisation to implement DT. In Latvia, micro enterprises are shown to need government support, while bigger enterprises are more able to at least independently start the implementation of DT (Rupeika-Apoga et al., 2022). According to the official statistics, 96.1% of Portugal’s companies are micro-entreprises (PORDATA, 2023) and therefore it is relevant to study if the lack of government support is also a main factor that deters DT. The existence of government policies that function as enablers is needed to incentivise and help the organisations overcome the obstacles (Borovkov et al., 2021); in addition, they need to be relevant and updated to best suit what the companies need and not restrict the companies’ choice of how strong and drastic the DT implementation will be (Gkrimpizi et al., 2023).

The final contextual barrier, “shortage of specialists in the external labour market”, is very present

in the findings of Rupeika-Apoga and Petrovska (2022) and it should also be studied in Portuguese SMEs, as they may represent a similar mentality of wanting ready-to-work specialists. The lack of already trained professionals in certain technologies may mean two aspects that hinder DT implementation. First, the need to train and the extra resources that will be needed, and secondly, if specialists in the field are not up to date in a certain software or process, it may mean that such software is a niche (or less prevalent in market), meaning that it may be different from client or partners expectations and affect the value generated from DT.

Table 2.2 - Contextual DT barriers

Barrier's name	Description	Source
IT informational exchange incompatibility between industrial cooperation partners	Enterprises that the enterprise cooperates with do not support or are unable to keep up with the enterprise's digital transformation	Borovkov et al. (2021)
Uncertainty about future digital standards and laws	Uncertainty about future production and legal standards slows down digital transformation	Gkrimpizi et al. (2023); Regulation 2024/1689; Rupeika-Apoga & Petrovska (2022); Vogelsang et al. (2019)
Lack of adequate IT Infrastructure	Lack of quality in the IT infrastructure the enterprise acts may halt digital transformation, i. e. mobile network, wi-fi, electricity supply	ERSE (2024); Gkrimpizi et al. (2023); GSMA (2023); Vogelsang et al. (2019)
Low availability of relevant software to the organisation	Lack of availability of compatible software to the enterprise's activity	Nagy et al. (2010)
Lack of government support	How a government sets grants and programs regarding the different aspects of digital transformation may slow down or halt digital transformation	Borovkov et al. (2021); Gkrimpizi et al. (2023); Rupeika-Apoga et al. (2022)
Shortage of specialists in the external labour market	Lack of specialists in the external labour market require investment in training	Rupeika-Apoga & Petrovska (2022)

Considering the literature, the more contextual barriers a company experiences, the stronger the impact DT will have upon HR, both qualitatively and quantitatively. However, by definition, organisational context co-occurs with whatever are the internal factors that may facilitate or hamper any organisational process or outcome. Therefore, context variables are often treated in empirical research as moderators, i.e. variables that interact with the variables used as predictors, so that they are able to change the strength or valence of the relationship between these predictor variables and their respective outcomes.

We thus reason that these barriers do not operate isolated but rather together. Therefore, we cannot understand their full extent as regards the impact in HR if they are artificially separated. Thus, we hypothesise:

H2: Contextual barriers co-occur with internal barriers in explaining HR impact in such a way that both internal and contextual barriers will be positively associated to the expected impact.

H2a: Contextual barriers co-occur with internal barriers in explaining quantitative HR impact in such a way that both internal and contextual barriers will be positively associated to the expected impact.

H2b: Contextual barriers co-occur with internal barriers in explaining qualitative HR impact in such a way that both internal and contextual barriers will be positively associated to the expected impact.

2.5 Conceptual model

The conceptual model integrates both hypotheses but due to the number of internal and contextual barriers identified in literature, it his model identifies a configurational approach which is not readily grasped by the usual graphical models. The closest to reality option considers the multiple interactions between all internal and contextual barriers. Because at this stage there is no fixed number of such barriers, they will be broadly represented and either falling in the internal or contextual barriers and their multiple interaction effects are depicted as the crossed lines adding to the second hypothesis.

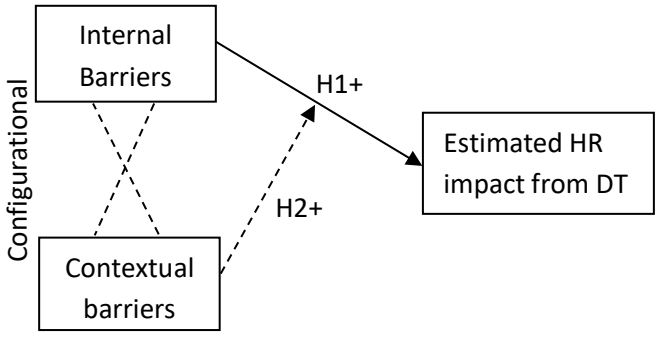

Figure 2.1 – Conceptual model

In practical terms, this configurational approach can be better depicted in a general hypothesis as follows:

General hypothesis: *The more the presence of barriers to DT (internal and/or contextual) in barrier configurations, the stronger the HR impact (separately tested for quantitative and qualitative).*

CHAPTER 3

Method

3.1 Procedure

A survey was deployed based on an online questionnaire produced in Qualtrics, comprehending data pertaining to sociodemographic variables, perceived barriers to DT, and perceived impact of DT on Human Resources.

Industry associations were contacted first by phone and the link to the online questionnaire was shared via email, if permission was granted, asking them to forward the link to their associates. In parallel, other organisations were contacted via their public emails, with a message explaining the study, its objective, academic nature and the link to the survey. Only organisations that can be classified as SMEs were eligible for this study. Within this category of SMEs we have included also the usually called micro firms which have up to 10 employees and an annual business volume below two million euro. All companies ranging from this size and business volume up to 250 employees and an annual business volume not exceeding 50 million euros have been considered eligible to this study. The data collection lasted from January to May 2024.

3.2 Sample

From the estimated minimum 814 invitations to participate in the study, only 71 entries in the link were registered. After analysing for missing values and removing answers from companies that describe themselves as “large company”, we kept only 30 thus corresponding to a very small response rate of those contacted. Therefore, this is a small size convenience sample. As time constraints pose a threat to the empirical study, we opted to consider these 30 valid answers as the workable sample. The sample comprises three micro companies, 20 small companies (up to 50 employees, annual business volume below 10 million euros), and seven medium size firms (up to 250 employees, annual business volume below 50 million euros). Participating firms are distributed across the national territory with the largest number found in Leiria District (n=7), Lisbon (n=6), and Braga (n=4). The remaining sample is located in Setúbal (n=3), Viseu (n=3), Oporto (n=2), Faro (n=2), Vila Real, Azores, and Aveiro with one company each.

These companies are mostly operating in Agriculture, animal production, hunting, silviculture, and fishing industry (n=5), construction (n=5), and Wholesale and Retail Commerce (n=5).

3.3 Data analysis strategy

As the scales have not been tested before it is advisable to test for their validity and reliability which were planned to be conducted with the commonly used data analysis techniques, namely exploratory factor analysis and Cronbach alpha (Heo et al., 2015). However, as the sample size precludes the application of these techniques, we opted to deploy correlational analysis (Spearman) and hierarchical cluster analysis on variables, which is a proxy to such psychometric information. This was conducted only for multi-item measures, namely the barriers. As per the single item measures, no such testing is required.

Likewise, both hypotheses were planned to be tested with ordinary least squares (OLS) regression but again, the small sample size prevents us from using this data analysis technique. As an alternative, and more suitable to offer a configurational view, fuzzy set Qualitative Comparative Analysis can be used with such sample to test which configurations (if any) of barriers can explain HR impact (Pappas & Woodside, 2021). This is already in line with the general hypothesis stated under the conceptual model section.

Small sample sizes are an impediment to using many data analysis techniques that operate with statistical distributions that require parameters such as the Gaussian curve, but such small sample sizes are not an impediment to using robust techniques such as fsQCA. This configurational approach can even outperform the usual interaction models (such as those previewed in PROCESS macro) as it offers a stronger understanding of real settings (as barriers are most likely interacting with each other simultaneously and not in pairs as usually tested with a regular moderation OLS analysis).

3.4 Measures

Internal barriers were measured based on several authors mentioned in the literature review that allow the identification of 19 items that express known factors that hinder DT implementation and development. In general, these are barriers that relate to aspects that the enterprise is responsible for (Töytäri et al., 2017). As listed in Table 2.1, these are: lack of holistic vision and strategic planning towards Digital Transformation (Vision); lack of action plan and institutional policy (NoPlan); insufficient elaboration of the regulatory framework in the field of information interaction in the enterprise (Manuals); insufficient elaboration of the issue of transferring limited-access information through secure-access channels

(NoInvest); low individual IT knowledge (DigSkill); low individual IT literacy (Literacy); individuals fear and uneasiness regarding Digital Transformation (EmpFear); aversion to change the culture and work methods (CultInert); lack/insufficiency of training, retraining, and advanced training programs for employees regarding Digital Transformation (Train); lack of time to train the employees in the new technologies and work methods (Train2); lack of financial resources (NoFinan); narrow view of ROI (UncROI); complexity of integrating new digital technologies with existing IT systems in the enterprise (Complex); data fragmentation (DataFrag); security and privacy risk (SecPriv); unreadiness or lack of interest of the enterprise decision makers to implement Digital Transformation (Mnagers); unreadiness of IT departments to implement and support Digital Transformation (ITDept); inadequate internal IT support service (InternIT); inadequate external IT support service (ExternIT) (Abdalla & Artoli, 2019; Borovkov et al., 2021; Burton, 2015; Cichosz et al., 2020; Gkrimpizi et al., 2023; Kratzer et al., 2024; Rego, 2004; Rupeika-Apoga & Petrovska, 2022; Syed et al., 2023; Verhoef et al., 2021; Vogelsang et al., 2019; Wei et al., 2012). Respondents were questioned as to which extent each item represented a felt barrier to DT and invited to answer in a 5-point scale ranging from 1 (Absent or Very weak) to 5 (Very strong) (see Appendix A).

Because this is a novel measure, before advancing, we opted to explore its dimensionality so to prevent multicollinearity and lack of parsimony. As the DT barriers may be theoretically linked among themselves, we have conducted a correlation analysis to evaluate the potential for latent variables.

Table 3.1 shows the Spearman bivariate statistics (as the assessment of normality indicates these variables do not follow a normal distribution). An analysis of the correlations shows most barriers are significantly correlated, which suggests further exploration as regards their shared variance.

An exploratory factor analysis would be the recommended data analysis technique but due to the small sample size, this data analysis technique was ruled out. In its place, we have opted to proceed to a cluster analysis focused on variables. This is the closest procedure to a factor analysis (although completely different from the mathematical approach) which allows to identify eventual groups of barriers that are more similar between themselves than they are to any other groups of barriers.

A hierarchical cluster analysis of the internal barriers with the aggregation based on Ward method suggests data is organised around four clusters. Figure 3.1 shows the dendrogram and respective structure.

Table 3.1 – Bivariate statistics for internal DT barriers

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. NoPlan	1																	
2. EmpFear	.613**	1																
3. DigSkills	.570**	.445**	1															
4. Literacy	.584**	.389*	.902**	1														
5. CultInert	.477**	.521**	.785**	.802**	1													
6. FinRes	.145	.169	.218	.372*	.245	1												
7. UncROI	.457**	.284	.614**	.713**	.581**	.476**	1											
8. NoInvest	.354*	.604**	.384*	.355*	.420*	.369*	.286	1										
9. Vision	.544**	.442**	.715**	.761**	.663**	.361*	.677**	.369*	1									
10. Train	.398*	.354*	.699**	.630**	.553**	.253	.387*	.413*	.668**	1								
11. Complex	.604**	.698**	.659**	.598**	.618**	.107	.250	.450**	.565**	.631**	1							
12. SecPriv	.322	.289	.475**	.347*	.388*	.355*	.355*	.354*	.332	.603**	.327	1						
13. DataFrag	.493**	.383*	.481**	.374*	.276	.252	.396*	.311	.325	.344*	.345*	.439**	1					
14. Mnagers	.554**	.556**	.581**	.549**	.591**	.270	.581**	.374*	.644**	.486**	.527**	.303	.255	1				
15. ITDept	.338	.406*	.356*	.349*	.350*	.385*	.365*	.265	.280	.207	.126	.247	.415*	.488**	1			
16. InternIT	.427*	.284	.475**	.384*	.240	.462**	.565**	.361*	.552**	.399*	.259	.428*	.606**	.295	.385*	1		
17. ExternIT	.613**	.589**	.543**	.512**	.503**	.453**	.616**	.458**	.626**	.298	.335	.446**	.589**	.428*	.513**	.707**	1	
18. Manuals	.373*	.281	.561**	.498**	.376*	.260	.478**	.236	.520**	.488**	.481**	.364*	.554**	.224	.279	.732**	.461**	1
19. Train2	.435*	.315	.595**	.558**	.447**	.275	.357*	.249	.545**	.478**	.439**	.390*	.463**	.301	.326	.476**	.559**	.550**

*p<.05; **p<.0.01

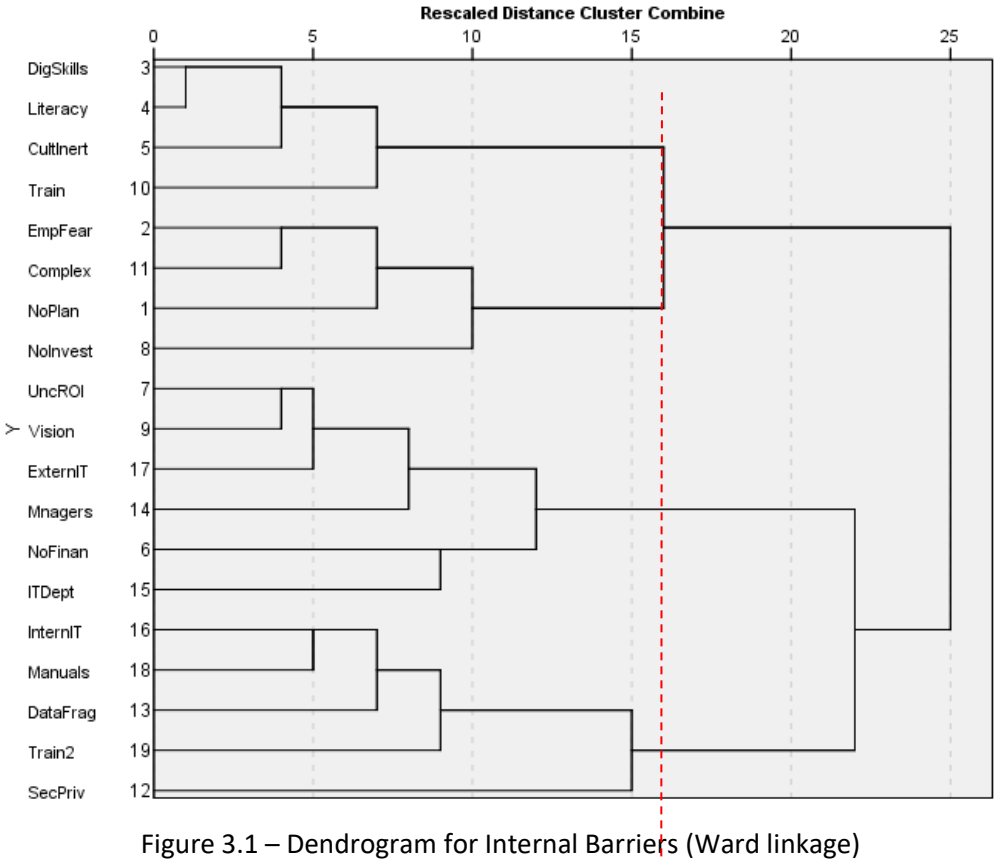

Figure 3.1 – Dendrogram for Internal Barriers (Ward linkage)

The first cluster (**competencies**) comprises four internal barriers (low individual IT knowledge; low individual IT literacy; aversion to change the culture and work methods; lack/insufficiency of training, retraining, and advanced training programs for employees regarding Digital Transformation) and overall expresses barriers linked to competencies.

The second cluster (**resistance**) also comprises four barriers (individuals fear and uneasiness regarding Digital Transformation; complexity of integrating new digital technologies with existing IT systems in the enterprise; lack of action plan and institutional policy; insufficient elaboration of the issue of transferring limited-access information through secure-access channels). Overall, it expresses resistance due to effort.

The third cluster (**management**) comprises six barriers (narrow view of ROI; lack of holistic vision and strategic planning towards Digital Transformation; inadequate external IT support service; unreadiness or lack of interest of the enterprise decision makers to implement Digital Transformation; lack of financial resources; unreadiness of IT departments to implement and support Digital Transformation). Overall, it expresses barriers linked to managers' unwillingness to proceed.

The fourth cluster (**internal IT**) comprises five barriers (inadequate internal IT support service; insufficient elaboration of the regulatory framework in the field of information interaction in the

enterprise; data fragmentation; lack of time to train the employees in the new technologies and work methods; security and privacy risk). Overall, it expresses barriers linked to IT.

Overall, the 19 internal barriers can be subsumed in four types of barriers which represent a much more meaningful and parsimonious measure.

Contextual barriers were also identified and measured based on literature. In general, contextual barriers are outside of the enterprise's reach but will affect the enterprise's decision regarding DT. As listed in Table 2.2, the following six barriers were identified based on relevant literature: IT informational exchange incompatibility between industrial cooperation partners (Partners); uncertainty about future digital standards and laws (UncLaw); lack of adequate IT infrastructure (Infrastruct); low availability of relevant software to the organisation (Software); lack of government support (Governm); shortage of specialists in the external labour market (Profess) (Borovkov et al., 2021; ERSE, 2024; Gkrimpizi et al., 2023; GSMA, 2023; Nagy et al., 2010; Regulation 2024/1689; Rupeika-Apoga and Petrovska, 2022; Rupeika-Apoga et al., 2022; Vogelsang et al., 2019). Answers were requested in identical way to the internal barriers.

Following the same rationale, we have conducted a bivariate analysis (Table 3.2) which has also indication of existing shared variance.

Table 3.2 – Bivariate statistics for contextual DT barriers

	1	2	3	4	5
1. Partners	1				
2. UncLaw	.542**	1			
3. Infrastruct	.188	.252	1		
4. Software	.296	.201	.395*	1	
5. Governm	.533**	.306	0.145	.421*	1
6. Profess	.526**	.618**	0.038	.429*	.568**

*p<.05; **p<.01

A similar procedure conducted with the contextual barriers suggests two clusters. Figure 3.2 shows the dendrogram and respective structure.

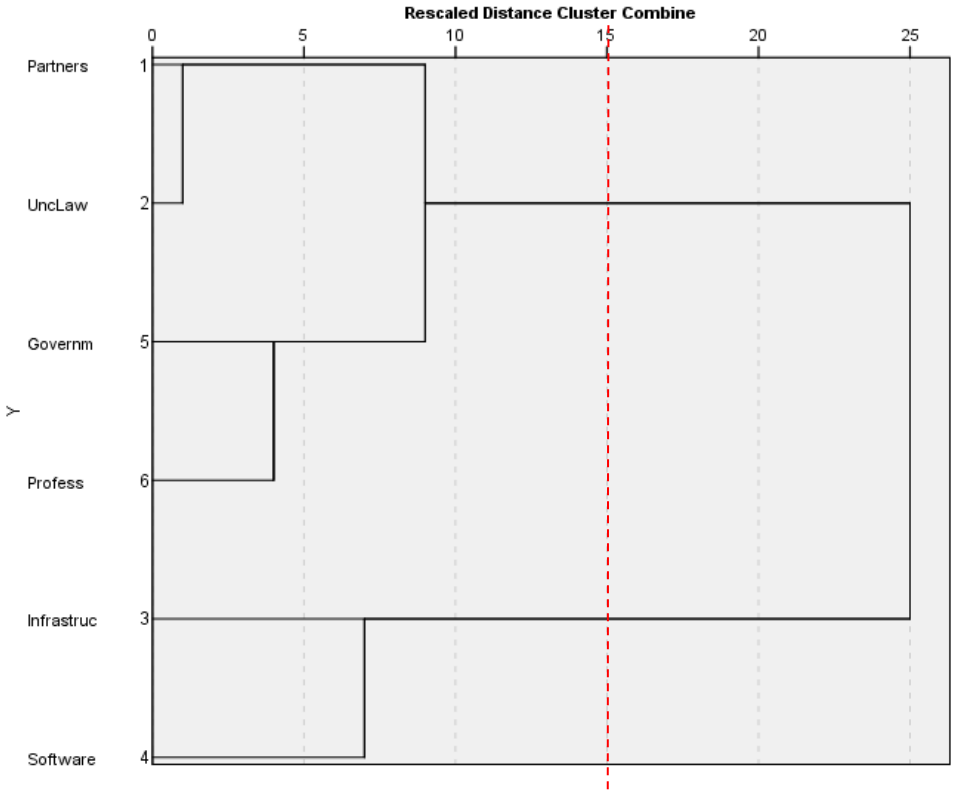

Figure 3.2 – Dendrogram for Contextual Barriers (Ward linkage)

The first cluster (**stakeholders**) comprises four contextual barriers (IT informational exchange incompatibility between industrial cooperation partners; uncertainty about future digital standards and laws; lack of government support; shortage of specialists in the external labour market) and overall expresses barriers linked to stakeholders' action.

The second cluster (**technical environment**) comprises two contextual barriers (lack of adequate IT infrastructure; low availability of relevant software to the organisation). Overall, it expresses unfavourable technical environment to sustain DT.

Expected HR Quantitative impact was measured with a single item created *ad hoc*. It pertains to the expected impact of digital transition on the size of workforce ("Consider your enterprise, how much impact do you think DT will have on the number of workers in your enterprise in the next 5 years"). Participants were requested to answer the HR quantitative impact in a 5-point scale as follows: 1) it will strongly decrease the required number of employees, 2) it will decrease the required number of employees, 3) it will have no impact on the number of employees, 4) it will increase the required number of employees, 5) it will strongly increase the required number of employees.

Expected HR Qualitative impact was measured with a single item also created ad hoc. It pertains to the impact as regards the qualification profile of the workforce ("Consider your enterprise, how much impact do you think DT will have on the functions of workers in your enterprise in the next 5

years, choose the option that best describes your situation”). Participants were requested to answer in a 3-point scale as follows: (1) will remain the same, 2) will substantially change, 3) will radically change.

CHAPTER 4

Results

4.1. Descriptive and bivariate analysis

Among the internal barriers it is skills that has the highest median (med=2.87), followed by resistance (med=.275), internal IT (med=2.70) and finally management (med=2.50). From the contextual barriers, it is the stakeholders that have the highest median (med=2.75) while the technical environment's value is quite modest (med=2.0) (see Appendix A). This indicates that among DT barriers, respondents ascribe to the ones depending on employees and stakeholder the stronger presence. As regards the impact, quantitative HR impact has a median of 3 and a very low variation associated with it. Namely, 25 out of the 30 respondents have chosen this option standing for "no impact". As for the qualitative impact, the median is 1.5 and the distribution of frequencies is n=15 for "will remain the same", n=14 for "will substantially change" and only n=1 for "will radically change".

Both organisational characteristics (size and experience in implementing DT) have been included in the correlations table and larger organisations tend to report an expected stronger qualitative impact of DT (r=.383, p<.05). The experience of having tried to implement DT is negatively correlated with all the internal barriers but not with any of the external ones. The strongest correlation is observed with skills (r=-.647, p<.01) and the more modest is observed with resistance (r=-.460, p<.05).

Table 4.1 – Descriptive and bivariate statistics (Spearman)

		Min-max	Median	1	2	3	4	5	6	7	8	9
1.	Org Size	1-3	2.00	1								
2.	Tried implement DT	No 1-3 Y	2.00	-.271	1							
3.	IB_skills	1-5	2.87	.206	-.647**	1						
4.	IB_resistance	1-5	2.75	.184	-.460*	.682**	1					
5.	IB_management	1-5	2.50	.026	-.479**	.682**	.685**	1				
6.	IB_internal_IT	1-5	2.70	.081	-.480**	.537**	.600**	.492**	1			
7.	CB_stakeholders	1-5	2.75	-.148	-.338	.468**	.420*	.463**	.508**	1		
8.	CB_technic_environt	1-5	2.00	.078	-.170	.361	.573**	.418*	.457*	.387*	1	
9.	Quantitative impact	1-5	3.00	.074	.164	-.259	-.259	-.411*	-.344	-.561**	-.433*	1
10.	Qualitative impact	1-3	1.50	.383*	-.109	.077	.163	.193	.120	.138	.474**	-.393*

*p<.05; **p<.01

4.2 Hypothesis testing

As explained in the data analysis strategy section, fsQCA analysis is deployed to test the general hypothesis. fsQCA analysis typically follows a sequence that will structure the remaining of this section: necessary conditions, truth table, and solution table. Data transformation was conducted to recalibrate values so to guarantee all are represented from 0 to 1 as explained in Pappas and Woodside, (2021). Firstly, a fsQCA will be shown for "Qualitative HR impact", and then again for "Quantitative HR impact".

4.3 Necessary conditions for Qualitative HR impact

Following Ragin (2008) and Schneider and Wagemann (2012), the first step in fsQCA is to analyse if there is any cluster of DT barriers that is so prevalent in explaining the expected HR impact on competencies that it must be considered a "necessary condition". Necessary conditions are those that are present in all the solutions which would make their inclusion redundant. According to these authors conditions presenting a consistency above 0.90 (≥0.90) are considered "necessary" and should then be removed from the analyses (Table 4.2).

Table 4.2 – Qualitative HR impact: analysis of necessary conditions

Conditions tested	Consistency	Coverage
IB_skills	0.781521	0.728470
IB_resistance	0.752174	0.748917
IB_management	0.739782	0.767998
IB_internal_IT	0.749565	0.731128
CB_stakeholders	0.730435	0.744186
CB_technical_environment	0.700000	0.795061

As shown above, the clusters' consistencies range from 0.70 to 0.78, and so none of the conditions can be considered necessary for this outcome. We thus kept all the conditions in the analyses.

4.4 Truth Table for Qualitative HR impact

After creating a truth table with all clusters for the outcome of "Qualitative HR impact", we can check the raw consistency, PRI consistency and SYM consistency of a configuration of barriers. After

removing all configurations that were not present in the data base (Table 4.3), we then remove all configurations, from the analyses, that have a raw consistency below 0.85 (<0.85) and PRI consistency below 0.70 (<0.70). The raw consistency threshold of 0.85 is applied to increase the reliability of the configurations (Mattke et al., 2021; Ragin, 2008) and the PRI consistency threshold of 0.75 is applied due to the exploratory nature of this study and is still an acceptable threshold (Greckhamer et al., 2018).

Table 4.3 – Qualitative HR Impact: truth table, sorted by PRI consistency

IBS	IBR	IBM	IBIT	CBS	CBT	N	QlHR	raw consist.	PRI consist.	SYM consist.
0	0	0	1	0	0	1	1	0.99	0.93	0.93
1	1	1	0	0	0	1	1	0.98	0.90	0.90
0	0	1	1	0	0	1	1	0.98	0.90	0.90
0	0	0	1	1	1	1	1	0.98	0.86	0.86
0	0	0	0	0	0	4	1	0.94	0.77	0.81
1	1	0	1	0	0	1	1	0.96	0.76	0.76
0	0	0	0	1	1	1	1	0.96	0.75	0.75
1	0	1	1	1	1	1	0	0.94	0.63	0.63
1	1	1	1	1	1	2	0	0.87	0.40	0.40
1	1	1	1	1	1	2	0	0.86	0.37	0.37

IBS – Internal barrier Skills; IBR – Internal barrier Resistance, IBM – Internal barrier Management; IBIT – Internal barrier Internal IT; CBS – Contextual barrier Stakeholders; CBT – Contextual barrier Technological Environment; QlHR – Qualitative HR impact

4.5 Solution table for Qualitative HR impact

Proceeding with the standard analyses, the following output is created (Table 4.4), which shows the solution table.

Table 4.4: Qualitative HR Impact: solution table

Barriers	Solution 1	Solution 2	Solution 3	Solution 4
Internal barriers				
IB_skills	⭘	⭘	●	●
IB_resistance	○	○	●	●
IB_management	○		●	⭘
IB_internal IT		●	●	○
Contextual Barriers				
CB_stakeholders		⭘	⭘	⭘
CB_Technical_Environment	○	○	●	●
Consistency	0.918733	0.989282	0.987114	0.967488
Raw Coverage	0.725	0.601956	0.632826	0.614565
Unique Coverage	0.123913	0.00326085	0.0328261	0.0160869
Overall solution coverage		0.816739		
Overall solution consistency		0.900959		

Core causal condition present (●); core causal condition absent (○); peripheral causal condition present (•); peripheral causal condition absent (◦)

The parsimonious solution presents the most important conditions, that should not be removed from any solution and represent the “core conditions”, as they appear in both the parsimonious and intermediate solution (see Appendix B) and the conditions that appear only in the intermediate solution are classified as “peripheral conditions”, where a causal relation with the outcome is weaker but present (Fiss, 2011).

Based on the solution table, four solutions are created to explain how the change in HR is perceived based on the barriers present:

- Solution 1 - Absence of barriers related to skills, resistance, management and the technical environment.
- Solution 2 - Absence of barriers related to skills, resistance, stakeholders; the technical environment; presence of barrier related to the internal IT.
- Solution 3 – Absence of barriers related to stakeholders; presence of barriers related to skills, resistance, management, internal IT and the technical environment.
- Solution 4 – Absence of barriers related to management, internal IT and stakeholders; presence of barriers related to skills, resistance and the technical environment.

4.6 Necessary conditions for Quantitative HR impact

Repeating the same data analysis procedure, the analysis of the necessary conditions to qualitative HR impact shows no DT barrier matches the required criterion (Table 4.5).

Table 4.5 – Quantitative HR Impact: analysis of necessary conditions

Conditions tested	Consistency	Coverage
IB_skills	0.875714	0.621073
IB_resistance	0.847143	0.641774
IB_management	0.852286	0.673211
IB_internal_IT	0.875428	0.649702
CB_stakeholders	0.852857	0.661129
CB_technical_environment	0.834286	0.720987

So, after analysing the consistency of the conditions for the outcome "Quantitative HR impact" and concluding that none of the conditions have a consistency above 0,90 (≥0,90) they are not classified as "necessary conditions" so all conditions should be included in the truth table analyses (Table 4.6) (Ragin, 2008; Schneider & Wagemann, 2012).

4.7 Truth Table for Quantitative HR impact

Table 4.6: Quantitative HR Impact: truth table, sorted by PRI consistency

IBS	IBR	IBM	IBIT	CBS	CBT	N	QnHR	raw consist.	PRI consist.	SYM consist.
0	0	0	1	0	0	1	0	0.92	0.48	0.48
0	0	0	1	1	0	1	0	0.92	0.44	0.44
1	1	1	0	0	1	1	0	0.91	0.42	0.42
0	0	1	1	0	0	1	0	0.91	0.35	0.35
1	1	0	1	0	1	1	0	0.90	0.34	0.34
0	0	0	0	1	0	1	0	0.90	0.33	0.33
1	0	1	1	1	0	1	0	0.88	0.26	0.26
0	0	0	0	0	0	4	0	0.80	0.16	0.18
1	1	1	1	1	0	2	0	0.80	0.15	0.16
1	1	1	1	1	1	2	0	0.81	0.15	0.16

IBS – Internal barrier Skills; IBR – Internal barrier Resistance, IBM – Internal barrier Management; IBIT – Internal barrier Internal IT; CBS – Contextual barrier Stakeholders; CBT – Contextual barrier Technological Environment; QlHR – Qualitative HR impact

The truth table created shows very low values for PRI consistency, meaning that the configurations have significant inconsistency (Pappas & Woodside, 2021) and should not be used to draw the solution table thus ending the fsQCA analysis for quantitative HR impact.

CHAPTER 5

Discussion and Conclusion

DT barriers are a popular recurrent topic in research due to its obvious negative effects into achieving institutional goals as regards the modernisation of business and the economics digital leverage. The assumption that DT barriers operate as a sum of individual contributions to the final status of resistance to DT implementation is questioned in this study under the reasoning that these DT barriers should not be treated individually (because they should co-occur in clusters) and their effects upon DT implementation acceptance can be configurational, i.e. a single cluster of barriers will not suffice or be even a necessary condition for such acceptance to occur.

Before discussing findings, we would like to start by the obvious fragility of this study: the small sample size. This surprisingly low response rate to this survey is an unfortunate situation as it precludes a more robust study and more relevant conclusions. However, we also reason that it can be an expression of the exact processes that determine DT resistance. This low response rate may just mirror the very low rate of persistent response found in the National Statistics Institute annual survey on the Use of Information and Communication Technologies in Companies. Eventually, such low response rates may be considered an important proxy of a potential barrier to data-driven economy and public policies but, most likely, it will just signal a lack of interest, lack of resources to comply with additional requirements than those SMEs already face daily.

The clusters that emerged from the first analysis clearly indicate patterns of association between DT barriers which can inform about how extensively policies destined to mitigate such barriers are targeting a sufficient number of those within the same cluster of if the impact may be only partial. From the breakdown analysis of the configuration generated by the fsQCA analyses, one can expect a change in the qualifications of employees based on the barriers present in the organisation.

As regards the qualitative expected impact upon HR there are four configurations that emerged from the analyses.

Configuration 1 refers to when the workforce has adequate skills, presents no resistance to the implementation of DT, managers are favourable to that, and the technical environment is ready (functional infrastructure and software required available). This makes it very likely that DT implementation will lead to stronger employee qualification changes. We may assume that a learning readiness environment is present in this situation and that DT requires specific training and therefore the workforce should be willing to receive such training and further change their skills profile.

Configuration 2 highlights the resistance or lack of readiness from IT dimension. The IT department is critical in today's operations in any organisation, also for SMEs (Surya et al., 2021). The willing stakeholders align with the trend to implement DT and despite some favourable internal conditions (i.e. workforce skill availability, lack of resistance) yet there seems to be more need for technical market and the internal IT department development that is yet unable to do so. Still, as management is neither a barrier or a facilitator, one can assume that once ready, managers will start deploying resources to capacitate IT or seek in the market emerging solutions.

Configuration 3 may be justified because the internal overall lack of readiness for DT implementation together with an external pressure to do so, will likely push the organisation into postponing DT implementation up to the point of having to do so hastily, when the pressure prevails as the internal IT is already capable of doing so. As the environment is not ripe for DT implementation, i.e. workforce does not have the right skills and is resistant to DT, and management is also not open to DT implementation, any pressure to implement DT should be cushioned and therefore, incremental changes towards preparing the organisation to DT, will not occur. Still, as the mounting pressure from stakeholders is in line with the market trends (De Gooyert et al., 2017) and the IT department can deploy the system quickly, the speed of change will be mostly felt by the workforce that is not ready for such implementation. Therefore, either there is a swift and strong investment in upgrading skills or newcomers will have to be hired to replace the existing workforce. All in all, either through heavy training or job replacement, the workforce qualification profile should change.

Configuration 4 may be justified due to a similar lack of readiness in the internal environment concomitant with an external pressure from stakeholders that is accompanied by a willingness from managers. Because the technical environment and the internal IT are not ready to deploy DT, one can infer that managers will start acting by overriding the IT resistance and buy the infrastructure and software that the market already has available, so to deploy the second phase which is to either train or fire unwilling employees. Outsourcing IT is also a possibility in this case. This scenario is characterised by a muscled action of managers which may lead to strong pressure on people to upskill or leave.

As regards the quantitative expected impact on HR, i.e. the change in the number of employees based on the barriers present, it was not possible to identify any configuration because 83% of the valid answers to the questionnaire were "there will not be an impact on the number of necessary workers". It is still possible to draw the general conclusion that it is not predicted that DT will affect the number of employees on Portuguese SMEs, but it is also likely that this is a sensitive topic since downsizing or job displacement is a serious subject in the labour relations and generally in the labour code. Alternatively, it is possible that participants hold the idea that some specific types of job may be

created while other destroyed with a final balance that does not contrast much with current headcount.

Still, there are many questions raised by our findings. Firstly, those that originate from the limitations of this study. The sample size is the most visible, but the data analysis deployed is suitable for such small samples. Still, would results hold with a much larger sample size? Would they change according to the industry? Judging on Dauth et al. (2017) it should change, as automation in manufacturing or, e.g. e-commerce in retail will quickly settle (Al Mashalah et al, 2022). Additionally, we can ask: would results remain stable across a certain time period, e.g. one year after will managers have the same expectations?

Answering these questions requires most likely a mix of qualitative and quantitative longitudinal studies. However, we trust our contribution may raise the important question of understanding to which extent is it worthy to approach DT barriers effects from a configurational viewpoint as such configurations emerged and offer comprehensive possibilities to tackle DT resistance.

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Appendix

Appendix A – Responses to the felt presence of a barrier in a 5-point scale ranging from 1 (Absent or Very weak) to 5 (Very strong)

	N (%)				
Digital Transformation Barrier	1	2	3	4	5
Lack of holistic vision and strategic planning towards Digital Transformation	5 (16,7%)	9 (30%)	12 (40%)	4 (13,3%)	0 (0%)
Lack of action plan and institutional policy	8 (26,7%)	4 (13,3%)	13 (43,3%)	5 (16,7%)	0 (0%)
Insufficient elaboration of the regulatory framework in the field of information interaction in the enterprise	4 (13,3%)	9 (30%)	10 (33,3%)	5 (16,7%)	2 (6,7%)
Insufficient elaboration of the issue of transferring limited-access information through secure-access channels	3 (10%)	9 (30%)	14 (46,7%)	3 (10%)	1 (3,3%)
Individual IT knowledge	3 (10%)	7 (23,3%)	13 (43,3%)	7 (23,3%)	0 (0%)
Individual IT literacy	4 (13,3%)	8 (26,7%)	11 (36,7%)	7 (23,3%)	0 (0%)
Individuals fear and uneasiness regarding Digital Transformation	6 (20%)	7 (23,3%)	13 (43,3%)	4 (13,3%)	0 (0%)
Aversion to change the culture and work methods	6 (20%)	8 (26,7%)	8 (26,7%)	8 (26,7%)	0 (0%)
Lack/insufficiency of training, retraining, and advanced training programs for employees regarding Digital Transformation	5 (16,7%)	9 (30%)	11 (36,7%)	5 (16,7%)	0 (0%)
Lack of time to train the employees in the new technologies and work methods	4 (13,3%)	6 (20%)	11 (36,7%)	8 (26,7%)	1 (3,3%)
Lack of financial resources	5 (16,7%)	12 (40%)	10 (33,3%)	1 (3,3%)	2 (6,7%)
Narrow view of ROI	4 (13,3%)	8 (26,7%)	12 (40%)	6 (20%)	0 (0%)
Complexity of integrating new digital technologies with existing IT systems in the enterprise	5 (16,7%)	8 (26,7%)	11 (36,7%)	6 (20%)	0 (0%)
Data fragmentation	4 (13,3%)	9 (30%)	10 (33,3%)	7 (23,3%)	0 (0%)
Security and privacy risk	7 (23,3%)	10 (33,3%)	7 (23,3%)	4 (13,3%)	2 (6,7%)
Unreadiness or lack of interest of the enterprise decision makers to implement Digital Transformation	6 (20%)	9 (30%)	9 (30%)	5 (16,7%)	1 (3,3%)
Unreadiness of IT departments to implement and support Digital Transformation	8 (26,7%)	11 (36,7%)	6 (20%)	5 (16,7%)	0 (0%)
Inadequate internal IT Support Service	4 (13,3%)	9 (30%)	10 (33,3%)	6 (20%)	1 (3,3%)
Inadequate external IT Support Service	7 (23,3%)	8 (26,7%)	12 (40%)	3 (10%)	0 (0%)
IT informational exchange incompatibility between industrial cooperation partners	6 (20%)	10 (33,3%)	9 (30%)	5 (16,7%)	0 (0%)
Uncertainty about future digital standards and laws	9 (30%)	11 (36,7%)	6 (20%)	4 (13,3%)	0 (0%)
Lack of adequate IT infrastructure	11 (36,7%)	10 (33,3%)	6 (20%)	3 (10%)	0 (0%)
Low availability of relevant software to the organisation	7 (23,3%)	9 (30%)	8 (26,7%)	5 (16,7%)	1 (3,3%)
Lack of government support	8 (26,7%)	4 (13,3%)	12 (40%)	5 (16,7%)	1 (3,3%)
Shortage of specialists in the external labour market	4 (13,3%)	7 (23,3%)	10 (33,3%)	7 (23,3%)	2 (6,7%)

Appendix B – Output for truth table analyses (Table 4.3).

```
**********************
*TRUTH TABLE ANALYSIS*
**********************


Model: Q12_19_6 = f(IB_skills01, IB_resistance01, IB_management01, IB_internal_IT01, CB_stakeholders01, CB_technical_environment01)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.945504
                                                                                                                                raw         unique
                                                                                                                               coverage    coverage    consistency
                                                                                                                               ----------  ----------  ----------
~IB_skills01*~IB_resistance01*~IB_management01*~CB_technical_environment01                                                     0.725       0.123913    0.918733
~IB_skills01*~IB_resistance01*IB_internal_IT01*~CB_stakeholders01*~CB_technical_environment01                                  0.601956    0.00326085  0.989282
IB_skills01*IB_resistance01*IB_management01*~IB_internal_IT01*~CB_stakeholders01*CB_technical_environment01                    0.632826    0.0328261   0.987114
IB_skills01*IB_resistance01*~IB_management01*IB_internal_IT01*~CB_stakeholders01*CB_technical_environment01                    0.614565    0.0160869   0.967488
solution coverage: 0.816739
solution consistency: 0.900959


**********************
*TRUTH TABLE ANALYSIS*
**********************


Model: Q12_19_6 = f(IB_skills01, IB_resistance01, IB_management01, IB_internal_IT01, CB_stakeholders01, CB_technical_environment01)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.945504
                         raw         unique
                        coverage    coverage    consistency
                        ----------  ----------  ----------
~CB_stakeholders01      0.847826    0.0543478   0.869565
~IB_management01        0.847609    0.0293478   0.853359
~IB_skills01            0.782608    0.00999987  0.885609
solution coverage: 0.923913
solution consistency: 0.817937

**********************
*TRUTH TABLE ANALYSIS*
**********************


Model: Q12_19_6 = f(IB_skills01, IB_resistance01, IB_management01, IB_internal_IT01, CB_stakeholders01, CB_technical_environment01)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.945504
Assumptions:
                                                                                                                                raw         unique
                                                                                                                               coverage    coverage    consistency
                                                                                                                               ----------  ----------  ----------
~IB_skills01*~IB_resistance01*~IB_management01*~CB_technical_environment01                                                     0.725       0.123913    0.918733
~IB_skills01*~IB_resistance01*IB_internal_IT01*~CB_stakeholders01*~CB_technical_environment01                                  0.601956    0.00326085  0.989282
IB_skills01*IB_resistance01*IB_management01*~IB_internal_IT01*~CB_stakeholders01*CB_technical_environment01                    0.632826    0.0328261   0.987114
IB_skills01*IB_resistance01*~IB_management01*IB_internal_IT01*~CB_stakeholders01*CB_technical_environment01                    0.614565    0.0160869   0.967488
solution coverage: 0.816739
solution consistency: 0.900959
```