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## DIGITAL TRANSFORMATION: A QUANTITATIVE ANALYSIS OF ROMANIAN SMEs

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### **Abstract:**

*With the expansion and omnipresence of digital technologies in most aspects of human life, organizations have felt the need to implement changes. Thus, digital transformation has become imperative, with organizations having to adapt to the new standards imposed by a digitalized world. This paper analyses the digital transformation in Romanian SMEs using a methodology based on quantitative analysis of data collected through a questionnaire. The aim is to understand how these companies' approach and implement digital transformation, as well as the impact of this process on management strategies and business models. The analysis of the quantitative research results will focus on the demographic profile of the companies, the stage of the digital transformation process, the impact on business performance, investments in digital transformation and predictive models. This work makes a significant contribution to understanding and promoting digital transformation among SMEs, providing a specific and relevant insight into the Romanian SME context.*

**Key words:** *Digital Transformation, Romanian SME, Quantitative Analysis, Digital Impact, Digitalization*

### **1. Introduction**

Digital transformation, crucial for organizational evolution, involves utilizing technology to enhance efficiency, effectiveness, and customer value. SMEs, particularly in Romanian manufacturing, face distinct challenges and opportunities in this process. Understanding digital transformation's essence and impact is vital amid evolving business landscapes.

The research aims to scrutinize digital transformation in Romanian SMEs, focusing on factors contributing to success or challenges encountered. It seeks to analyze its effects on operational efficiency, organizational culture, customer relations, and management strategies. By examining these aspects, the study aims to offer insights and recommendations for SMEs navigating the digital landscape.

The research's focus on SMEs in Romania is justified by: (1) The pivotal role of SMEs in Romania's economy, driving innovation and growth (Badulescu et al., 2024; Codruța Dura, 2016; Corinne Cordina, 2023; European Investment Bank., 2023); (2) Romania's varying digitization levels among SMEs, offering unique insights (Roman & Rusu, 2022); (3) Local market-specific challenges and opportunities, including regulatory and cultural factors (European Investment Bank., 2023; Sabin Dragoman et al., 2021); (4) The importance of digital adoption for SMEs' international competitiveness (European Investment Bank., 2023; OECD, 2000; Roman & Rusu, 2022); (5) Sectoral diversity in Romanian SMEs, influencing digitization approaches (European Investment Bank., 2023); (6) Contributions to literature and policy development in emerging economies.

Thus, studying digital transformation in Romanian SMEs helps to understand both local dynamics and wider insights into digital transformation in emerging economies. The primary study issue concerns how digital transformation affects SMEs' management strategies and business models in Romania, as well as the problems and opportunities it brings.

## **2. Research objectives and hypotheses**

The objectives determined from the scope of the research are mainly based on the following relevant themes:

- Exploring the drivers of digital transformation: Knowledge of these drivers is crucial to develop a clear roadmap for transformation, especially in the context of SMEs.
- Characteristics of digital transformation in SMEs: SMEs, being the backbone of economies, face unique challenges and opportunities in the digital age. Understanding how these businesses are approaching digital transformation and adapting to technologies is key to assessing the overall impact of this process on them.
- Impact on organizational culture and business strategy: organizational culture and strategy play a crucial role in the success of digital transformation (Isensee et al., 2020; Ninh Nguyen et al., 2024; Trenkle, 2019). The research assesses how these aspects are influenced and reconfigured in the context of Romanian SMEs.
- The role of digital technologies in delivering a better customer experience: A key aspect of digital transformation is the ability of SMEs to deliver an enhanced digital experience to their customers, a key factor in remaining competitive (Rojas-García et al., 2024).
- Challenges and opportunities of digital transformation in SMEs: SMEs face specific challenges such as limited resources and lack of experience in digital transformation. It is important to investigate these challenges and how they are managed (Clemente-Almendros et al., 2024).
- The role of innovation and experimentation in organizational culture: A culture that fosters innovation and experimentation is crucial for the success of digital transformation in SMEs. Exploring this will provide insight into the adaptability and resilience of SMEs in the face of change (Muduli & Choudhury, 2024).

- Digital transformation strategy and alignment with business goals: A clear and well-executed strategy is critical to the success of digital transformation. The study looks at how Romanian SMEs formulate and implement these strategies.
- Efficiency and operational costs in the context of digital transformation: Digital transformation can help SMEs minimize costs and improve efficiency, an important competitive advantage. It is relevant to assess how these benefits are realized in practice (Kallmuenzer et al., 2024).

Therefore, the following research objectives have been formulated to provide a comprehensive perspective on how Romanian SMEs are responding and adapting to the challenges and opportunities of digital transformation:

| OBJECTIVES                                                                                             | HYPOTHESES                                                                                                                              |
|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Determining the impact of digital transformation on the operational and financial performance of SMEs. | H1. Digital transformation is driving significant improvements in operational and financial efficiency in SMEs.                         |
| Assess how organizational culture is influenced by the digital transformation process.                 | H2. Digital transformation is driving a cultural change in organizations, promoting a mindset of innovation and adaptability.           |
| Analysis of employees' preparedness and adaptation to new digital technologies and processes.          | H3. SMEs face challenges in training and adapting employees to digital technologies.                                                    |
| Identify the main obstacles and challenges to organizational change through digital transformation.    | H4. The main barriers to digital transformation are related to resistance to change and lack of digital skills.                         |
| Assess the impact of digital transformation on relationships with customers and business partners.     | H5. Digital transformation improves relationships with customers and business partners by increasing efficiency and quality of service. |

**Table 1 Research Objectives and Hypotheses**

## **2.1. Research methodology**

A questionnaire-based research methodology has been developed to address research objectives and test proposed hypotheses. Applied to a diverse sample of 27 companies, it aims to assess digital transformation states, motivations, challenges, and benefits comprehensively. Structured questions cover strategy, planning, implementation, and evaluation aspects. The methodology ensures objectivity and inclusivity by carefully selecting a varied company sample. The process includes: (1) Descriptive analysis: Utilizing basic statistics for data understanding; (2) Correlation analysis: Examining relationships between digital investments and efficiency enhancements; (3) Cluster analysis: Segmenting companies based on responses to identify typical profiles; (4) Visualizations: Employing charts and graphs for clear data representation.

## **Questionnaire**

The questionnaire is a versatile research tool commonly used for data collection in both quantitative and qualitative studies, offering detailed insights into organizational perceptions and behaviours regarding digital transformation. It enables researchers to gather data from numerous respondents, facilitating statistical analysis and trend identification. Various sources, including renowned institutions like McKinsey, BCG, and Deloitte, offer digital maturity surveys to assess organizations' integration of digital technologies. Forrester and Gartner also provide frameworks and models for assessing digital maturity, often through detailed questionnaires.

The questionnaire, designed to analyse the impact of digital transformation on management and business models, focuses on key themes:

- Assessing the current state of digital transformation in companies.
- Understanding the motivations behind the decision to adopt digital transformation.
- Identifying the challenges and obstacles encountered in the process.
- Highlighting perceived benefits and lessons learned.

Structured around these core themes, the questionnaire aims to provide comprehensive insights into digital transformation. Specific questions delve into aspects such as the existence of a well-defined strategy, motivations for digital transformation, changes in organizational culture, and negative effects or unintended consequences.

The questionnaire is the backbone of this research, providing valuable data and insights into digital transformation in business. Through this tool, a clear picture of how companies perceive, approach, and implement the changes brought about by the digital era has been obtained. This information is essential to understand current market dynamics and anticipate future trends. The survey was conducted among companies during the period June 2023 - November 2023.

## **Statistical analysis**

The current research methodology focuses on analyzing data from the questionnaire applied to Romanian SME manufacturing companies. Python code executed in Google Colab was exclusively used for analysis, chosen for its accessibility and scalable computational resources. The analysis began with data preparation, converting categorical values into numerical for statistical processing. Descriptive analysis involved assessing data distribution and central trends through graphical representations and tables. Regression analysis explored relationships between variables, while correlation analysis identified associations between digital transformation aspects and organizational performance. Cluster analysis segmented data into homogeneous groups to reveal distinct patterns in SME digital transformation approaches. Rigorous statistical methods ensured the accuracy and relevance of results, contributing to a comprehensive understanding of digital transformation's impact on SMEs.

### **3. Results of the quantitative research**

This chapter delves into interpreting and analyzing questionnaire data, exploring respondent profiles, conducting qualitative analysis, and dissecting questionnaire sections to uncover themes, patterns, and insights. It addresses:

- Demographics: Company turnover, employee count, shareholding structure, and company nature distribution.
- Digital transformation status: Distribution across transformation stages and perceived importance.
- Business performance impact: Changes in operational and financial efficiency, highlighting impactful transformation aspects.
- Investment in transformation: Average turnover percentage allocated to digital investment and correlation with efficiency improvements.
- Modelling and prediction: Regression models evaluating operational or financial efficiency based on variables like digitization investment and transformation stage.

#### **3.1. Data preparation**

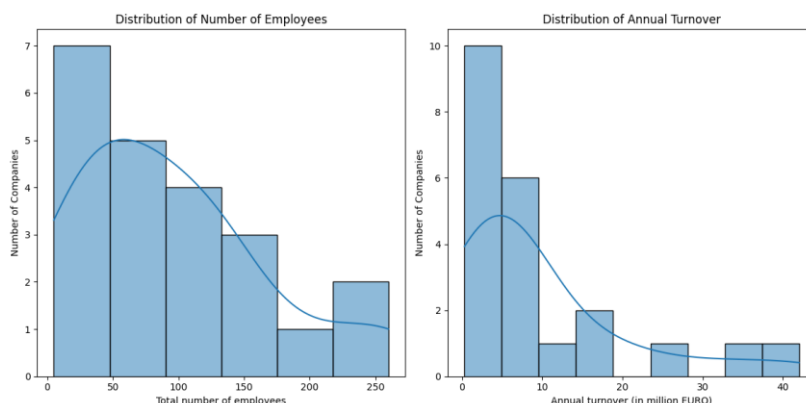
In preparing data for analyzing the digital transformation's impact on Romanian SMEs' management and business models, adjustments were made for consistency and relevance. Two companies exceeding the EUR 50 million turnover threshold were removed to maintain focus on SMEs, ensuring findings' validity. Additionally, three companies were excluded due to misalignment with research objectives, maintaining industry-specific focus. These optimizations enhance dataset accuracy, enabling a more robust analysis of SME digital transformation.

#### **3.2. Profile of respondents**

Before delving deeper into the analysis of the responses, it is essential to present the study participants through different characteristics captured in the questionnaire.

##### ***Number of employees and annual turnover***

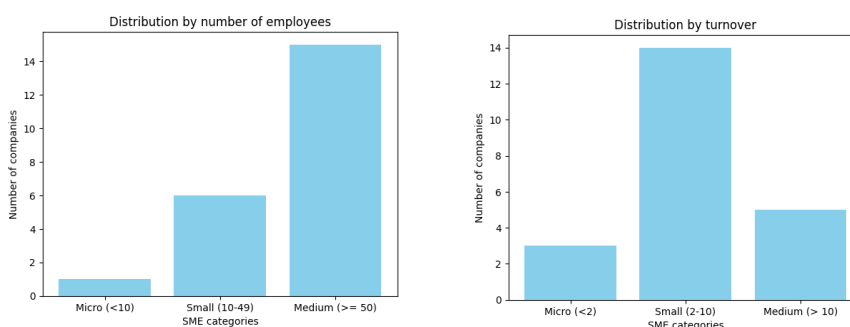
The histograms depict company distributions based on total employees and turnover (in EUR million). Most companies have turnovers ranging from 0 to 10 million EUR, with over half employing 0 to 100 individuals. According to the European Commission, SMEs employ fewer than 250 people and have turnovers below €50 million or balance sheet totals under €43 million. Micro-enterprises employ fewer than 10 individuals, small enterprises have 10 to 49 employees, and medium-sized enterprises have 50 to 249 employees. This study primarily adheres to the employee count definition utilized by the Eurostat's Structural Business Statistics (SBS) database.



**Figure 1. Distribution of respondents according to number of employees and turnover**

Source: own calculation

Among the questionnaire respondents, most companies are medium sized in terms of number of employees or small in terms of turnover:



**Figure 2. Distribution of companies by number of employees and turnover**

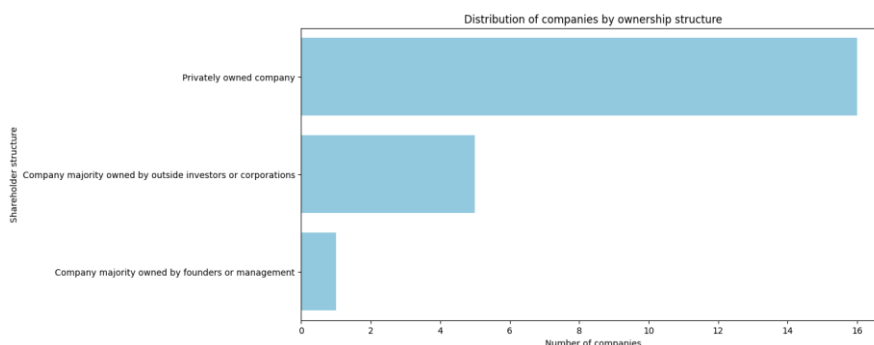
Source: own calculation

### Scope of activity

Respondent companies span various sectors, mostly *leather goods equipment and machinery manufacturing*. This diversity underscores differing impacts of digital transformation across industries. Geographically, companies vary in presence, with some being subsidiaries of foreign firms in Romania, others having international activity, and some operating solely nationally. This highlights how digital transformation is influenced by both local and international dynamics.

### Ownership structure

Shareholding structure significantly influences digital transformation pace and approach (Meng et al., 2022; Wang et al., 2023). Privately owned firms often have more autonomy to experiment with new technologies, while externally owned ones may access additional resources and expertise. Majority ownership by founders or management can strongly shape digitization efforts. This diversity highlights that digital transformation strategies vary based on organizational specifics.



**Figure 3 Distribution of companies by ownership structure**

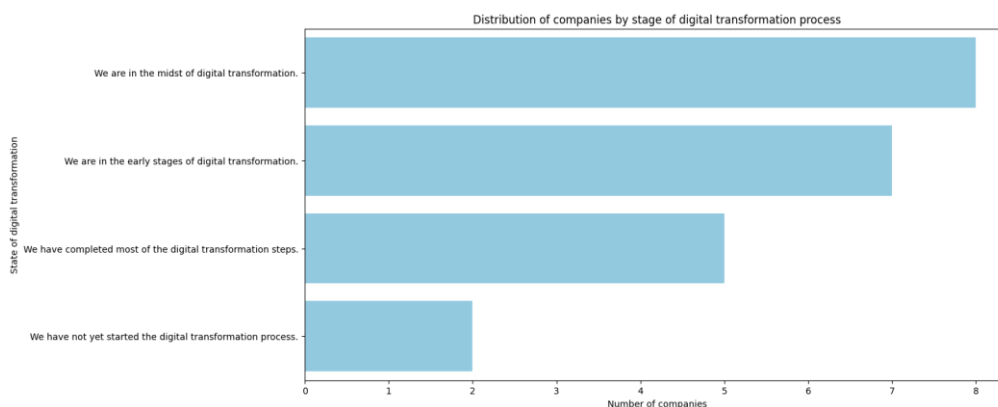
*Source: own calculation*

The distribution among respondents is depicted in Figure 3. It shows that most respondents (16 firms) are privately owned, suggesting a concentration of ownership in individuals or small groups, potentially influencing decision-making flexibility, including digital investment. Five firms are majority owned by external investors or corporations, indicating access to global perspectives and resources for advanced technology adoption. Only one firm reported majority ownership by founders or management, highlighting the potential for digital transformation decisions to rely heavily on their vision and commitment.

### **Stage of digital transformation process**

The analysis of digital transformation status in respondent companies offers insights into technology adoption and progress. The varied stages of digital transformation reflect different adoption levels influenced by internal and external factors like resources, culture, and strategy. Tailored approaches to digital transformation are crucial.

The analysis of digital transformation status among respondent companies reveals a spectrum of progress, influenced by factors like resources and organizational culture. Figure 4 illustrates the distribution of companies across various stages: 8 companies are mid-transformation, 7 are in early stages, 5 have completed most steps, and 2 have yet to begin.

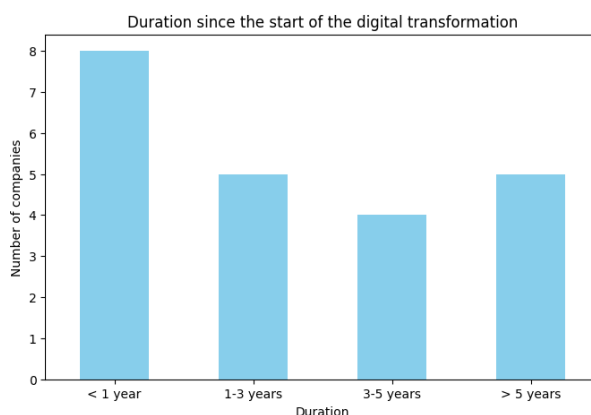


**Figure 4 Distribution of respondents by stage of digital transformation process**

*Source: own calculation*

### ***Duration since the start of the digital transformation***

Most companies (8) started the digital transformation process in the last year, followed by 5 companies that started the process between 1-3 years, 4 companies that started the process between 3-5 years ago and 5 companies who started more than 5 years ago. This distribution shows a recent trend of accelerating adoption of digital transformation, with many companies starting this process in the recent period. At the same time, the presence of companies that started digital transformation more than 5 years ago indicates an early interest in digitization among some organizations.

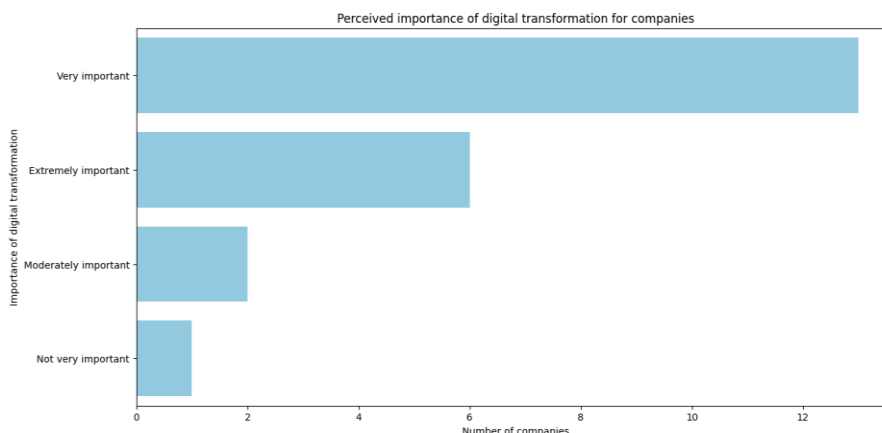


**Figure 5 Distribution by duration since start of digital transformation**

*Source: own calculation*

### ***The importance of digital transformation for companies***

Analysis of respondents' perceptions on digital transformation importance reveals their assessment of its impact and necessity in operations. While there's widespread recognition among respondent companies of its importance, variations exist in their assessments, influencing adoption speed and extent of digital technologies. Most companies, 13 in total, deem digital transformation very important, reflecting a broad awareness of its benefits for competitiveness and efficiency.



**Figure 6 Perceived importance from respondents**

*Source: own calculation*



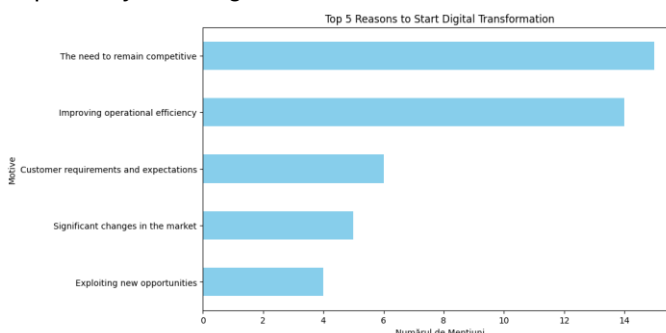
Six companies rank it as extremely important, indicating a deep understanding of its transformative potential. Two companies view it as moderately important, possibly indicating a more cautious approach or other strategic priorities. Lastly, one company considers it slightly important, potentially due to sector-specific considerations or a different assessment of digital technology's impact. See Figure 6 for detailed distribution.

### 3.3. Analysis of responses by section

The qualitative analysis aims to explore in depth the perceptions, feelings and opinions of the respondents.

#### Motivation

The analysis reveals primary motivations for digital transformation among respondent companies, showcasing diverse drivers from internal enhancements to external demands. These include maintaining competitiveness, enhancing operational efficiency, meeting customer expectations, adapting to market changes, seizing new business opportunities, and addressing supply chain challenges. External factors like funding availability, global instability, and the COVID-19 pandemic also influence digitization. Manufacturing SMEs prioritize competitiveness and operational enhancement, emphasizing efficiency in production processes over direct customer interaction. The COVID-19 pandemic accentuates the urgency to revamp processes for resilience and employee safety, making digital transformation crucial for agility and efficiency amidst market shifts. Thus, for manufacturing SMEs, it's a strategic imperative to optimize production and adapt swiftly. See Figure 7 for a concise overview.



**Figure 7 Top reasons for initiating digital transformation**

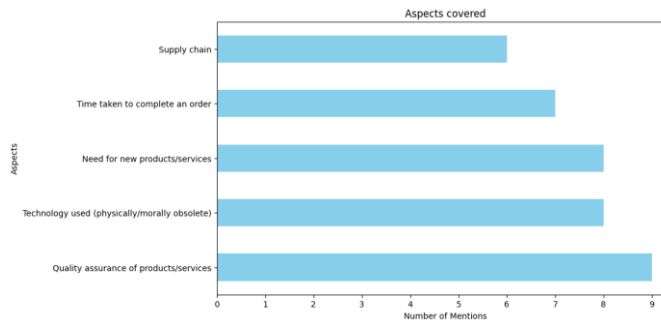
*Source: own calculation*

#### Aspects covered

Analyzing companies' digital transformation focus reveals key priorities: resource planning, cost control, employee skills, process efficiency, and technology selection. This underscores the SMEs' emphasis on operational efficiency, cost management, and upskilling, crucial for competitiveness. Digital transformation ensures continuous optimization and modernization across various areas.

### Production / Operations

The focus is on optimizing production and operations, enhancing resource planning, monitoring, and predictive maintenance, and updating technology to boost efficiency and quality. Companies prioritize technology updates, production optimization, and product development to stay competitive and responsive. Digital transformation entails not only adopting new technologies but also reconfiguring operations to meet evolving market needs. Key areas of emphasis include quality assurance, reduced order completion time, technology modernization, new product development, supply chain optimization, and predictive maintenance.

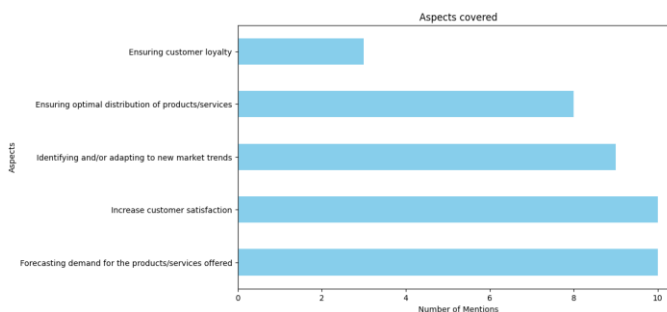


**Figure 8 Production/Operations focus**

*Source: own calculation*

### Markets and customers

Analysis of responses regarding Market and Customer aspects in the digital transformation process reveals top priorities of respondent companies. They aim to anticipate product/service demand (10 mentions), enhance customer satisfaction (10 mentions), adapt to new market trends (9 mentions), optimize product distribution (8 mentions) and foster customer loyalty (3 mentions). These priorities underscore a focus on customer-centric strategies to meet evolving market needs and enhance competitiveness.



**Figure 9 Market and Customer**

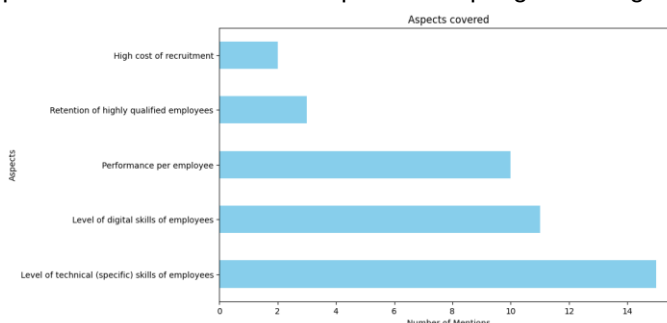
*Source: own calculation*

These responses demonstrate a strategic, customer-centric approach to digital transformation, emphasizing understanding customer needs, adapting to market dynamics, and enhancing the customer experience. This focus on customer-centric strategies

underscores the importance of remaining competitive and relevant in a consumer-driven business environment.

### **Human resources**

The analysis of HR-related responses in the digital transformation process emphasizes key priorities of respondent companies. With a focus on enhancing technical and digital skills, improving employee performance, and retaining talent, companies recognize the importance of skilled human capital in adapting to the digital era.

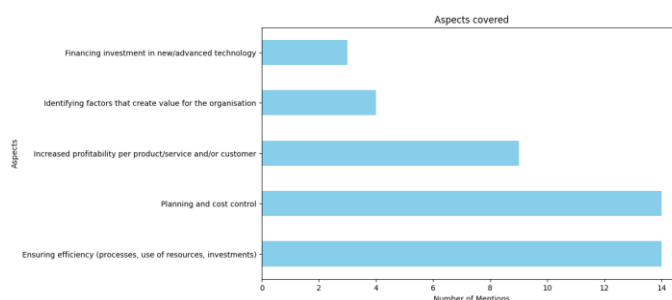


**Figure 10 Human Resources**

*Source: own calculation*

### **Financial**

Analyzing responses on digital transformation from a financial viewpoint reveals key priorities. Cost control is emphasized (14 mentions), indicating the importance of managing expenses. Maximizing efficiency (14 mentions) directly impacts financial performance. Increasing profitability (9 mentions) focuses on revenue enhancement. Identifying value (4 mentions) and financing innovation (3 mentions) underscore strategic investment. Overall, these responses show a concentrated effort on financial optimization alongside technology in digital transformation.



**Figure 11 Financial Aspect**

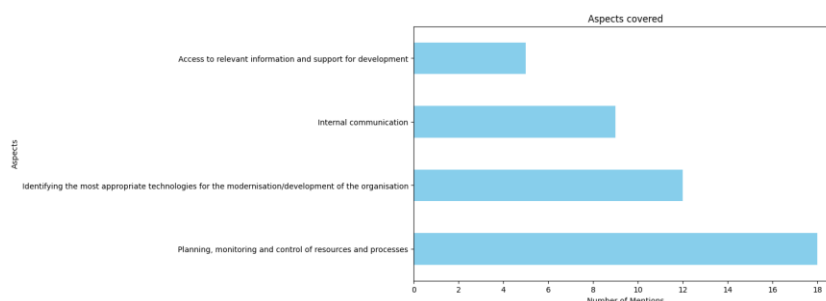
*Source: own calculation*

### **Management and internal processes**

The analysis of responses on digital transformation from a Management and Internal Processes perspective reveals key priorities.

Firstly, there's a strong emphasis (18 mentions) on improving internal resource and process management. Secondly, selecting suitable technologies (12 mentions) tailored to

company needs is highlighted. Thirdly, enhancing internal communication (9 mentions) is seen as crucial for successful transformation. Lastly, access to relevant information and development support (5 mentions) indicates a desire for growth. Overall, these responses demonstrate a concerted effort towards optimizing internal management and processes, recognizing that successful digital transformation hinges on effective internal resource management alongside technology adoption.



**Figure 12 Management and Internal Processes**

*Source: own calculation*

### **Mode of implementation**

Surveyed companies took a strategic approach to digital transformation, relying on internal resources rather than seeking external advice. They analysed data from digital solutions to assess the transformation's impact and invested in specialized hardware and custom software. Key areas of focus were IT infrastructure and production process automation, with senior management and operations playing crucial roles. They emphasized employee training and collaboration with external experts.

Regarding strategies, 11 companies had defined ones, 10 were developing, and one lacked a strategy. In terms of action plans, 13 were formulating, 7 had established plans, and 2 lacked them. While many companies didn't seek external consultancy, 4 did, indicating recognition of its value. Among those with clear strategies, nearly half used external consultancy, balancing internal capabilities with external guidance.

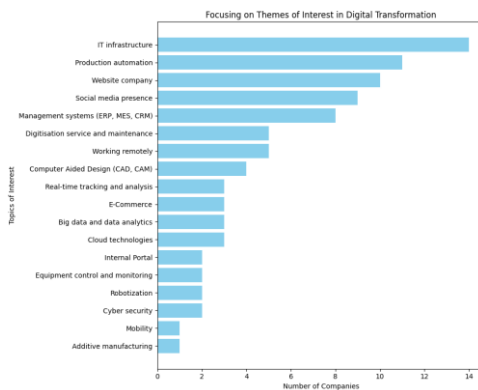
Companies employing consultancy services for digital transformation adopt a pragmatic, data-driven approach. They utilize data analytics, monitor KPIs, and gather feedback to adjust strategies, enhancing implementation.

In terms of investments, 14 companies invested in hardware, 13 in custom software, and 10 in data storage. Regarding software, 6 developed custom solutions, 7 combined custom development with purchasing existing ones, and 6 acquired existing software. In digital infrastructure, 14 extended existing setups, while 8 built new ones. Companies investing higher percentages of turnover in digital transformation tend to approach it more comprehensively, indicating a deeper commitment.

### **Topics of interest**

The 5 most frequently named themes reflect a focus on improving internal efficiency, digital customer interaction and data management, highlighting how digital

transformation is essential for SMEs to remain competitive and adaptable in a dynamic and increasingly digitalised business environment.



**Figure 13 Topics of interest**

*Source: own calculation*

### ***Roles and Actions***

Identifying key departments and managerial roles driving digital transformation is crucial for understanding its impact on management. Insights into leadership and organizational structure influence digital initiatives' adoption and success. Organizations can optimize management strategies, allocate resources effectively, and shape a culture supporting innovation by understanding these roles. Aligning digital transformation goals with management strategies is essential for an effective transition and maximizing benefits across the enterprise. The most frequently named themes focus on improving internal efficiency, digital customer interaction, and data management, emphasizing digital transformation's importance for SMEs to remain competitive. Responses highlight strong involvement of senior management, Operations/Production, and IT/Technology teams. Finance/Accounting and Marketing/Sales also play significant roles, albeit to a lesser extent.

Executive leadership is crucial in guiding and supporting digital transformation initiatives. SMEs' digital transformation success largely depends on top management's commitment and vision, mobilizing resources and influencing organizational culture. Active involvement of operational and IT departments indicates a practical, implementation-oriented approach. Analyzing companies' responses on actions taken for digital transformation, training existing employees for digital adaptation is crucial. Working with external experts and consultants is also common. Some companies create new roles or departments dedicated to digital transformation or hire specialized staff. Investment in existing human capital through training and development of digital skills is crucial for SMEs' successful digital transformation. Using external experts reflects a proactive and strategic approach in managing digitization's changes.

Results show varied approaches among companies to digital transformation, underscoring differences in strategic development, operational planning, and use of

external resources. Tailored approaches are essential for each company's digital transformation journey.

### **Organizational change and competence development**

Companies have approached organizational change during digital transformation with a strong commitment to employee training and development, ensuring that employees are prepared for new digital technologies and processes. This has been achieved through the implementation of dedicated training and coaching programmes, but also through the development of a change management plan that involved effective communication and active employee participation. In addition, companies have promoted a digital culture by involving employees in transformation projects and providing the resources needed to adapt to new technologies. However, they have encountered significant obstacles, such as insufficient financial resources to implement the necessary digital infrastructure and resistance to change from both employees and management, challenges that have required a strategic and adaptive approach to overcome.



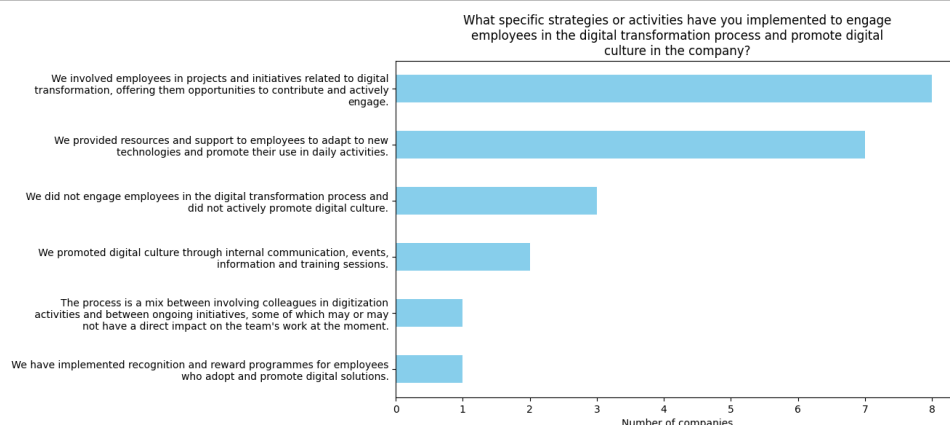
**Figure 14 Answers related to organizational change management**

*Source: own calculation*



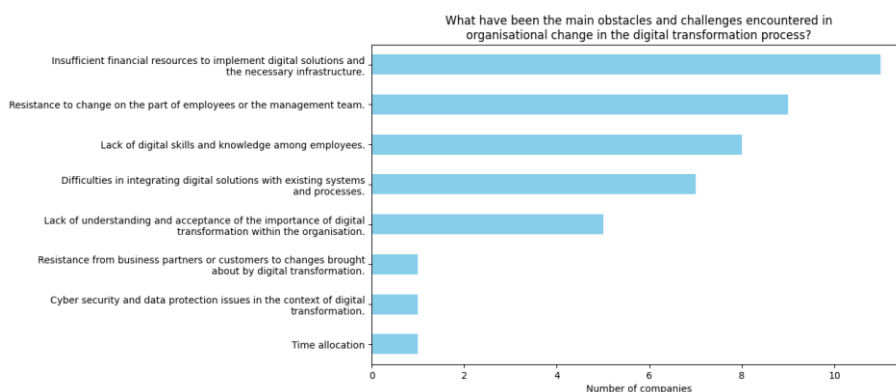
**Figure 15 Responses related to employee training**

*Source: own calculation*



**Figure 16 Responses related to employee involvement**

*Source: own calculation*



**Figure 17 Responses related to obstacles and challenges**

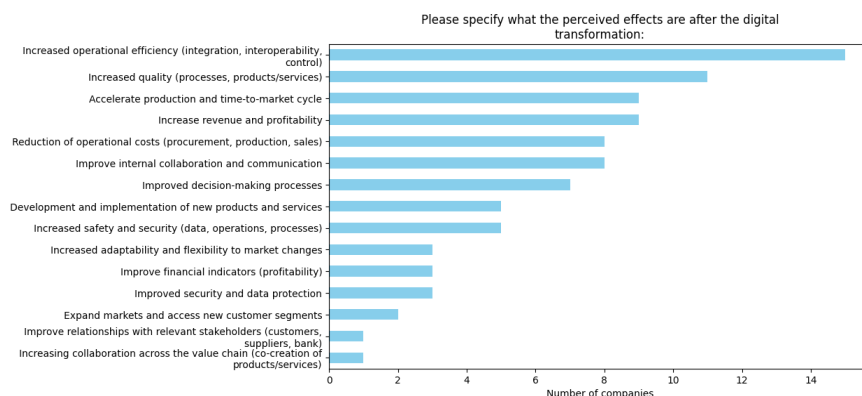
*Source: own calculation*

### **Impact**

Digital transformation has positively impacted companies, enhancing operational efficiency and product/service quality. Departments like production, operations, finance, and accounting are notably affected. New management skills, particularly in digital platform use and data analysis, are required. Managing the transformation entails focusing on employee engagement and communication for cohesive implementation. Changes include improved decision-making with greater transparency and data-driven culture. Challenges include adapting to new technologies, highlighting the need for a well-managed transition and adequate employee support.

### **Perceived effects**

Digital transformation positively impacts businesses with various measurable improvements. Enhanced operational efficiency stands out, achieved through improved process integration and system interoperability. This efficiency uplifts internal processes and product/service quality, aligning with customer expectations.

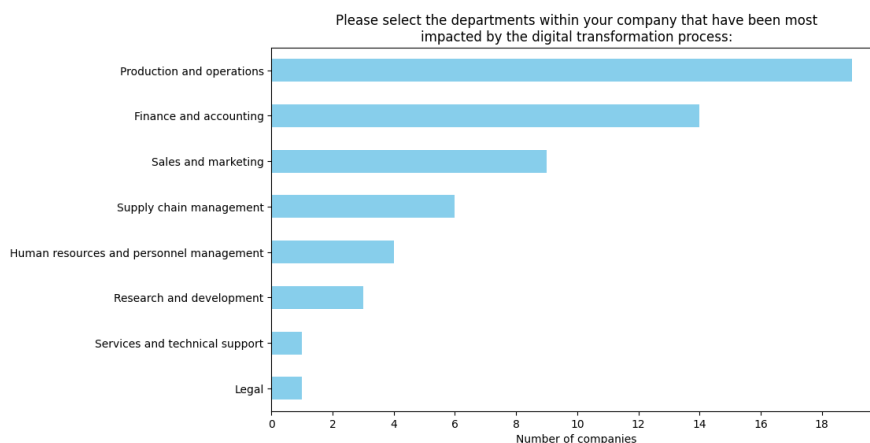


**Figure 18 Responses related to perceived effects**

*Source: own calculation*

Moreover, digitization accelerates production cycles, enabling quicker responses to market demands and changes. This agility boosts financial performance, leading to increased revenue and profitability. Investing in digital technologies not only streamlines operations but also enhances competitive positioning, allowing companies to seize new business opportunities and enhance financial outcomes.

### ***Affected departments***



**Figure 19 Responses related to affected departments**

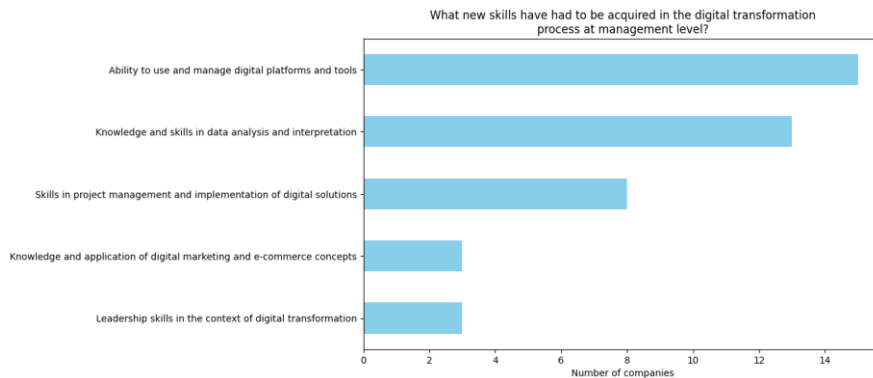
*Source: own calculation*

Digital transformation significantly impacts key company departments, revolutionizing their operations. Production and operations witness enhanced efficiency and productivity due to streamlined workflows and task completion time reduction. In finance and accounting, automation accelerates financial data processing, enhancing accuracy and reporting.



Sales and marketing benefit from digital tools, providing deeper customer insights and precise segmentation for effective campaigns and increased sales. Supply chain management sees improved inventory and logistics visibility, enabling better planning and quicker responses to market changes. Overall, digitization modernizes operations, enhancing adaptability and overall performance.

### ***Skills required***

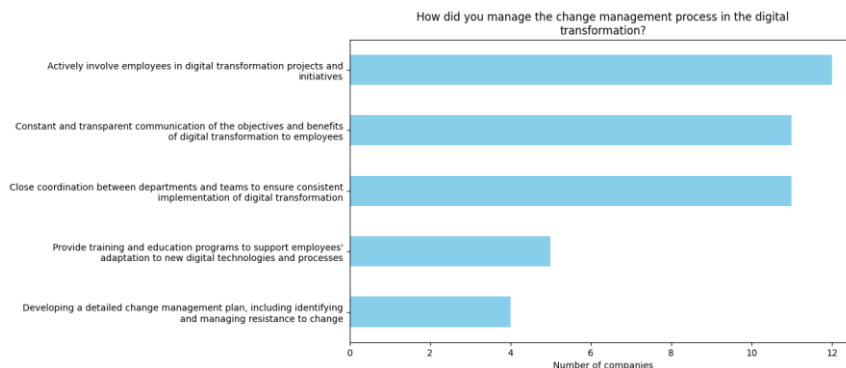


**Figure 20 Answers related to required competences**

*Source: own calculation*

In digital transformation, management must acquire skills in digital platforms, data analysis, project management, and digital marketing to adapt to the evolving business landscape and ensure success in the digital era. These skills enable efficient processes, informed decision-making, and effective adaptation to market changes.

### ***Process management***



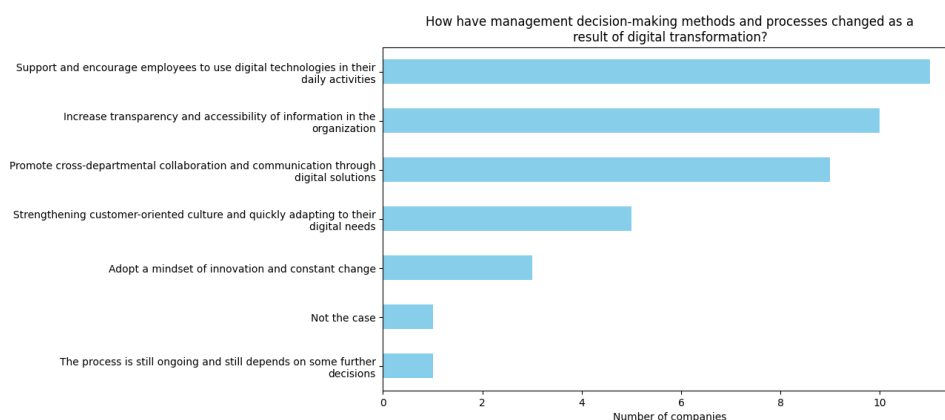
**Figure 21 Answers related to process management**

*Source: own calculation*

Active employee involvement in digital transformation projects is vital for change management, ensuring acceptance and participation in innovation. Transparent communication of transformation goals is crucial for team alignment and understanding. Close coordination among departments ensures unified implementation of digital changes.

Emphasis on training supports employee adaptation to new technologies, facilitating smoother transitions and integration into daily activities.

### ***Impact on decision-making***



**Figure 22 Responses on decision-making**

*Source: own calculation*

Digital transformation reshapes company decision-making, encouraging employee digital tool adoption for integrated operations. Enhanced transparency and information accessibility informs decisions. Digital solutions improve collaboration and communication, boosting team efficiency. A customer-centric culture adapts swiftly to digital demands, enhancing market response agility. These changes signify a shift toward digital-centric decision-making, improving processes and operational efficiency.

### ***Aspects of changed organizational culture***

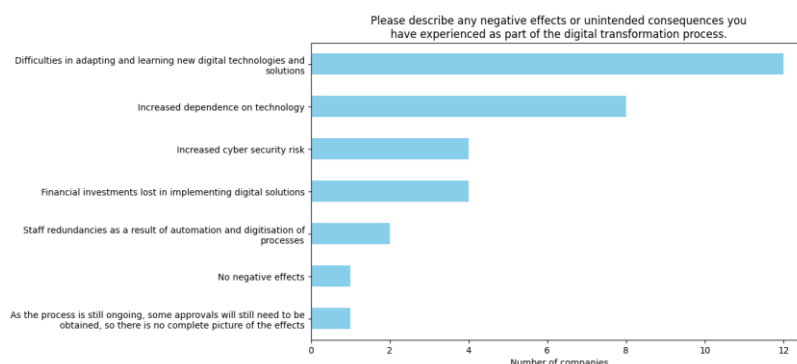


**Figure 23 Answers on organizational culture**

*Source: own calculation*

Digital transformation revolutionizes organizational culture, emphasizing data-driven decision-making and centralized information access. Integration of digital systems enhances efficiency and departmental coordination, while business intelligence and automation anticipate market trends, reflecting a shift towards adaptable, data-driven practices and technological innovation.

### Negative effects

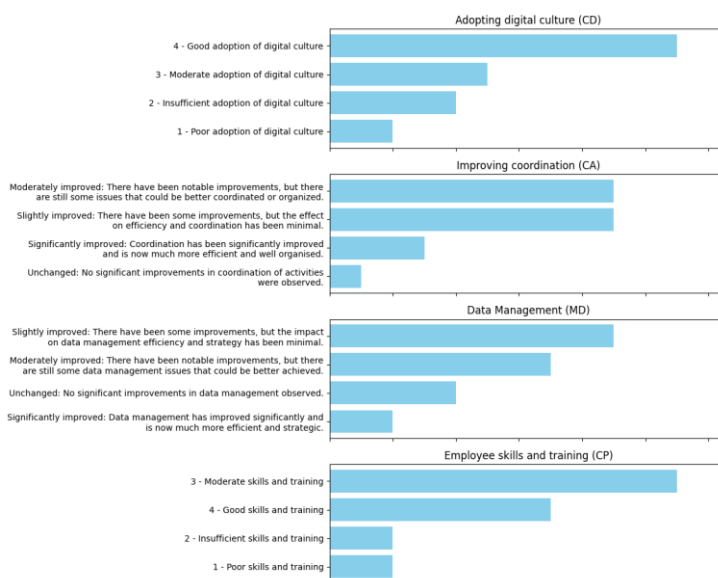


**Figure 24 Responses on negative effects**

Source: own calculation

Companies grappled with challenges in adapting to new technologies, emphasizing the need for ongoing training and support. Increased dependence on technology raised vulnerability to disruptions and cybersecurity risks, highlighting the importance of careful planning and evaluation to ensure successful digital transformation.

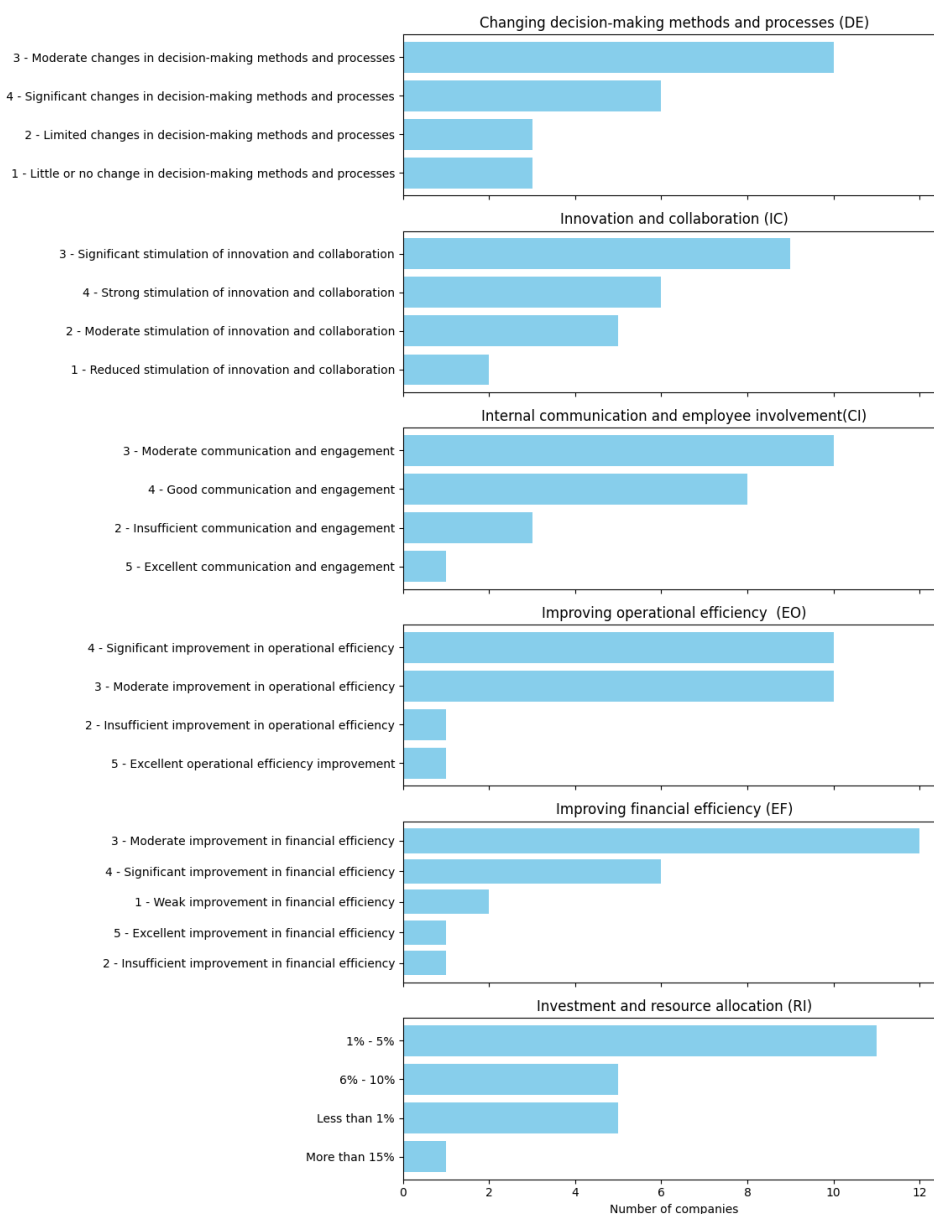
### Assessment of key parameters



**Figure 25 Detailed answers for key parameters (part 1)**

Source: own calculation

The questionnaire assesses key aspects of digital transformation in companies, including digital culture adoption, coordination improvement, data management, employee skills, decision-making methods, innovation, collaboration, internal communication, employee engagement, operational and financial efficiency enhancement, and investment/resource allocation. Analysis of these dimensions reveals correlations and trends crucial for understanding transformation success factors, facilitating tailored recommendations for companies based on their specific needs and profiles.



**Figure 26 Detailed answers for key parameters (part 2)**

*Source: own calculation*

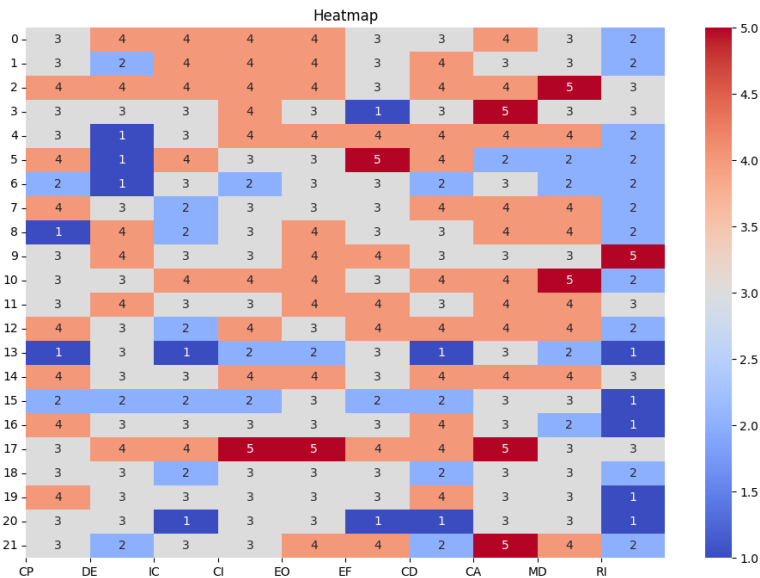


Figure 27 Heatmap essential parameters

Source: own calculation

Analyzing the heatmap reveals insights into the state of digital transformation among the represented companies. Dark red areas signify higher scores, indicating better performance or advanced adoption of digital practices. Noteworthy findings include certain companies excelling in *financial efficiency improvement (EF)*, *operational efficiency (EO)*, *digital culture adoption (CD)*, and *effective data management (DM)*. However, variability in scores for *employee skills and training (CP)*, *decision-making processes (DE)*, *innovation and collaboration (IC)*, and *internal communication and employee engagement (CI)* suggests opportunities for enhancement. Overall, the heatmap provides a valuable tool for targeting improvement efforts, identifying best practices, and understanding internal dynamics in digital organizational change.

### Lessons learned, positive outcomes, advice and recommendations

Analysis of responses regarding lessons learned from digital transformation underscores several key insights. Transparent communication is emphasised as critical for stakeholder commitment and understanding, while the first step of commencing digitization is highlighted for its long-term clarifying effect. Digitization is praised for its role in streamlining operational processes, enhancing customer insight, and enabling real-time data analysis. Collaboration and result measurement are facilitated by digitization, yet overcoming resistance to change requires strategic planning. A clear action plan, optimization of processes before digitization, and active employee engagement are underscored, alongside the pivotal role of effective communication in successful transformation efforts. These responses collectively emphasize the critical importance of communication, strategic planning, and organizational adaptability in navigating the digital transformation journey.

### 3.4. Regression analysis

To conduct regression analysis on dimensions impacting digital transformation stages, responses were quantified, and ordinal regression applied. Positive coefficients indicate direct association with advanced transformation stages, while negative coefficients signify inverse association. For instance, higher *Data Management (DM)* scores predict advanced transformation, while higher *Coordination Mode Improvement (CA)* scores predict less advancement. Findings reveal data management, digital culture adoption, and innovation as strong predictors, while coordination, investment, and employee skills show inverse influence. Logistic regression, using duration of digital transformation as dependent variable, showed positive coefficients for factors like digital culture adoption and data management, suggesting longer transformation duration, while negative coefficients for employee skills and decision-making methods hint at shorter duration since initiation.

| PREDICTOR                                            | COEFFICIENT |
|------------------------------------------------------|-------------|
| Data management (MD)                                 | 0.789       |
| Adopt digital culture (CD)                           | 0.739       |
| Innovation and collaboration (IC)                    | 0.670       |
| Improve financial efficiency (EF)                    | 0.324       |
| Change in decision-making methods and processes (DE) | 0.207       |
| Improve operational efficiency (EO)                  | -0.083      |
| Internal communication and employee engagement (CI)  | -0.243      |
| Competencies and employee training (CP)              | -0.417      |
| Investment and resource allocation (RI)              | -0.524      |
| Improved coordination mode (CA)                      | -0.646      |

**Table 2 Calculated coefficients of essential parameters (using the stage of digital transformation as dependent variable)**

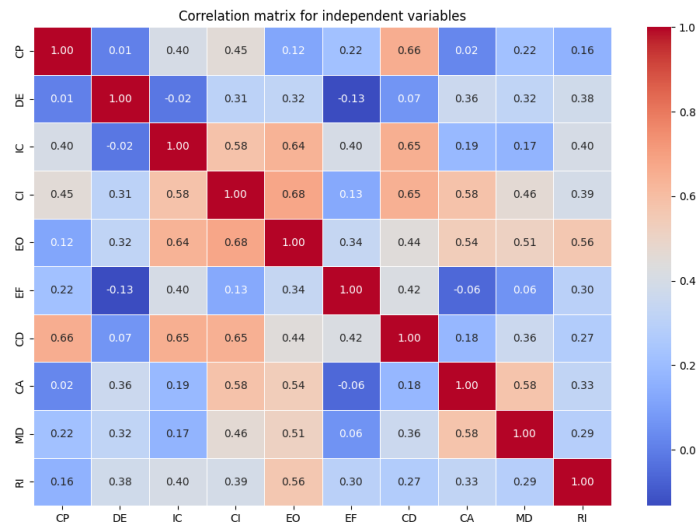
*Source: own calculation*

| PREDICTOR                                            | COEFFICIENT |
|------------------------------------------------------|-------------|
| Adopt digital culture (CD)                           | 0.675       |
| Data management (MD)                                 | 0.654       |
| Improve financial efficiency (EF)                    | 0.448       |
| Improve operational efficiency (EO)                  | 0.241       |
| Investment and resource allocation (RI)              | 0.112       |
| Innovation and collaboration (IC)                    | 0.045       |
| Internal communication and employee engagement (CI)  | 0.011       |
| Improved coordination mode (CA)                      | -0.405      |
| Change in decision-making methods and processes (DE) | -0.565      |
| Competencies and employee training (CP)              | -0.566      |

**Table 3 Calculated coefficients of essential parameters (using duration of digital transformation as dependent variable)**

*Source: own calculation*

### 3.5. Correlation analysis



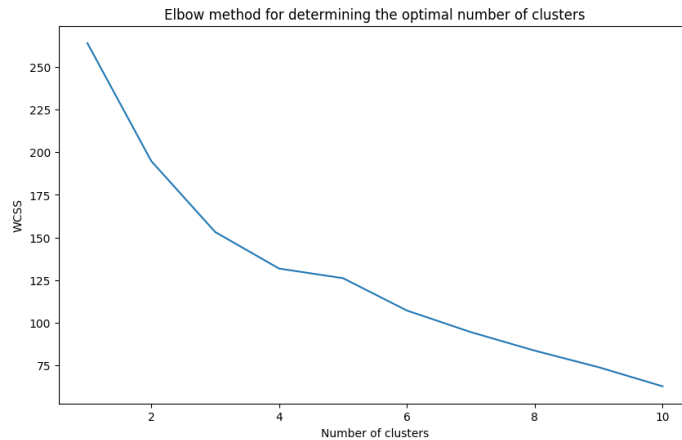
**Figure 28 Correlation matrix independent variables**

Source: own calculation

The correlation matrix displays relationships between 10 independent variables, measured by correlation coefficients. Strong correlations near +1 or -1 indicate significant relationships, while values near 0 suggest little correlation. Identifying these correlations can reveal insights and prevent collinearity issues in regression models. For instance, moderate positive correlations between *Internal Communication* and *Employee Involvement* (IC) and *Innovation and Collaboration* (IC) or *Improved Operational Efficiency* (EO) imply companies prioritizing internal communication also tend to foster innovation and efficiency. Overall, predominantly positive coefficients suggest digital transformation measures tend to progress together.

### 3.6. Cluster analysis

Cluster analysis groups data into clusters based on similarity, aiding in understanding patterns and trends in SME responses to digital transformation. It reveals varied approaches, influenced by factors like company size and resources, while identifying common challenges and success factors. Steps include data pre-processing to handle missing values and normalization, choosing a clustering method (e.g., K-means, hierarchical clustering), determining cluster numbers via techniques like the Elbow method, applying algorithms, analysing results, and validating clusters using significant columns like *employee count*, *turnover*, *skills*, *decision-making changes*, *innovation*, *efficiency*, *digital culture adoption*, *coordination*, and *data management*. Standardizing data ensures each feature contributes equally, avoiding bias from value magnitude differences. Using the Elbow method to determine the optimal number of clusters, three clusters are identified as most appropriate for the analysis, balancing specificity with model complexity and offering a clear and easy-to-interpret segmentation of the dataset.

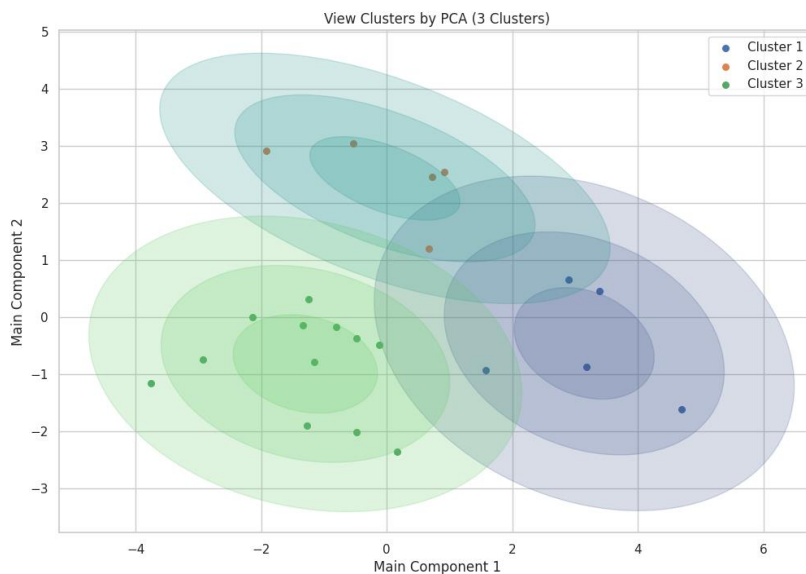


**Figure 29 Elbow Method**

Source: own calculation

Principal Component Analysis (PCA) was utilized to condense the dataset for efficient graphical representation of clusters. The first two principal components, explaining 56% of data variation, were employed to create a two-dimensional space for cluster visualization. This visualization revealed distinct clusters representing various SME approaches to digital transformation, offering valuable insights into strategy diversity and digital maturity stages. The PCA showed that Principal Component 1 primarily reflects internal communication, operational efficiency, and organizational culture, while Principal Component 2 encompasses factors like company size and digital transformation elements such as employee skills and innovation.

Cluster analysis yielded three clusters, each showcasing unique characteristics and digital transformation scores.



**Figure 30 Visual representation of identified clusters**

Source: own calculation



Based on the analysis, clusters were named as follows:

- **"Digital Emergents"**: Companies with moderate resources and early-stage digital adoption, facing challenges due to limited resources or experience.
- **"Digital Pioneers"**: Industry leaders with advanced digital maturity, high innovation, and operational efficiency scores, likely due to abundant resources and progressive management.
- **"Digital Adapters"**: SMEs with balanced approaches to digital transformation, focusing on communication, data management, and coordination, demonstrating adaptability and responsiveness to digital needs.

The evaluation of research hypotheses revealed partial support for hypotheses related to operational efficiency, cultural change, employee training, resistance to change, and digital skills barriers. However, the impact of digital transformation on customer and partner relationships remains indirectly assessable through cluster data.

#### **4. Validation of research hypotheses**

##### **H1 Digital transformation leads to significant improvements in operational and financial efficiency in SMEs.**

To validate the hypothesis *"H1 Digital transformation leads to significant improvements in operational and financial efficiency in SMEs"* questionnaire responses directly related to these efficiencies were analyzed. Responses in the *Impact* section addressed operational issues like *"Increased operational efficiency"* and financial aspects such as *"Increase revenue and profitability"*. Additionally, responses in the *Evaluation* section were assessed for questions regarding *Operational efficiency improvement (EO)* and *Financial efficiency improvement (EF)*.

Mean responses for *Operational efficiency improvement* and *Financial efficiency improvement* were 3.5 and 3.14, respectively, suggesting moderate to good improvements overall. Most SMEs reported scores of 3 or higher, indicating a positive perception of digital transformation's impact. However, while operational efficiency improvements were statistically significant (t-statistics: 3.487, P-value: 0.0022), financial efficiency improvements lacked statistical significance (t-statistic: 0.680, P-value: 0.5041). These results support operational efficiency gains but don't provide sufficient evidence for significant financial efficiency improvements, emphasizing the need for additional evaluation methods.

##### **H2 Digital transformation is driving a cultural change in organizations, promoting an innovation and adaptability mindset**

To analyse the hypothesis *"H2 Digital transformation is causing a cultural change in organizations, promoting an innovation and adaptability mindset"* variables and questionnaire responses indicative of such a cultural change were scrutinized. The mean response for *Adoption of digital culture (CD)* is 3.14, indicating a moderate to good perception of digital culture adoption. However, the t-test yielded a P-value of 0.5441 ([Google Colab](#)), indicating no significant difference from a neutral level. Despite this, there is a moderate to strong positive correlation (0.6543) between *Adoption of digital culture*

(CD) and *Innovation and Collaboration (IC)*, suggesting that as digital culture adoption increases, so does innovation and collaboration. Furthermore, *Improved internal collaboration and communication (IC)* scored a mean of 3.32, indicating a moderate to good perception of improved collaboration due to digital transformation, reinforcing the notion of a positive impact on organizational culture. These results partly support the hypothesis that digital transformation fosters an innovation and adaptability mindset in organizations.

### **H3 SMEs face challenges in training and adapting employees to digital technologies**

To evaluate the hypothesis regarding SMEs and their challenges in training and adapting employees to digital technologies, relevant questionnaire data were examined. This included assessing employee skills and training in digital technologies and the adoption of digital culture within the organization. Additionally, the presence of training programs and strategies for employee engagement in digital transformation was considered. Analysis of the data revealed that while most SMEs show moderate proficiency and cultural integration, a notable portion faces challenges, particularly in employee training and digital culture adoption. Thus, the findings partially support the hypothesis, indicating significant but not overwhelming obstacles in this aspect of digital transformation for SMEs.

### **H4 The main barriers to digital transformation are related to resistance to change and lack of digital skills**

To assess the hypothesis "*H4 The main obstacles in the digital transformation process are related to resistance to change and lack of digital skills*" data from the questionnaire's section on obstacles encountered in digital transformation was examined. Participants reported various challenges, including resistance to change, lack of digital skills, financial constraints, integration difficulties, and insufficient understanding of digital transformation's importance. Analysis revealed that financial constraints were the most frequently cited obstacle, followed by resistance to change and lack of digital skills. These findings support the hypothesis that resistance to change and lack of digital skills are significant barriers to digital transformation, though financial constraints also play a prominent role.

Regarding employees' skills and readiness, responses indicated a mix of perceptions, with most companies considering their employees moderately prepared for digital technologies. However, notable gaps in skills were identified by some. Despite efforts to engage employees in the transformation process, such as involvement in projects and providing resources, resistance to change and digital skills deficiencies persist as significant challenges.

To further analyze these findings, statistical tests were conducted. The *Chi-square* test on employee skills and training distribution showed no significant deviation from a uniform distribution, implying that perceptions of digital skills readiness vary among companies. Additionally, the correlation between employees' digital skills and engagement in the transformation process was weak, suggesting that engagement strategies are not strongly influenced by current skill levels. These results support the partial validation of

hypothesis H4, indicating that while resistance to change and digital skills gaps are acknowledged challenges, their impact varies among SMEs.

#### **H5 Digital transformation improves relationships with customers and business partners by increasing the efficiency and quality of services offered**

The hypothesis "*H5 Digital transformation enhances relationships with customers and business partners through improved service efficiency and quality*" was examined using questionnaire data. Analysis encompassed various aspects, including the perceived impact of digital transformation on relationships, assessment of operational efficiency enhancement, investment in customer- and partner-focused technologies, perceptions of service quality improvement, and feedback from stakeholders. Results showed that increased operational efficiency was the most common effect, aligning with the hypothesis. Other mentioned effects such as improved quality, faster production cycles, increased revenue, and lower operational costs also supported the hypothesis indirectly. Direct confirmation of improved relationships with stakeholders was observed. Additionally, effects like enhanced internal collaboration and market expansion indirectly contributed to improved relationships. Overall, the findings validate hypothesis H5, indicating that digital transformation significantly enhances relationships with customers and business partners through various positive impacts on service efficiency and quality.

### **5. Discussion and conclusion**

Technological advancements have led to widespread digitalization, impacting both personal and professional spheres (Akbarjonovna, 2024; Blanco-González-Tejero et al., 2024). Organizations benefit from digital solutions, enhancing communication speed, streamlining processes, and identifying new opportunities. Mass adoption of digital technologies drives societal transformation. For organizations, this entails rethinking processes, implementing digital solutions, and fostering innovation. Examining organizations' internal perspectives on digital transformation aids understanding. The study aimed to assess its impact on SMEs' operational and financial performance. Responses indicated perceived improvements in operational efficiency and reduced costs post-transformation, supporting the hypothesis (Hansen et al., 2011; Pagani & Pardo, 2017; Shirish C. Srivastava & G. Shainesh, 2015). However, insufficient evidence was found regarding financial efficiency. Literature suggests optimized digital technology integration can enhance business processes (Beldiq et al., 2024).

Another objective was to analyse the influence of digital transformation on organizational culture. Findings revealed moderate digital culture adoption and a positive correlation between digital culture adoption and innovation. While some organizations struggle with digital culture adoption, insufficient evidence supports a direct link between digital transformation and fostering innovation (Kalman, 2013; Tran et al., 2024; Vey et al., 2017).

Assessing employee training and adaptation to digital technologies highlighted a mixed response. While most organizations reported moderate skills and digital culture adoption, a significant proportion faced challenges in these areas. Various challenges were

identified, with financial constraints, employee resistance, and lack of digital skills being prominent (Fitzgerald et al., 2013; Gobniece & Titko, 2024; Lucas & Goh, 2009; Singh & Hess, 2017). Literature suggests addressing these challenges through funding training programs (Amr Okasha, 2023; Hitesh Dhawan, 2023).

The study also aimed to evaluate digital transformation's impact on relationships with customers and partners. Results indicated increased operational efficiency, quality improvement, and revenue growth, validating the hypothesis. Enhanced operational efficiency positively influences customer service. However, challenges persist despite the promised benefits of digital technologies, highlighting the need for effective change strategies.

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