




WORKPACKAGE 3 INVESTIGATION

SYNTHESIS REPORT

*This publication was created as part of the Erasmus+ Alliance for Innovation project Responsible Dynamic Digital Change Agents for Food And Beverage SMEs (DIGIFABS, Project ID: 101140130).
Co-funded by the European Union. Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.*

EXECUTIVE SUMMARY



This report is based on a systematic literature review and interviews with key stakeholders. The literature review included 96 scientific papers that examined aspects of digital maturity, digital transformation models, and maturity frameworks for SMEs in the F&B sector. The analysis documents the current state of technological transformation in the F&B sector, identifies best practices in Europe, and understands the needs of SMEs for dynamic digital change agents. Additionally, interviews were conducted with industry experts, SME managers, and academic representatives to gain qualitative insights and complement the results of the quantitative data and theories.

The systematic literature review and interviews revealed important insights into the skills and maturity model for digital transformation. The research identified 28 main dimensions for thematically coding the literature on digital maturity models and identifying potential skills of Responsible Dynamic Digital Change Agents (RDDCAs). These dimensions include strategy, organization, culture, value chain/ecosystem, technology, innovation, products, customers, partnerships/networks, leadership, governance, people and skills, process digitalization, collaboration, transformation management, cloud & data, digital environment, insights, monitoring & control, and digital business development.

The next steps for the DIGIFABS project include the development and piloting of a comprehensive training program for students, educators, and SMEs. This includes a multidisciplinary action learning summer school and bootcamps designed to equip participants with the necessary skills to lead digital transformations in their respective fields. The results of the literature review and interviews will be used to support the development of these training programmes and will be made publicly available on the DIGIFABS project website.





CONTENTS

- 01 [Introduction](#)
- 02 [Literature Review](#)
- 03 [Expert Interviews](#)
- 04 [Training Program Analysis \(Excerpt\)](#)
- 05 [Student Skill Gap Analysis \(Excerpt\)](#)
- 06 [Conclusion](#)
- 07 [Appendix](#)



01

INTRODUCTION

THE PROJECT

Responsible Dynamic Digital Change Agents (RDDCA) for Food and Beverage (F&B) SMEs (hereafter 'DIGIFABS') aims to foster digital, resilience, and innovation skills to optimise the management of digital transformation in small and middle-sized Enterprises (SMEs) in the F&B processing sector. DIGIFABS is an Erasmus+ Alliance for Innovation project, co-funded by the European Union (project ID: 101140130). DIGIFABS started in February of 2024 and is expected to run for 36 months. The overall project coordination is the responsibility of FH Münster University of Applied Sciences.

A consortium of partners and collaborators, including Higher Education Institutions (HEIs), Vocational Educators and Trainers (VETs), businesses, and network organisations, is driving the execution and delivery of DIGIFABS. Representing seven European regions with varying levels of digitalisation and significant engagement in the food and beverage (F&B) sector, this diverse partnership brings together expertise and resources to ensure the project's success. The consortium partners are:

- FH Münster University of Applied Sciences (Germany – Overall DIGIFABS project lead)
- Wirtschaftsförderungs- und Entwicklungsgesellschaft Steinfurt mbH (Germany)
- Amsterdam University of Applied Science (Netherlands)
- Preneurz (Netherlands)
- University Industry Innovation Network (Netherlands)
- Slovak University of Agriculture (Slovakia)
- EDU (Slovakia)
- University of Szczecin (Poland)
- SWTP (Poland)
- Maynooth University (Ireland)
- BIA Innovator Campus (Ireland)
- Momentum Marketing Services (Ireland)
- European Centre for Emerging Competencies and Technologies (Cyprus)
- Consorcio de la Ribera (Spain)

Furthermore, the HEIs will engage 100 students from three disciplines and 10+ scientists from Engineering/IT, Agriculture/Nutrition and Business fields. The business network organisations will engage 15+ SMEs from the sector to pilot the course programme including:

- A multidisciplinary action learning Summer School and Challenge for STUDENTS to acquire the digital, green and resilience skills of a RDDCA theoretically and practically; and
- Piloting of Bootcamps for Educators and F&B SMEs to facilitate a RDDCA challenge in their region. The final materials will be made publicly available including introductory Massive Open Online Courses (MOOCs).

DIGIFABS seeks to raise awareness of the critical skills required for successful and sustainable digital transformation among students, educators, and businesses. In addition, this project aims to advance research and understanding of digital and green skills to enhance the innovation, resilience, and sustainability of regional and European economies.

THE PROJECT

Therefore the primary objective of this project is to create a DIGIFABS course program tailored for students, educators, and SMEs in the F&B industry. The program aims to train participants in the skills necessary to act as an RDDCA, an emerging role that incorporates aspects of the DigiComp, LifeComp, and GreenComp frameworks. This involves:

- Identifying new digital opportunities beyond established best practices.
- Seizing these opportunities within the context of a specific organisation.
- Leading the transformation by facilitating the change process.

To achieve this, DIGIFABS will research, design, develop, pilot, and create a comprehensive multidisciplinary RDDCA training program for its primary stakeholders: students, educators, and SMEs. Key components include:

- Student Training Through Action Learning Summer School and Challenges
 - An immersive summer school program will equip students with both theoretical and practical RDDCA skills. Participants, representing five consortium regions and three disciplines (business administration, engineering/IT, and nutrition-related fields) with balanced gender representation, will gain a foundational understanding of RDDCA skills, including their importance and application, alongside insights into technological advancements and the F&B sector.
 - After the summer school, students will return to their regions to apply and enhance their skills by tackling real-world challenges in F&B manufacturing SMEs. Working in multidisciplinary teams, students will be mentored by trained educators who serve as facilitators.
- Bootcamps for Educators and SMEs
 - Two pilot bootcamps—one for educators and one for F&B SMEs—will complement the student program. These intensive international sessions will introduce both groups to the RDDCA concept and sector-specific technological insights.
 - Educators will be trained to facilitate RDDCA challenges in their regions.
 - SMEs will be prepared to participate in RDDCA challenges or implement similar internal digital transformation processes.

DIGIFABS will also develop an innovative, multidisciplinary teaching and learning methodology that integrates entrepreneurial approaches, problem-based learning, and action-oriented training. Furthermore, this project will foster an entrepreneurial mindset and sense of initiative in students, educators, and SMEs, creating a European hub for academia-business collaboration, knowledge-sharing, and co-creation to ensure sustainability beyond the project's duration.



APPROACH TO SYNTHESIS REPORT

Firstly, a systematic literature review of 96 papers identifies and discusses aspects of digital maturity, digital transformation models, and maturity frameworks relevant to SMEs in the F&B sector. Analysis seeks to document the current state of technology transformation in the F&B sector, identify best practices across Europe, understand the needs of SMEs for dynamic digital change agents, and synthesize findings to support students as digital change agents, educators as course facilitators, and SMEs looking to innovate with emerging technologies.

Secondly, we assess current research on dynamic capabilities and digital change agent skills; identify key cases of dynamic digital change agents; and explore preliminary course requirements for both students and educators in this field. To understand skillset dynamics from educator and student perspectives, interviews were conducted with key stakeholders to deepen understanding of factors shaping digital transformation in the F&B industry. These interviews were conducted with industry experts, SME managers, and academic representatives intended to provide qualitative insights to complement prior quantitative data and theory.

Findings based on the synthesis of relevant literature and interviews with F&B SMEs and educators/trainers are compiled in this report and subsequently will be made publicly available on the DIGIFABS project website www.DIGIFABS.eu. Furthermore, these findings – presenting insights from the perspectives of digital change agents, SMEs, students and identify respective training needs – will be used to help shape development of both a Summer School and Challenge for students (Work package 4) and of Responsible Dynamic Digital Change Agent Bootcamps aimed at educators and F&B SMEs (Work package 5).

METHODOLOGY

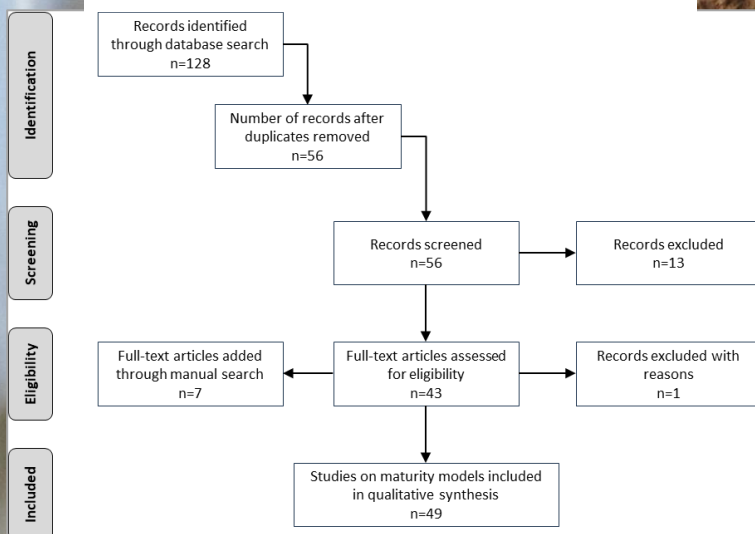
LITERATURE REVIEW

The methodology for the systematic literature review follows a structured approach to ensure rigor, objectivity, and transparency. The process is divided into three main phases. In the preparation phase, the need for review is identified, establishing the research questions and objectives to justify the study's purpose. The review focuses on studies since 2019, examining the conceptualization of Responsible Dynamic Digital Change Agents (RDDCA) skills and Digital Maturity Models (DMMs) for businesses. A review protocol is developed, aligning with the "PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (Page et al., 2021) guidelines. This protocol sets inclusion and exclusion criteria, such as excluding editorials and book reviews, and employs a systematic search structure adapted for databases such as Scopus.

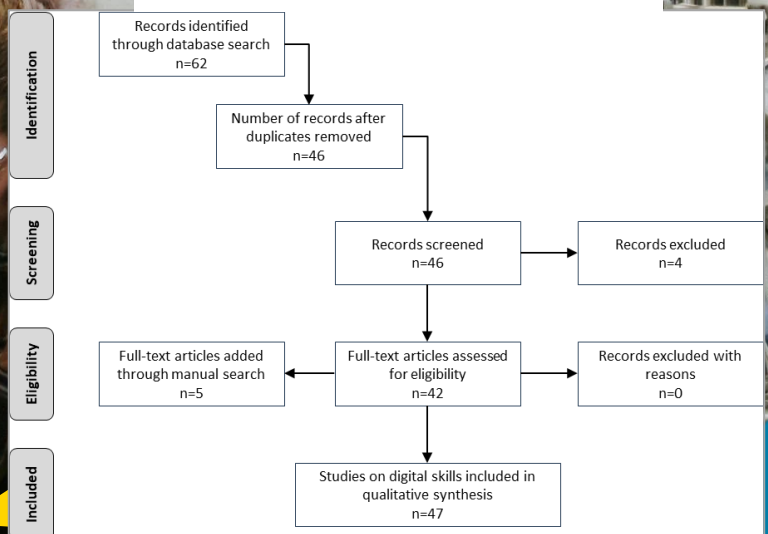
The second phase involves conducting the review using a set of structured queries to identify relevant literature. The search process includes both mechanical and thematic screening criteria. Duplicate or irrelevant articles are excluded, and articles undergo a final soft screening to ensure they align thematically with the study. The selected studies are then reviewed using coding techniques to classify information such as study type, methodology, findings, and implications. Bibliometric tools like Mendeley are used to manage references effectively.

In the final phase, the review is reported by synthesizing the findings to provide a critical account of the state of the art in RDDCA skill sets and digital (transformation) maturity models, with a focus on the F&B sector. Figure 2: PRISMA framework - Digital maturity model and Figure 3: PRISMA framework - RDDCA skill sets summarizes the output of systematic literature review. Following the Prisma framework, we initially identified 128 papers for the digital maturity model. After removing duplicate papers, 56 papers remained. Upon screening these, we included 49 papers for further review. Regarding the RDDCA skill sets, 62 records were identified, and after the screening process, 47 were selected for inclusion.

PRISMA framework: Digital maturity model



PRISMA framework: RDDCA skill sets



02

LITERATURE REVIEW

Digital Maturity



Digital maturity (see definition in 2.2) is a key determinant of an organisation's ability to leverage digital technologies to enhance business performance and achieve strategic objectives (Omol et al., 2023). Based on a systematic review of 96 papers addressing aspects of digital maturity, digital transformation models, and maturity frameworks, this report analyses and synthesizes a spectrum of digital maturity frameworks and models seeking to identify and integrate insights as the basis for a comparative analysis. A key area of focus is on digital capabilities and skills essential for driving digital transformation. As digital technology is an integral part of our society and economy, industry leaders face growing pressure to make digital transformation a top priority (Daminov et al., 2021), and the F&B industry is no exception. This means embracing the opportunities presented by new technologies like artificial intelligence, big data, cloud computing, cyber-physical systems, robot technologies and 3D printing. However, digital transformation is not limited to adopting new technology as, in addition, businesses and professionals must also continuously adapt to a changing landscape (Browder et al., 2024). Businesses face challenges such as evolving customer expectations, stricter regulations, and thinner margins. This is exacerbated by new entrants disrupting traditional markets, forcing established companies to innovate or risk falling behind. A guideline or framework for digital transformation can be an opportunity to gain a competitive advantage (Aghamiri et al., 2022). This is important for business leaders and/or managers who struggle to know where to begin as they frequently lack clear frameworks for framing and implementing a digital agenda. While they understand the need to act, they often feel overwhelmed and unsure of the right course of action.

Several researchers have proposed frameworks for digital transformation, providing roadmaps for action (Brozzi et al., 2021; Li, 2022; Varbanova et al., 2023; Santos et al., 2024a; Zhu et al., 2020; J. C. Huet et al., 2022; Utami et al., 2020). These frameworks highlight different "action fields" that companies must address, recognizing that specific needs will vary depending on the industry and individual company characteristics (Schallmo et al., 2020). On the practical side, consulting firms have produced several practice-oriented publications about digital transformation, including the digital maturity models (Hamidi et al., 2018; Bumann & Peter, 2019).

Based on our systematic literature review, the transformation towards digital maturity explores the integration of digital technologies into all areas of a business, fundamentally changing how organisations operate and deliver value to customers. In this synthesis report, the IT Capability Maturity Framework (IT-CMF) developed by IVI (Curley et al., 2017), coupled with key insights from various digital transformation maturity models, provides a structured approach to assess and enhance digital maturity across various dimensions of IT capabilities.

To ensure a consistent understanding when comparing digital transformation maturity theories, it is essential to agree on the definitions of key terms used in this research. These definitions, chosen from various academic sources relevant to our context, will serve as the foundation for our model development and interviews. The importance of these terms was determined by deconstructing 'digital transformation maturity models' into their core dimensions and/or categories. A selection of these definitions is presented in the following table.

Term	Description
Digitalisation	<p>“Digitalisation has the potential to improve resource efficiency, help address supply constraints, and make production processes safer” (p.2). (McDermott et al., 2023)</p> <p>“Digitalisation ... describes socio-technical processes and their impacts on human activities that result from the use of interconnected digital technologies” (p.2). (Santos et al., 2024a)</p>
Digital Transformation	<p>“Digital transformation is often understood as the process of implementing digital technologies” (p.4). (Hortovanyi et al., 2023)</p> <p>“Digital transformation is a must for companies aiming to stay competitive, which means that they need to transform their resource base into IT-enabled resources and in the meantime develop digital capabilities” (p.7). (Hortovanyi et al., 2023)</p> <p>“Digital transformation of companies’ businesses and operations is driven by investments in information and telecommunication technologies and new machineries.” (p.77). (Ustundag & Cevikcan, 2018)</p> <p>“Digital Transformation (DT) refers to the combination of digital technology and areas of the business to finally realize the transformation of the management model and business model” (p.2). Ustundag & Cevikcan, 2018)</p> <p>“DT is a convergence of hard (technology) and soft (people and businesses) forces and movements from which additional value emerges” (p.2). (Huet et al., 2022)</p>
Digital Maturity	<p>“Maturity, as a qualitative parameter, continuously changes over time, where companies learn to appropriately respond to the digital competitive environment” (p.5). (Sándor & Gubán, 2022)</p>
Digital capability maturity	<p>“Capability Maturity theory suggests that firms need to develop digital transformation capability incrementally by focusing on a ‘vital few’ improvement priorities for advancing progress” (p.2). Hortovanyi et al., 2023)</p> <p>“We aim to develop a measurement scale that underpins a digital capability maturity model (DCMM) that can depict stages in the digital transformation process of B2B firms and identify the resource configurations that describe each digital capability maturity stage” (p.3). Hortovanyi et al., 2023)</p> <p>“... the process of becoming mature implies a potential for growth in capability and indicates the consistency of building an infrastructure and corporate culture that supports the development of explicitly defined, managed, measured, and controlled processes, that are mature” (p.5). Hortovanyi et al., 2023)</p>
Industry 4.0 readiness	<p>“Readiness dimensions for Industry 4.0 can differ in criticality depending on the size of the enterprise, whether large or small” (p.4). (McDermott et al., 2023)</p> <p>“... readiness models clarify whether an organisation is ready to start development process or not” (p.77). Hortovanyi et al., 2023</p>
(Industry 4.0) Technologies	<p>“Industry 4.0 focuses on the establishment of intelligent and communicative systems including machine-to-machine communication and human-machine interaction” (p.23). (Hortovanyi et al., 2023)</p> <p>“The most well-known technologies used by Industry 4.0 are IoT, Cloud Computing, Big data, and cyber-physical systems (CPS)” (p.2). (J. C. Huet et al., 2022)</p>

Term	Description
Digital Maturity Level	<p>"The determination of the individual digital maturity level is therefore an essential assessment of where the company is ranked currently" (p.1). (Blatz & Dietel, 2018)</p> <p>"Maturity models enable organisations to audit and benchmark with regard to assessment results, to track progress towards to desired level and to evaluate elements of an organisations such as the strengths, weaknesses and opportunities by sequencing maturity levels in an order from basic to advanced stage: Initial, Managed, Defined, Quantitatively Managed and Optimizing "(p.77)</p> <p>"maturity models target to demonstrate which maturity level the organisation is in" (p.77). (Hortovanyi et al., 2023)</p>
Circular maturity model	<p>"Circular Maturity Model guiding organisations to gain a comprehensive understanding of their circularity level and have a powerful insight into their future strategy" (p. 1). (Uztürk & Büyüközkan, 2022)</p>
Maturity Model	<p>"The Digital Maturity Models (DMMs) help to assess the digitalisation of companies by determining their current position based on different factors and identifying areas of development, providing guidance for reaching the target status. They also contribute to the transformation of organisations and the improvement of their competencies by launching process of change" (p.2). (Sándor & Gubán, 2022)</p> <p>"These models contain pre-defined maturity levels and outline a step-by-step progression along an evolutionary path in the shape of discrete stages. In addition, assessment criteria and characteristics that define each maturity stage are provided. The highest stage defines the goal of full maturity and postulates the complete realization of the assessed aspects. The different stages in-between these two extrema form a continuum and describe an evolutionary progression from immaturity to maturity" (p. 2-3). (Bretz et al., 2022)</p> <p>"The principal idea of the maturity models is that they describe the typical behaviour exhibited by a firm at each 'maturity' stage" (p.5). (Chen et al., 2022)</p> <p>"The total of the stages is considered to be the completion of full transformation and as such being digitally ready for taking advantage of Industry 4.0." (p.5). (Chen et al., 2022)</p> <p>"MMs can be applied as a proven methodology for systematically documenting and managing an organisation's digitalisation process based on archetypal capability levels" (p.3). (Chen et al., 2022)</p>
Digital Maturity Model	<p>Digital maturity models aim to evaluate the level of DT by identifying and defining multiple dimensions considered crucial for implementing digital technologies. These models conceptualize maturity as an evolutionary progression toward an ideal state. The objectives of maturity assessments typically encompass evaluating processes/structures, objects/technology, and people/culture dimensions. (Santos et al., 2024b)</p> <p>"Digital maturity models serve to determine the current state and the degree of digital maturity in the context of DT (e.g., regarding competence, performance, and level of experience) and allow recommendations for future actions deriving from the current degree of maturity" (p. 4). (Schallmo et al, 2020).</p> <p>The degree of digital maturity of SMEs, particularly how they integrate digital services with physical products, is challenging to ascertain. The digital maturity model includes variables such as strategy and leadership, company culture and organisation, IT infrastructure, data maturity, processes and operations, product (use-phase). (Blatz et al., 2018)</p>

A foundational understanding of digital transformation is essential for accurately assessing the digital maturity of organisations. When looking at different definitions of 'digital transformation', the term was often described in the context of implementing digital technologies. This included not only the process of implementing digital technologies (Hortovanyi et al., 2023) but also the combination of digital technology and areas of the business (Huet et al., 2022). Combining all these insights found in literature, digital transformation is defined by us as follows:

Digital transformation is the comprehensive process of incorporating digital technologies into every facet of a business, which fundamentally changes how the organisation operates and delivers value. It involves converting the resources into IT-enabled ones and developing the necessary digital capabilities to remain competitive.

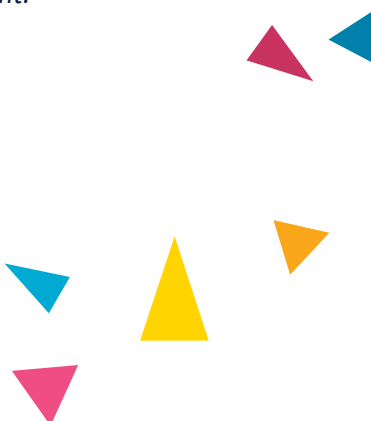
Specific focus is put on digital maturity itself. The digital maturity concept is also related to digital capability maturity (Hortovanyi et al., 2023) and Industry 4.0 readiness (McDermott et al., 2023), which is described as the capability or ability of organisations to adapt and respond effectively to digital competition or Industry 4.0 technologies. Therefore, the following definition of digital maturity based on McDermott et al. (2023), Hortovanyi et al. (2023) and Sándor and Gubán (2022) will be used in this project:

Digital maturity refers to the evolving ability of organisations to adapt and respond effectively to digital competition. It signifies the progressive development of capabilities to manage digital environment, with a focus on continuous learning and improvement.

Lastly, to fully comprehend the main goal of this research, it is necessary to understand what is meant by the term 'Digital Maturity Model':

A Digital Maturity Model (DMM) is a framework that helps organisations assess their current level of digitalisation by analysing various factors such as technology, processes, and organisational capabilities (Blatz et al., 2018).

These models provide a structured pathway that guides companies through different stages of digital maturity, from initial adoption to full optimisation (Hortovanyi et al., 2023). By using pre-defined maturity levels, DMMs help organisations identify areas for development, track progress, and implement changes needed to achieve higher levels of digital competency. The goal of the model is to facilitate the transformation of an organisation's digital capabilities to improve overall performance and competitiveness in the digital era. Therefore, a DMM shall be defined as: a structured framework designed to evaluate the current state of an organisation's digital transformation (DT) by assessing multiple critical dimensions. These models view maturity as an evolutionary progression toward an ideal state of digital integration and capability. Table 4 gives an overview of the final definitions for maturity model used within this project.



Term	Final definitions
Digitalisation	Digitalisation refers to the socio-technical process that enhances resource efficiency and production processes through the integration of interconnected digital technologies.
Digital Transformation	Digital transformation is the comprehensive process of incorporating digital technologies into every facet of a business, which fundamentally changes how the organisation operates and delivers value. It involves converting traditional resources into IT-enabled ones and developing the necessary digital capabilities to remain competitive.
Digital Maturity	Digital maturity refers to the evolving ability of organisations to adapt and respond effectively to digital competition. It signifies the progressive development of capabilities to manage the digital environment. It also describes the incremental development of a company's digital transformation capabilities.
Digital Maturity Level	Digital maturity levels assess where a company currently stands in its digital transformation journey. These levels provide a structured evaluation of strengths, weaknesses, and development opportunities, moving from basic digital adoption to fully optimised and mature digital processes.
Digital Maturity Model	A Digital Maturity Model (DMM) is a structured framework designed to evaluate the current state of an organisation's digital transformation (DT) by assessing multiple critical dimensions. These models view maturity as an evolutionary progression toward an ideal state of digital integration and capability.

Digital maturity model dimensions

Within the context of this research, DMMs conceptualize maturity as a gradual progression towards an ideal state of digital integration and capability. Key dimensions within these models are crucial for assessing an organisation's competence, performance, and experience levels in various digital areas. By evaluating these dimensions, organisations can gain valuable insights into their current digital maturity. This assessment provides actionable recommendations for future improvements, guiding their digital transformation journey by highlighting strengths, weaknesses, and areas for growth. Additionally, this assessment helps F&B SMEs stay competitive in today's increasingly digital markets.

We have identified 24 distinct approaches to digital transformation maturity models from the surveyed literature. These approaches have been classified into the following main sub-dimensions: models, dimensions, and levels of digital maturity. The following sections provide detailed descriptions of each.

Digital Maturity Models (DMMs) are essential frameworks for evaluating the degree to

which an organisation has integrated digital technologies into its operations and strategic processes. This section explores various digital maturity models, highlighting their core dimensions.

Hortovanyi et al., (2023) proposed a maturity model for Industry 4.0 strategy. The model comprises three main dimensions with associated sub-dimensions and associated fields (Table 5: Proposed Industry 4.0 maturity model). The first dimension measures the company's products and services features. The second dimension evaluates the degree of adoption of Industry 4.0 technologies (e.g. AI, IoT, machine learning, smart manufacturing, big data analysis), while the third dimension is considered "input" for Industry 4.0 growth and development. Each dimension further breaks down into sub-dimensions that cover critical aspects of Industry 4.0, such as smart production, Information technologies, and strategic partnerships. This model aims to evaluate an organisation's ability to adopt intelligent systems, integrate digital technologies, and align their business processes with the principles of Industry 4.0.

Dimensions	Sub-dimensions	Associated fields
Smart products and services		Smart products and services
Smart business processes	Smart production and operations	Production, logistics, and procurement
		R&D – Product development
	Smart marketing and sales perations	After-sales service
		Pricing/Promotion
		Sales and distribution channels
	Supportive operations	Human resources
		Information technologies
Smart finance		
Strategy and organisation		Business models
		Strategic partnerships
		Technology investments
		Organisational structure and leadership

Brozzi et al. (2021) developed an Industry 4.0 roadmap service for SMEs. Analysing the existing roadmaps in the literature through a SWOT analysis, the authors designed their roadmap (see Figure 4: Developed I4.0 roadmap service) which outlines a structured approach to guide companies through the phases of implementing Industry 4.0 projects. This roadmap comprises five distinct phases:

- Phase 1: Self-Assessment evaluates the current digital maturity and identifies key challenges.
- Phase 2: Design Thinking Workshop help SMEs explore digital transformation needs and brainstorm Industry 4.0 solutions.
- Phase 3: Scenario Development creates tailored digital transformation plans based on the company's specific maturity level.
- Phase 4: Project Development provides a detailed plan for implementing the chosen digital strategy.
- Phase 5: Implementation guides SMEs in executing the digital transformation with expert support.

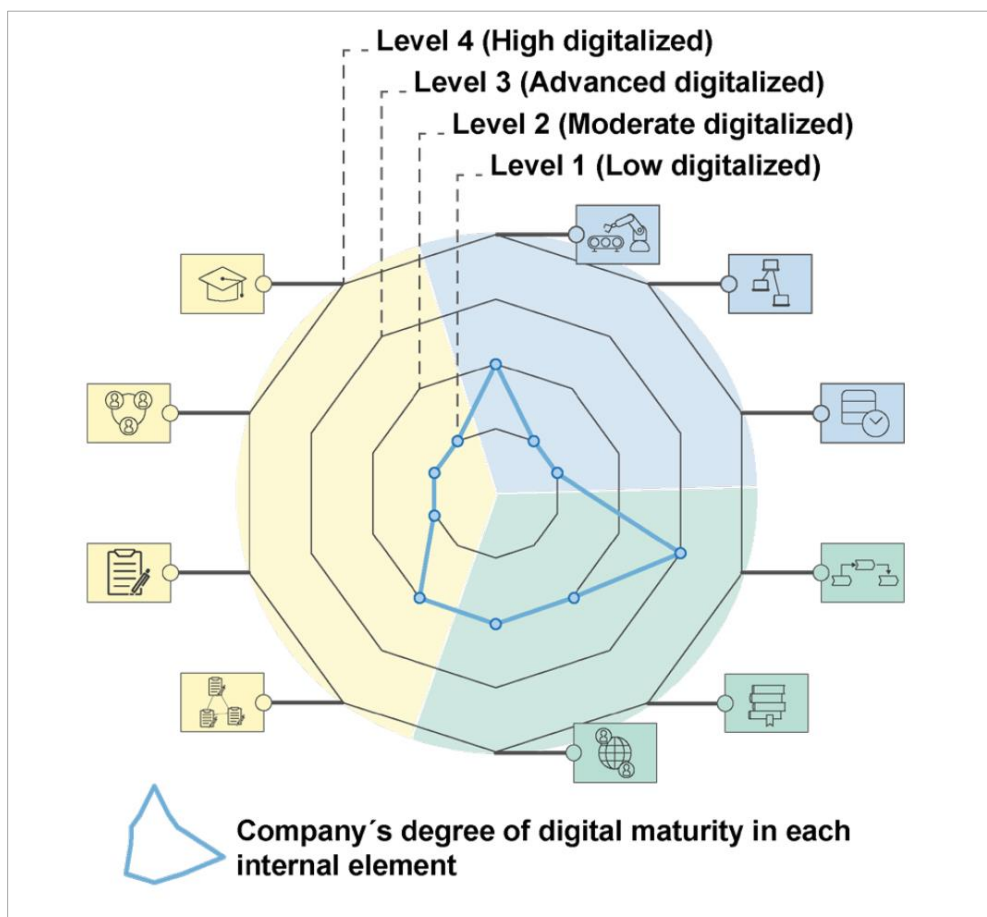
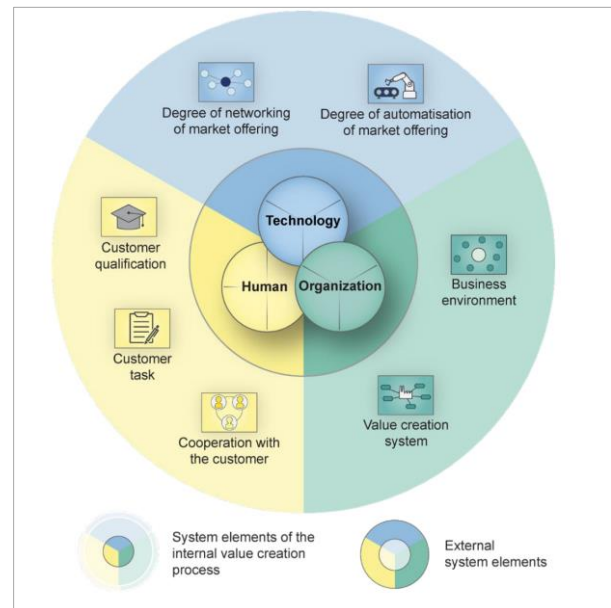
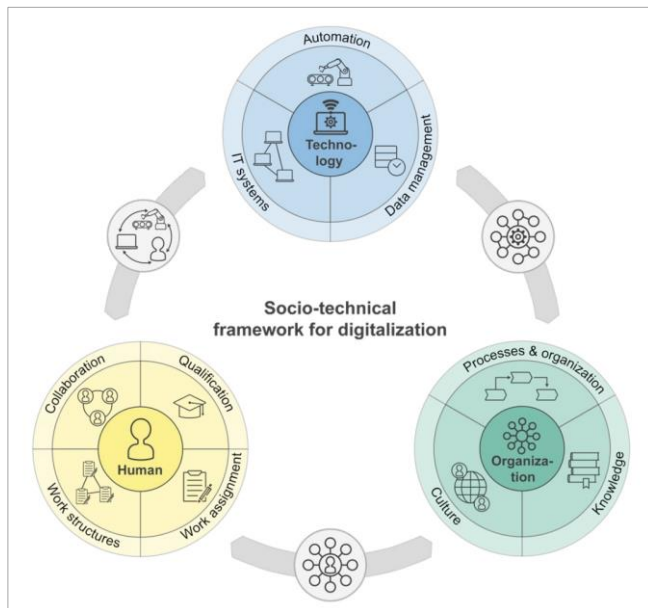
Each phases represent a critical step in the digital transformation process by providing a tailored and strategic pathway. Therefore, the roadmap emphasises assessing and improving digital maturity to align with Industry 4.0 goals.

Santos et al., 2024a proposes a framework and a methodology for assessing the global level of digital transformation of agri-food cooperatives and the relevance of certain critical factors. First, the authors considered the characteristics of the agri-food cooperatives in terms of age, size, position in the value chain and destination markets. Then economic barriers to implementing digital technologies were considered. Keeping in mind the hypothesis of the study, the authors elaborated the global level of digital transformation dimensions: dimensions of DT, infrastructure, processes, organisation and employees, products and services, and clients.



Menzefricke et al. (2021) developed a maturity model in the context of risk management. Focusing on the company's internal value creation process, the paper first considered the socio-technical framework of Hobscheidt et al. It is composed of 3 dimensions: human, technology, and organisation (see Figure 5: Socio-technical framework for digitalisation). Secondly, the side-cross company value creation is

considered so the dimensions are integrated by external elements necessary to structure changes within the company (Figure 6: External elements necessary to structure changes). Finally, the company can assess its maturity level at each dimension, scoring a digitalisation level on a scale from 1 to 4 (Figure 7: Socio-technical framework enhanced by external elements).



Spaltini et al. (2022) analysed existing DMMs that are most recent and/or used in the EU with respect to manufacturing SMEs (see Table 6). From this analysis, 31 areas have been identified as the most assessed. These areas are therefore divided into 6 macro-categories which are: Product, Process, Platform, People, Partnership, and Performance. This model has been defined as

“The 6Ps Migration Model”. The 6 dimensions are finally divided into other 6 areas. Each area is evaluated according to a 5-level scale of DM in which level 1 (INITIAL) represents no or minimum adoption of digital solutions and level 5 (EXPLOITED) describes an area in which digital solutions represent the state-of-the-art for the industry.

Model	Dimensions of analysis
DREAMY 4.0 (Carolis, 2017)	<ul style="list-style-type: none"> •6 processes: Design & engineering, production, maintenance, quality, logistics and supply chain •4 dimensions: Execution, Monitoring & Control, Technology, Organisation
Test I4.0 (Pirola et al., 2020)	<ul style="list-style-type: none"> •8 processes + products + strategy •4 dimensions: Plan, Monitoring & Control, Technology, Organisation
Industry 4.0 readiness check (IMPULS, 2020)	<ul style="list-style-type: none"> •6 dimensions: Strategy and Organisation, Smart factory, Smart operations, Smart products, Data-driven services, Employees
Industry 4.0 maturity index (Schuh et al., 2017)	<ul style="list-style-type: none"> •4 structural areas: Resources, Information systems, Culture, Organisational structure •5 Functional areas: Development, Production, Logistics, Services, Marketing & Sales
Industry 4.0 readiness self-assessment (BEinCPPS, 2018)	<ul style="list-style-type: none"> •5 dimensions: Technology, Manufacturing, Economy & Market, Organisation, Society & Culture
BEinCPPS Industry 4.0 Maturity Method (BEinCPPS, 2018)	<ul style="list-style-type: none"> •6 dimensions: General, Strategy, People, Processes, Technologies, Integration
FAR-EDGE Maturity Model (Calà et al., 2018; Rocca et al., 2020)	<ul style="list-style-type: none"> •3 dimensions: Technological, Operational, Human
Dreamy4Skills (Acerbi et al., 2019)	<ul style="list-style-type: none"> •1 dimension: people •3 analysis dimensions: soft skills, hard skills, ICT literacy

Denning & Liyanage (2022) conducted a systematic literature review of Industry 4.0 implementation frameworks. Their systematic literature review assesses the models and frameworks based on their types, focus areas, benefits, and drawbacks of the applicability of Industry 4.0 in the manufacturing SMEs considered. Key points from the comparison include:

- **Framework or Model Focus:** Most frameworks and models concentrate on the manufacturing system's implementation, providing a structure to assess the maturity of Industry 4.0 technologies in this domain.
- **Benefits:** The frameworks and models break down the levels of Industry 4.0 implementation and align them with manufacturing systems, offering a structured path for companies to follow.

- **Drawbacks:** Many of the frameworks lack coverage in areas beyond manufacturing, such as organisational culture, management, finance, agility, and sustainability. This narrow focus limits their applicability in broader digital transformation initiatives. Additionally, most of the models or frameworks lack focus on sustainability and agility.

Uztürk and Büyüközkan (2022) proposed a circular maturity model for SMEs, which focuses on sustainability. The factors outlined in Table 7: Circular maturity model derive from developing the agricultural chain's triple bottom line (environmental, social, and economic). This model helps organisations identify their strengths and areas for improvement in their journey towards sustainable, circular economy integration

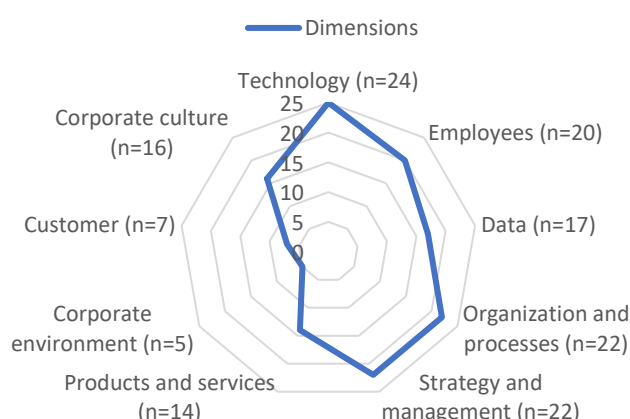
Dimensions	Factors
Product	<ul style="list-style-type: none"> •Packaging •Material •Disposal
Process	<ul style="list-style-type: none"> •Eco-design •Resource consumption •Waste management
Business model	<ul style="list-style-type: none"> •Environmental management •Cooperation •Type of business models
Technology	<ul style="list-style-type: none"> •Technology readiness •Smartness •Integrated modern architecture
Stakeholder	<ul style="list-style-type: none"> •Marketing and communication •Products/services performance •Post sale services

Hein-Pensel et al. (2023) conducted a literature review examining several Industry 4.0 maturity models and identified nine dimensions: Strategy and Management, Corporate Culture, Organisation and Processes, Products and Services, Employees, Technology, Data, Customer, and Corporate Environment. Out of 24 relevant papers, the examination of the categories revealed that the category of Technology was present in all models. This was followed by the categories of Organisation and Processes and of Strategy and Management, with each having 22 MMs involving them. External factors such as the

Corporate Environment and Customers are less significant. The frequency of the dimensions is shown in Figure 8: Industry 4.0 dimensions.

Blatz & Dietel (2018) have developed a maturity model for the digitalisation of SMEs composed of 6 dimensions: strategy and leadership, company culture and organisation, IT Infrastructure, data maturity, process and operations, and product (Use-Phase). Each dimension is weighted based on its relevance to digital transformation using a utility analysis.

Industry 4.0 dimensions



Hortovanyi et al. (2023) identified four digital capability dimensions: novice, beginner, competent, and expert. The dimensional structure corresponding to DCMM (digital capability maturity model) was divided into five dimensions: strategy, operations, technology, organisation and culture, and customers. They were assessed on individual indices by measuring the status of digital capabilities in the company, ranging from 0 (incapable) to 100 (fully capable). Results highlight that strategy and organisation-

related IT-enabled resources are the key drivers of digital transformation.

Hortovanyi et al. (2023) propose six dimensions suited to evaluation of digital maturity in relation to Industry 4.0 readiness: strategy and organisation, smart factory, smart operations, smart products, data-driven services, and employees. Each dimension of this model has specific sub-dimensions.

Dimensions	Associated fields
Strategy and organisation	<ul style="list-style-type: none"> Strategy Investments Innovation management
Smart factory	<ul style="list-style-type: none"> Digital modelling Equipment infrastructure Data usage IT systems
Smart operations	<ul style="list-style-type: none"> Cloud usage IT security Autonomous processes Information sharing
Smart products	<ul style="list-style-type: none"> Data analytics in usage phase ICT add-on functionalities
Data-driven services	<ul style="list-style-type: none"> Sharing of data used Sharing of revenues Data-driven services
Employees	<ul style="list-style-type: none"> Skill acquisition Employee skill sets

Varbanova et al. (2023) identify 21 variables to aggregate in 6 dimensions for evaluating the Industry 4.0 implementation factors in agri-food and manufacturing SMEs (Figure 9: Critical implementation factors for Industry 4.0). These 6 critical implementation factors

for Industry 4.0 include: management strategy, organisational culture, resources – MIS; agile project management and cybersecurity, cross-lined product life cycle and circular economy.

Management strategy (Mean: 10.34)

1. The company is planning to digitalize its business processes to a higher level.
 2. The company foresees introduction digital tools in the near future.
 3. The company plans more investment for digitalization more in short-term.
 4. The company already disposes with the necessary resources to apply more digitalized processes and services.
 5. The company has the necessary knowledge to use more digitalized processes and services.
-

Leadership (Mean: 13.23)

6. In general, the organization is interested in digitalization and supports it.
 7. Digitalized processes benefits employees' and the company performance.
 8. Digital technologies contribute for the cost-effectiveness.
 9. Digitalization increases the profit of the company.
-

Organizational culture (Mean 19.44)

10. Digitalization of the company makes work more interesting
 11. Digitalization is a well-accepted by the workers in the company.
 12. Digitalized processes and services increases productivity.
-

Resources - MIS; agile project management and cybersecurity

13. Digitalization decreases costs.
 14. A specific person (or group) is available for assistance if difficulties with digitalization at the company arise
 15. Digitalizing helps for the customized production.
-

Cross-lined product life cycle and focus on consumer/ business relations (Mean for Organizational culture 8.64 (combining Resources and Consumer/Business relations)

16. Business partners require more digitalization for our business.
 17. There is a regulatory pressure for digitalization.
 18. Customers require more digitalization of our business.
-

Circular economy (Mean: 21.11)

19. Digitalization contributes for extending the lifecycle of the products.
 20. Digitalizing leads to less waste.
 21. Digitalizing reduces carbon emissions from our business.
 22. Our company has integrated SGDs into its long-term strategy.
-

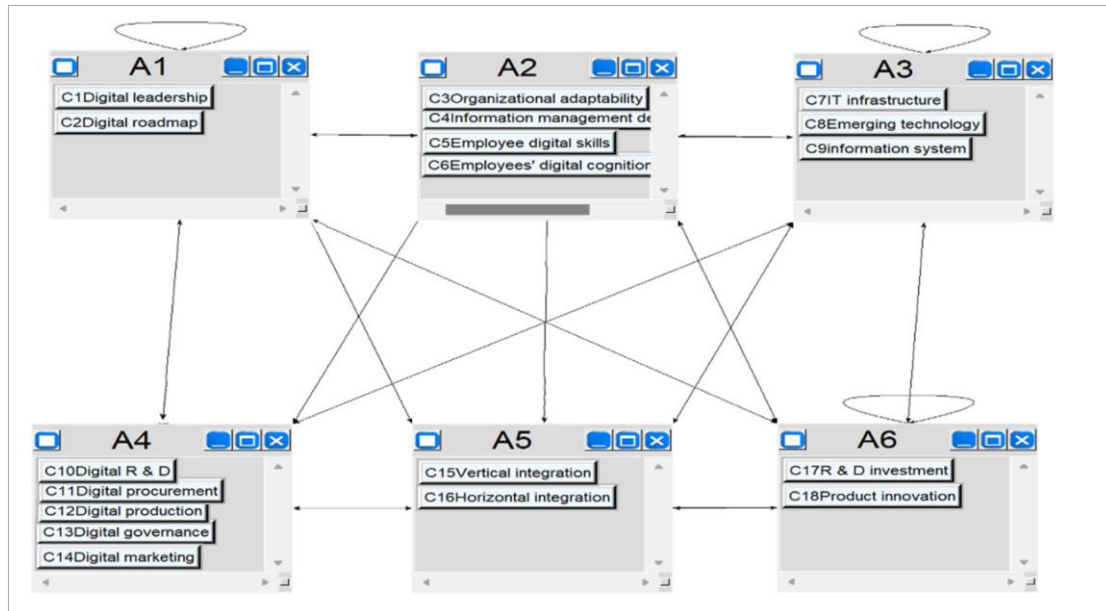
Li (2022) created an evaluation model for SMEs' digital maturity with a three-level index system that includes dimension, category, and domain (Table 9: Evaluation model of digital maturity for SMEs). As a result, the

SMEs considered are judged as “digital transformers.” They have achieved some upgrades and achievements, but the overall digitalisation level still needs improvement

First level indicators	Secondary indicators	Three-level indicators
Strategy (A)	Relevance to business strategy (A1)	Relevance to business strategy (A11)
	Oriented to a long-term digital strategy (A2)	Oriented to a long-term digital strategy (A21)
	Focus on realizing customer value (A3)	Focus on realizing customer value (A31)
Transportation technology (B)	R&D (B1)	Rapid R&D (B11) Customized (B12)
	Procurement (B2)	Expenditure visualization (B21) Collaborative advanced platform (B22) Procure to pay process (B23) Procurement performance management (B24)
		Resource/process effectiveness (B31) Production quality management (B32) Workforce efficiency (B33) Asset utilization (B34)
	Manufacturing (B3)	
	Supply chain (B4)	Supply chain strategy (B41) Supply chain planning (B42) Physical logistics (B43) Supply chain performance management (B44) Order management (B45) Supply chain collaboration (B46)
	Marketing (B5)	Marketing management strategy (B51) Market analysis (B52) Digital marketing management (B53) Customer experience (B54)
Cultural, organisational competence (C)	Culture (C1)	Risk appetite (C11) Test and learn (C12) Speed/agility (C13)
	Organisation (C2)	Roles and responsibilities (C21) Talent and leadership (C22) Governance mechanisms/digital KPIs (C23) Organisational science for decision-making (C24)
	Ability (C3)	Data-driven decision-making (C31) Organisational process automation (C32) IT system support (C33)
Ecosphere (D)	Internal collaboration (D1)	Internal collaboration (D11)
		External resilience (D21)

Chen et al. (2022) developed a six-dimension digital maturity evaluation system that applied a hybrid method of DEMANTEL (Decision testing and evaluation laboratory method), ANP (Analytic hierarchy process), and FCE (Fuzzy Comprehensive Evaluation) to evaluate the digital transformation level of small and medium-sized manufacturing companies. DEMANTEL-ANP

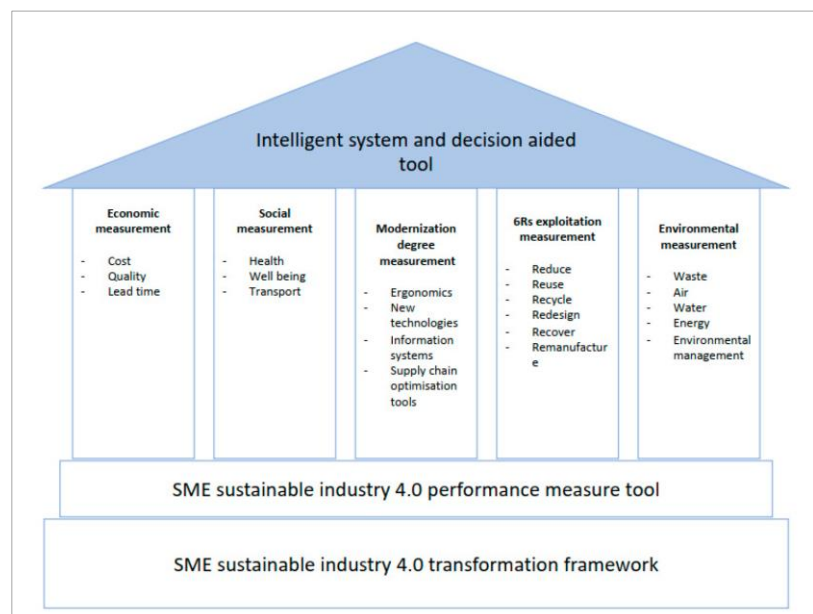
clarifies the causal relationship and weights each indicator. The FCE method evaluates the maturity index. The 6 dimensions (strategy, personnel, technology, process and integration) considered were integrated by 18 criteria (C1, C2, ..., C18). The network diagram is shown in Figure 10: Network diagram of criteria in systems design (SD).



Digital maturity model levels

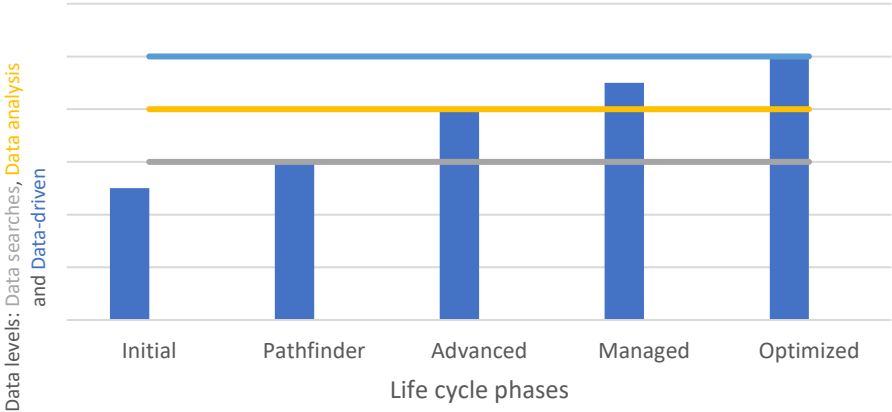
DMM levels represent an evolutionary progression, guiding companies from initial digital adoption to full digital integration and optimisation. The levels within DMMs are essential for evaluating how companies leverage digital technologies to enhance organisations' operations and processes, such as strategy, technology, culture, and overall performance. The literature proposes different maturity model levels to evaluate the digitalisation of companies.

The framework outlined below (Dossou & Liyanage, 2022) focuses on sustainability as the central component of SME digital transformation. This transformation involves changes in the decision-making, physical, digital, and smart aspects of the framework. The performance measurement structure developed for SMEs is based on five main criteria or levels: environmental, social and societal, economic, modernization, and 6Rs exploitation (e.g., reduce, reuse, recycle, redesign, recover, remanufacture). These criteria incorporate sub-criteria that together form the Industry 4.0 performance measurement model (Figure 11: Sustainable Industry 4.0 performance measurement model).



Sándor & Gubán (2022) detailed 5 maturity phases that SMEs face (Figure 12: Classification of maturity levels). These phases can be classified into 3 levels in terms of data information:

1. Data searches, interpretation of information, queries.
2. Data analysis with statistical methods, statistical prospective analysis.
3. Data-driven Big Data technologies, use of business intelligence.



Blatz and Dietel (2018) analyse the overall maturity level of the participating companies in the study. The three maturity levels and the results are shown in Table 10: Maturity level. Blatz and Dietel (2018) describe a three-level structure: Level 1 (Initial), where companies take the first

steps in digitization, Level 2 (Managed), where formal digital processes are implemented, and Level 3 (Optimised), where companies use data-driven objectives to continuously improve and adapt.

Level	Description	Digital Maturity /Points
Level 1	First digitization steps in the company are taken, but so far, no mature approach has been defined. The impact on company and processes is minimal.	> 0 points
Level 2	Some digitization steps are described in a formal way and are executed accordingly.	> 2 points
Level 3	Quantitative objectives and their evaluation are set. Reflection and adaption of actions of digitization.	> 3 points

Hortovanyi et al. (2023) expand on this concept with a four-level model with “stages”, including Novice, Beginner, Competent, and Expert, which reflects a firm’s growing digital capability from basic to highly advanced stages. Each maturity

stage defines improvements, guiding the selection of actions needed for moving to the next stage with the focus of IT, strategy, operations and synergies (Table 12: Maturity stages).

Maturity stages	Description	Generic description
Novice	New to	IT-enabled resources are used by nearly every firm, however, the transformation level is low, mainly conceptual, and technology focused.
Beginner	Learning	Progress is made by combining, deploying, and converting resources. The right strategy is critical for effect deployment of IT-enabled resources.
Competent	Practicing	The interactions between IT enabled resources elevates transformation.
Expert	Transformed	The firm’s digital capability matures. Organisation is continuously seeking new transformation opportunities.

McDermott et al. (2023) conducted both a quantitative survey and qualitative interviews. As shown in Table 13, Table 14 and Table 15, the themes of the questions were centred around definition, benefits,

motivations, current Industry 4.0 initiatives, alignment with strategy, the government supports, implementation of a lean program, CSFs, challenges, and readiness factors for Industry 4.0 implementation.

Support	Importance (%)
Training and education on Industry 4.0	26%
Grants	24%
Sharing of best practice stories	16%
Networking with other businesses	15%
Mentoring	11%
Benchmarking opportunities	4%
Digital transformation roadmaps	4%

CSF (Critical Success Factors)	Importance (%)
The right equipment and software solution	20%
Qualified, knowledgeable staff	19%
Clear guidance, consultancy	18%
Adequate budget	17%
Knowledge of processes	13%
Team engagement	13%

Requirement	Importance (%)
Finance/Budget	21%
Grants	21%
Training	21%
Government support	20%
Staff skills	13%
Employee buy-in	9%
Understand how it would help	8%
Management support	8%

Huet et al. (2022) proposes Maturity Model Levels for smart beehive technology. The system at the hive level is between levels 1 and 5. Depending on the CPS (cyber-physical

systems) setup by the beekeeper, the level of alerts and notifications that the beekeeper receives varies (Table 16: Maturity model levels adapted for smart beehives).

Maturity Model Levels	1	2	3	4	5
Data input	Manual or vocal input (semi-automatic) and global connection to environmental data	Automatic input by sensors and global connection to environmental data	Automatic input by sensors and global connection to environmental data	Automatic input by sensors and local/global connection to environmental data	Automatic input by sensors and local/global connection to environmental data
Intelligence	Centralized	Centralized	Centralized and locally limited	Centralized + Local (including history of decisions made) + Local analysis of the data and automatic alerts sending	Centralized + Local cooperation and negotiation between beehives
Communication	Vertical with synchronization for several days or weeks	Vertical with synchronization for several days or weeks	Vertical with Real Time Synchronization	Vertical with Real Time Synchronization	Horizontal and Vertical with Real Time Synchronization

Digital maturity model tools

Sándor and Gubán (2022) investigated the level of digitalisation in agri-food companies, including questions about the presence of digital tools in the interview sample. The study focused on the presence and the perceived impact of several digital management tools (in communication, production, project management, finance, customer relationship management, etc.). Knowing the tools for a DMM is crucial, as outlined in Table 17: Tools used in F&B sector and their frequency which highlights the specific digital tools commonly used within the F&B sector and their frequency of adoption among businesses.

Results show that agricultural businesses are much less equipped than other sectors when it comes to communication tools, financial management tools, online document storage

and management tools, collaborative work tools, customer relationship management tools, and project management tools. The only tools for which the results are not significant are business management and steering tools, computer-aided design and/or production tools, and big data management tools, as they are present in less than 10% of companies (Table 17: Tools used in F&B sector and their frequency). This table highlights significant differences in tool usage between agri-food companies and non-agri-food sectors, underlining the importance of equipping organisations with appropriate digital tools to enhance their digital maturity. Understanding and adopting these tools enables organisations to efficiently manage processes, streamline operations, and drive digital transformation efforts.

Tools used in F&B sectors, focusing on the agri-food sector	Examples	% of agri-food companies for which tools are present	% of non-agri food companies for which tools are present
Communication tools	Email, instant messaging	85.0%	93.2%
Financial management tools	Automated estimates and invoicing, online accounting	27.2%	41.3%
Online document storage and management tools	Cloud computing/cloud drive, shared document management	18.8%	31.0%
Collaborative work tools	Intranet, collaborative platforms	13.6%	20.0%
Management and steering tools for the company	ERP (enterprise resource planning), SAP	10.3%	9.6%
Customer relationship management tools	Salesforce, SugarCRM, Zendesk, HubSpot CRM	6.1%	15.4%
Computer-aided design and/or production	Smapi3D, AutoCAD	4.2%	7.5%
Big data management tools	Tableau, RapidMiner, Informatica	3.3%	5.8%
Project management tools	Trello, Slack, Microsoft Teams	1.4%	5.0%

Digital maturity model hurdles

Understanding the hurdles associated with DMMs is essential for businesses embarking on digital transformation journeys. These challenges, ranging from internal organisational issues to technological limitations, can significantly impact the success of digital initiatives. Addressing these hurdles early on enables companies to anticipate and mitigate risks, ensuring smoother transitions and more effective adoption of digital technologies.

Amaral and Peças (2021) define struggles or hurdles as challenges and obstacles that companies need to overcome, in the implementation of digital initiatives. Table 18: Description of SMEs hurdles category based shows the hurdles categories, disclosing both the difficulties that are inherent to SMEs, and the struggles that exist in the development of approaches to ease their integration in I4.0 (Schumacher et al., 2016; Ganzarain and Errasti, 2016; Lichblau et al., 2015; Schuh et al., 2017; Griessbauer et al., 2016; König, 2017; Darnley et al., 2018).

Hurdles category	Description
Data security	Lack of confidence in data security and privacy; Unsolved questions around data security and data privacy in connection with the use of external data; IT-data security; Concerns with cybersecurity deter many companies from digitizing their processes;
Internal problems	Internal bureaucracies and regulations; Organisation, leadership; Conservative company strategy; Hierarchic structure; Many companies hesitate to change their business structure for digitization due to the experimental nature of Industry 4.0 technologies.
Culture	Lack of corporate culture for I4.0 concepts.
Skilled labour	Lack of expertise or skilled labour; The biggest challenge of Industrial leaders is not the technology, it is the people; Insufficient talent; Companies tend to fail to assess their own capabilities in I4.0 with restrains from taking any coordinated action; Most companies do not possess the required knowledge of I4.0 to self-assess their own capabilities; Limited human capital; Lack of experience; Lack of personal; Utilization of Industry 4.0 technologies results in reallocation of personnel from unskilled to technically skilled labour.
Economic benefits	Lack of clarity about economic benefit; Lack of market need; One of the main reasons is that many companies currently fail to appreciate the concrete benefits of I4.0; Unclear economic benefit & digital investment; Lack of a clear idea of I4.0 and uncertainty about benefits and outcomes; SMEs do not know where to start from in order to generate new growth opportunities.
Lack of clarity	General lack of clarity, hesitance; Lack of clear operations vision and support/leadership from top management; Difficulty of grasping new concepts.
Lack of norms	Lack of norms and standards; Unresolved legal issues; Lack of digital standards, norms, and certifications.
Broadband infrastructure	Inadequate broadband infrastructure; Slow expansion of broadband infrastructure technology.

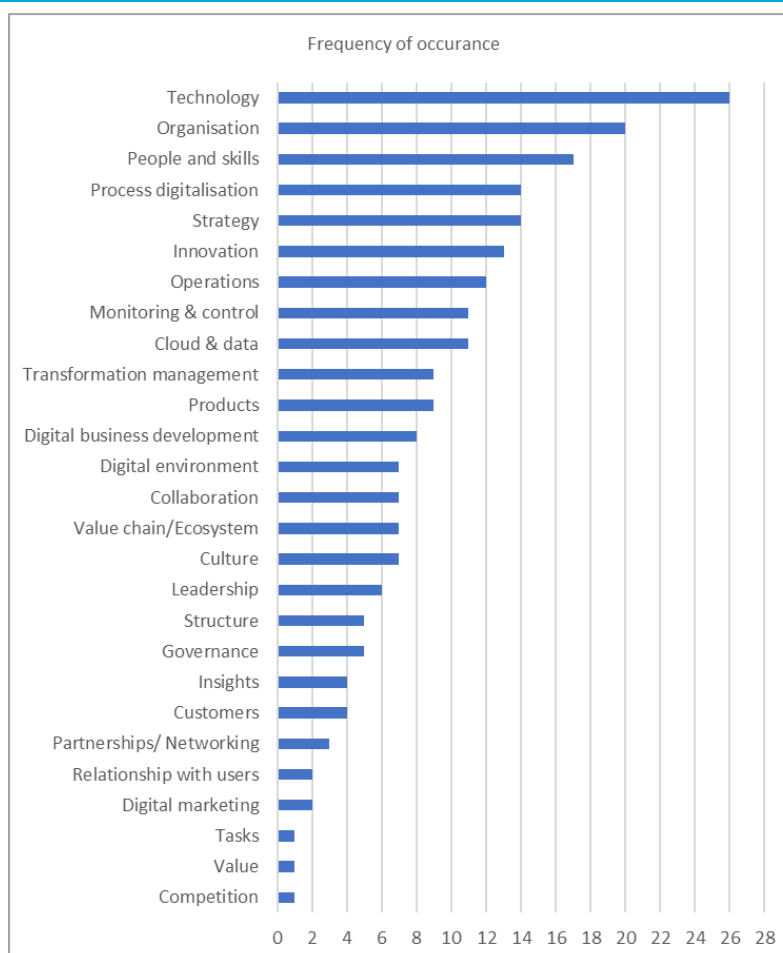
The below table displays the problems that digitalisation helps to overcome. It starts with outlining the issue faced by the organisation, then identifies the root cause of the problem

and provides information on how the digital tool (in this case, a cloud-based freeware website/application) resolves the problem.

Problems the digitalisation allow the process to overcome	Problems' root-causes	Outputs
Interruption of chiefs of production's work due to constant communication with sales department	Workers don't have instant access to Information	Swiftness in access to the information
Two cards for the same module	Workers don't have instant access to Information	Swiftness in access to the information, Exchange or edit the information more efficiently
Prevents one module of being rented twice	Information dispersed in different silos	Swiftness in access to the information, Exchange or edit the information more efficiently
Feeding information into the boards by hand	Information dispersed in different silos	Exchange or edit the information more efficiently
Physical movement to obtain information	Information dispersed in different silos	Swiftness in access to the information
Physical transport of the cards	Information dispersed in different silos	Swiftness in access to the information, Exchange or edit the information more efficiently

Descriptive analysis based on coding of digital maturity model literature

The below figures show the frequency of occurrence of main dimension themes in the reviewed maturity model-related literature. The most frequently occurring main dimensions are Technology (53.1%), Organisation (40.8%), People and skills (34.7%), Process digitisation (28.6%), Strategy (28.6%), Innovation (26.5%), and Operations (24.5%). The % figure indicates the percentage of papers in which the main dimension was found.



With respect to main dimensions where sub-dimensions are also coded, below Table summarises the frequency of occurrence of sub-dimensions, where the most prevalent

sub-dimensions are Knowledge (18.4%), Training programmes (14.3%), Collaboration (14.3%), Data management (8.2%), and Digital Challenges (8.2%).

Main-dimension	Sub-dimensions	Frequency of occurrence	% papers mentioning sub-dimension
Organisation	Culture	1	2,0%
Organisation	Process & organisation	4	8,2%
Organisation	Knowledge	9	18,4%
Organisation	External environment	1	2,0%
Technology	Automation	2	4,1%
Technology	Data management	4	8,2%
Technology	IT systems	3	6,1%
People and skills	Collaboration	7	14,3%
People and skills	Training program	7	14,3%
People and skills	Qualification	3	6,1%
People and skills	Work assignment	0	0,0%
People and skills	Work structure	0	0,0%
Process digitalisation	Digital challenges	4	8,2%
Process digitalisation	Digital opportunities	2	4,1%

In the process of coding the DMM literature, it became clear that many DMM papers also framed digital skills and technology themes as aspects of, or as related to, digital maturity. As a result, DMM literature was also coded

against the technologies and tools sub-dimensions. literature shows the frequency of the top 14 technology and tool related themes coded from the analysis of DMM literature.

Sub-dimensions	Frequency of occurrence	% papers mentioning sub-dimension
Digital literacy	18	36,7%
Digital transformation	17	34,7%
Policy	11	22,4%
IoT	9	18,4%
Sustainability	7	14,3%
AI	6	12,2%
Investments/Financial tools	5	10,2%
Digital strategy	5	10,2%
Disintermediation technologies (e.g. blockchain)	4	8,2%
Stakeholder engagement	4	8,2%
Supply chain	4	8,2%
Cyber security	3	6,1%
3D printing	3	6,1%
Market orientation	3	6,1%

From this analysis, aspects of digital maturity and digital skillsets are intertwined and interdependent. In section 11.1, we combine the DMM literature review with findings from interviews with F&B SMEs and educators/trainers to propose a DMM suited to SMEs in the F&B sector.

This chapter provided a comprehensive overview of DMMs underlining their critical role in facilitating digital transformation. Integrating insights from diverse frameworks, this chapter highlights how DMMs enable organizations to assess their current digital

capabilities and identify pathways for growth. Key dimensions, such as strategy, technology, organizational processes, and people, were identified as keys to evaluating and advancing digital maturity. Additionally, various challenges—ranging from cultural resistance to technological limitations—were discussed, underscoring the need for tailored approaches to implementation. Ultimately, the chapter underscores the importance of DMMs as structured tools for guiding organizations through the complexities of digital transformation in an increasingly competitive and dynamic digital landscape.

Digital Skillsets



In the context of digital transformation, having the right skill sets is critical for organisations to successfully adopt and implement new technologies. The shift toward digitalisation requires more than just technical upgrades; it demands a workforce equipped with the competencies to manage, adapt, and leverage digital tools effectively. This section explores the essential skillsets required for digital transformation, focusing on both technical and soft skills that enable individuals and organisations to navigate this complex process. Based on a review of relevant literature, the section outlines key areas such as digital literacy, leadership, relationship

management, problem-solving, and the ability to foster a culture of innovation.

A shared understanding of the definitions of key terms used in this project is essential to ensure alignment when evaluating RDDCA skills. The chosen definitions are based on various academic sources relevant to the project's context and will serve as the foundation for the skillset mapping process and subsequent interviews. A selection of these relevant definitions is provided in Table 22 and will guide our discussions and qualitative analyses of RDDCS skills.

Term	Overview of selective definitions
Digital capabilities	<p>"Digital capabilities are the firm's ability to deploy and convert IT-enabled resources" (p.4). (Hortovanyi et al., 2023)</p> <p>"...a firm's digital capabilities may emerge from the cross-functional integration of its marketing, IT, and operational capabilities" (p.5). (Hortovanyi et al., 2023)</p> <p>"...capabilities can be developed jointly, in a cumulative fashion" (p.5). (Hortovanyi et al., 2023)</p> <p>"Digital capabilities are required for continuous adaptation; these help advance the digital maturity of the company" (p.5). (Sándor & Gubán, 2022)</p>
Digital literacy	<p>"Digital literacy is a creative, practical, practical, smart, and safe moment with digital technology in all areas of life. Skills in using digital devices are referred to as digital literacy, as the ability to access and use information technology from various sources" (p.5). (Suparno et al., 2022)</p>
Digital literacy skills	<p>"Digital literacy skills include competent use of technology, interpretation, and understanding of digital content and assessment of its credibility, creating, researching, and communicating with appropriate tools efficiently and effectively" (p.5). (Suparno et al., 2022)</p>
Digital competence	<p>"...the competence dimension assesses aspects related to the individual worker and their qualifications." (p.4). (Bretz et al., 2022)</p> <p>"...key competence clusters for future employees lie within the use of data and information" (p.4). (Bretz et al., 2022)</p> <p>"...employees must understand the fundamental principles and technologies of Industry 4.0 to succeed in the digitized manufacturing environment" (p.4). (Bretz et al., 2022)</p>
Digital leadership	<p>"The term digital leadership describes leaders taking the right actions to manage digitalisation of organisations and involves leader qualities that positively influence the attitudes and behaviours of organisational members who are affected by digital technologies, including specific competencies within strategic management and technology management" (p.2). (Gilli et al., 2024)</p>
Digital change agent (DCA)	<p>A person capable of strategically guiding digital transformation projects inside companies and who is equipped with additional personal, social, and methodological skills to be able to drive digitalisation projects in an organisation and – through leadership, change management, and basic technological skills - facilitate the execution of digital change. (Solis, 2017).</p>
Responsible dynamic digital change agent (RDDCA)	<p>A person whose core capabilities as a digital change agent are further augmented with green skills (as in the GreenComp Framework) that consider addressing environmental as well as societal issues through digital technologies.</p>

Skillset dimensions

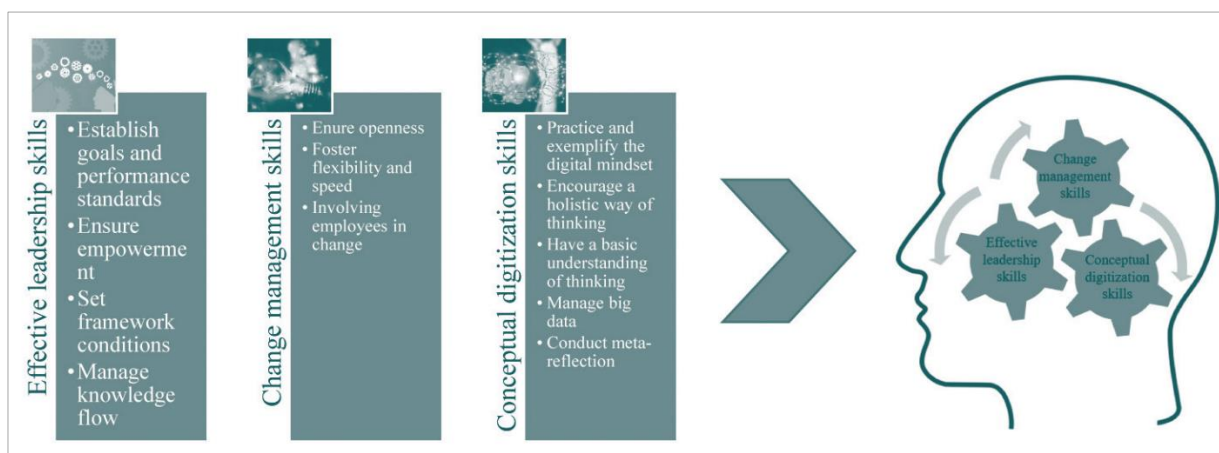
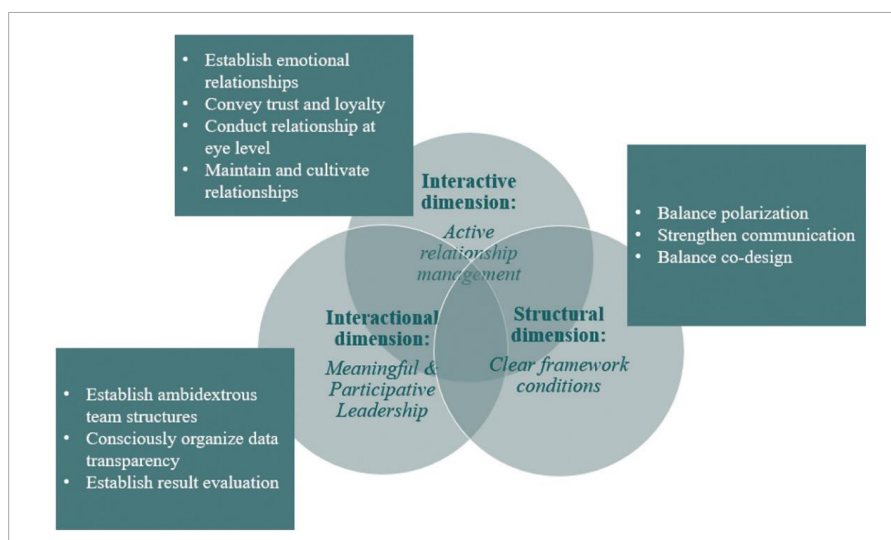
Ehlers et al. (2022) has identified 4 scenarios (Light digitalisation, Autonomous Technology, Digital Food Business, and Digital Regulation) of policy-relevant digitalisation of the European Agrifood sector by 2030. They are ordered on two main dimensions: whether digital technology faces an environment

conducive to its deployment or not and whether technologies and institutions are heterogeneous or homogeneous. Each scenario is differentiated from the other by the drivers of which it is composed (Table 23: Four scenarios of digitalisation of Europe's agri-food sector in 2030).

Category of the driver	Driver	Scenarios			
		Light digitalisation	Autonomous technology	Digital food business	Digital regulation
Data and its infrastructure	Data openness	Medium	High	Low	Low
	Data control	Spread across actors	Technology providers	Food companies	Government
	Providers of digital infrastructure	Public-private	Public-private	Public-private	Government
Acceptance	Farmers' technology acceptance	Medium	High	Medium	Low
	Social acceptance	Medium	High	Medium	Low
	Willingness to share data	Low	High	Medium	Low
Knowledge and learning	Farming skills	High	Low	Medium	Low
	Digital literacy	Medium	High	Medium	Low
	Inequality for farmers	Low	Medium	High	High
	Innovation rate	Low	High	Medium	Low
Policy	Policy style	Reactive	Proactive	Proactive	Reactive to proactive
	Dominant power	Farmers and Government	Technology providers	Food companies	Government
	Food system perspective	Farm focus	Farm focus	Food supply chain focus	Farm focus
	Spatial and temporal resolution of digitalisation	Coarse	Fine	Fine on food issues	Fine

Gilli et al. (2024) investigates how digital technologies affect the relationship between leader and team and what the crucial skills of leaders are to manage digital transformation (Figure 14: Digital transformation dimensions). It defines 3 main dimensions

influencing the leader-member relationship (Figure 15: Leader-member relationship). It also defines 3 dimensions of skills for managing digital transformation (Figure 16: Skills for managing digital transformation).



The results show that digital technologies greatly affect the relationship between leaders and team members. Additionally,

powerful change management skills are needed to drive digital change processes.

Digital skills and literacy

Digital transformation leverages digital technologies to enhance an organisation's strategy, processes, products, and services. For digital transformation to succeed, employees must possess knowledge and skills in digital technologies. Digital literacy, on the other hand, equips employees at a more operational level with the ability to understand technologies and their uses, operate them effectively and safely, choose the best digital tools for various tasks, and handle issues and challenges that emerge in a specific context (Arnaud et al., 2024).

Suparno et al., (2022) focus on digital literacy in a business context for digital transformation. They outline the key variables that define digital literacy in a business context, focusing on how entrepreneurs and organisations can effectively use digital tools for business purposes. These variables include:

- Accessing online stores: The ability to manage and develop business through online platforms.
- Updating sales information online: Keeping business data current in digital environments.
- Using multiple online media: Leveraging various digital channels for business growth and networking.

- Choosing accurate information: The skill to identify reliable digital content from multiple sources.
- Growing a business network: Using online tools to expand business relationships.
- Adding new business relationships: Establishing new digital connections for business purposes.
- The study of Bradač Hojnik & Huđek (2023) emphasises the importance of knowledge and skills in managing digitalisation projects and utilizing digital and technological solutions. SMEs require training and skill development programmes for effective technology utilization, while larger companies may rely on internal capabilities to adapt to digital advancements.

Saari et al. (2021) elaborate on potential steps for enhancing the employee's digital skills of Finnish manufacturing SMEs (Table 24: Potential digitalisation steps for employee skills development). This table outlines the key digital skill categories and associated steps needed to enhance employee capabilities in a digitalised work environment.

Digital skill category	Step
Information work	Digitalisation of work instructions available to everyone.
	Management and quality of product information and linking of tracking information to digitally manufactured products.
	Recording changes made and hours worked directly in the systems used.
Competence	Microsoft Office365 system training and access for everyone.
	Capacity building of personnel to introduce automation or robotics in production.
	Strengthening the digitalisation skills of employees to make better use of the potential of manufacturing technologies.
	Improving the digital capabilities of production staff in utilising IoT sensing
	Programming of automatic machines.
Remote working	Teaching tracks to robots.
	Development and training of tools for on-line monitoring of manufacturing cells.
Support schemes	Real-time control and monitoring of manufacturing cells via mobile.
	Utilising the use of 3D models on a mobile device at the installation site.
Situation awareness	Utilisation of AR welding visors or AR glasses to aid manual work.
	Manufacturing status table and KPIs available to everyone.

Michailidis et al. (2024) seek to identify and assess gaps in competencies related to precision agricultural technologies among Greek livestock

farmers. The competencies related to farm technologies can be seen in Table 25: Farmers' technology-related competencies.

Item	Mean score	S.D.
Choosing appropriate technologies for my farm.	3.63	1.06
Estimating the costs and benefits of new technologies.	4.25	0.89
Introducing new technologies to my farm.	4.25	0.89
Properly using technologies.	4.38	0.92
Reorganizing work after technology adoption.	4.63	0.74
Solving problems associated with newly introduced technologies.	3.63	0.92
Connecting precision agriculture technologies with those traditionally used.	3.63	1.30
Creating value from technologies.	4.25	0.71
Transforming technologies into productive resources.	4.25	0.89

The farmers' technology-related competencies had mean scores ranging from 3.63 to 4.63 on a five-point scale. The lowest mean scores were observed for the items concerning the adoption decision, the attempts to match existing and new technologies, and the difficulties and problems associated with the adopted technologies. On the contrary, farmers do not seem to face issues related to the allocation of on-farm activities after adopting precision agriculture technologies, as the high mean score of the item "Reorganizing work after technology adoption" indicates.

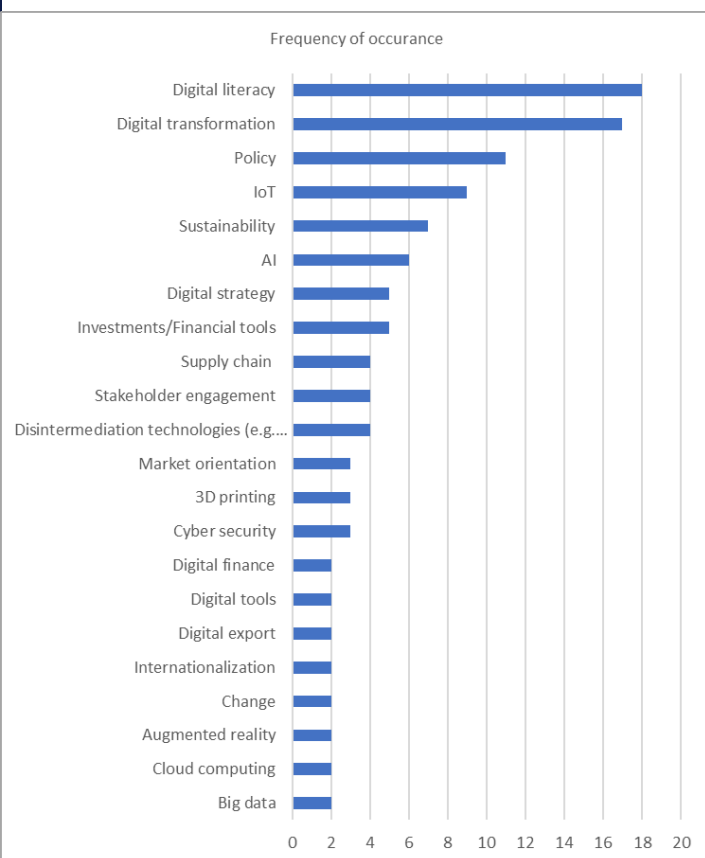
Kamariotou et al. (2022) seek to identify the Information System stages that have an impact on the success of developing a strategic Decision Support System (DSS) to enhance decision-making within agrifood supply chains. It has defined four dimensions of success, and the specific details are presented in Table 26: Success dimension. The

alignment success criteria ensures that digital transformation strategies align with the business's overall strategic objectives and top management priorities, such as understanding how IT and digital initiatives contribute to strategic directions. The analysis criteria focus on evaluating opportunities for process improvements and organisational changes driven by digital technologies. The cooperation highlights the importance of cross-departmental communication and collaboration. Successful digital transformation relies on cooperation among different organisational units and clear managerial responsibilities. The capabilities emphasise the ability to manage and respond to challenges, including problem-solving and dealing with unanticipated crises. The organisation's skill in handling risks and adapting to changes is crucial for digital transformation success.

Alignment	Analysis	Cooperation	Capabilities
Top managers understood that IS improve business strategy	Opportunities for improvement in organisational processes improvement were defined	Unambiguous guidelines of managerial responsibility were developed to implement ISP	Ability to define important negative results
Understanding the strategic priorities of top managers	Managers changed organisational processes and procedures	Potential sources of resistance to IT projects were defined and solved	Ability to deal with surprises and crises
Defining opportunities about IT to help the strategic direction of the company	New ideas were developed to reframe organisational processes using IT	Open lines of communication with other departments were created	Ability to deal with unanticipated changes
IS strategies were aligned with the strategic plan of the company	Information needs of subunits were understood	The development efforts of many organisational subunits were coordinated	Ability to increase collaboration among members of the development team
IS objectives were adapted to change organisational goals	Managers understood the dispersion of information, applications, and other technical infrastructure used in the company	A uniform basis to set priorities was established	
Top managers were educated about the significance of IS	A "blueprint" was developed to define business processes	An increased level of agreement about the risks/trade-offs among IT plans was achieved	
IT was adapted to strategic change	Increased comprehension of how the company operates	The overlapping development of significant systems was decreased	
The strategic significance of IT was evaluated	Business needs and the capability of IT to achieve certain requirements were evaluated		

Descriptive analysis based on coding of digital skillset literature

The figure below shows the frequency of occurrence of sub-themes within the Technology and tools main dimension in the reviewed digital skillset related literature (Figure 17: Frequency of occurrence of Tools and technologies sub-dimensions in skillset literature). The most frequently occurring sub-dimensions are Digital literacy (36.7%), Digital transformation (34.7%), Policy (22.4%), IoT (18.4%), Sustainability (14.3%), AI (12.2%), Investments/Financial tools (10.2%) and Digital strategy (10.2%). The % figure indicates the percentage of papers in which the sub-dimension was found.



In the process of coding the skillset literature, it became clear that many skillset papers also framed digital maturity as relevant to (the development of) digital skillsets. As a result, skillset literature was also coded against the DMM main dimensions (see Table 27: Frequency DMM-related themes coded from the analysis of skillset literature).

Main dimension	Frequency of occurrence	% papers mentioning dimension
Technology	22	46,8%
People and skills	17	36,2%
Process digitalisation	13	27,7%
Innovation	12	25,5%
Strategy	11	23,4%
Operations	6	12,8%
Products	6	12,8%
Digital business development	6	12,8%
Collaboration	5	10,6%
Digital environment	5	10,6%
Digital marketing	5	10,6%
Cloud & data	4	8,5%
Governance	4	8,5%
Customers	4	8,5%
Organisation	3	6,4%
Value chain/Ecosystem	3	6,4%
Leadership	3	6,4%
Structure	3	6,4%
Relationship with users	3	6,4%
Monitoring & control	2	4,3%
Transformation management	2	4,3%
Partnerships/ Networking	2	4,3%
Competition	2	4,3%
Culture	1	2,1%

Conclusions and limitations of literature review



Review of an extensive corpus of literature addressing digital maturity models examined DMM dimensions, and levels, in addition to studies exploring tools for measurement of phases of digital maturity development. Furthermore, we examined hurdles preventing development along the digital maturity continuum and examined digital transformation skills and elements of digital literacy.

In exploring literature, we encountered few papers addressing digital maturity in the F&B sector – a clear research gap. To help explore this research gap through structured interviews with F&B SMEs and educators/trainers, we identify first a second level topics identified in the Bumann (2017) paper (Table 28: An overview on the identified DMM and their specific focus). A 'Ref' code is attributed to each topic which is then referenced during the analysis of the interviews.

Ref	1st level	2nd level	3rd level - examples
1	Technology	Emerging tech	Tech examples (Big data; IoT (Internet of Things); Cyber-physical systems; Cloud computing; AI (Artificial Intelligence); Cyber security; Simulation; Autonomous robots; Horizontal & vertical integration; Augmented reality; Data input; Digital twins; Local business intelligence; Global business intelligence; Communication tools; Disintermediation technologies (e.g., blockchain); 3D printing; Sensor monitoring)
T2		Data (management/analytics)	Data centrality, big data, data privacy
T3			Data protection and compliance
T4			Information / cyber security
OP1	Operations & processes	Process digitalisation	Process examples
OP2		Smart of digital production and operation	
OP3		Smart Marketing	Sales examples, utilization of customer insights/data, online marketing, e-commerce, digital marketing, digitalisation of sales and services
OP4		Supportive operations	HR
OP5		Supply chain	
OP6		Transportation	
OP7		Supplier management	Enterprise information management / ERP
OP8			Solution delivery (ability to design, develop, and deploy solutions)
ES1	Eco system	Relationship management	Stakeholder relationship
ES2		Value chain	Partnership collaboration
ES3			Internal collaboration
ES4			External resilience

Ref	1st level	2nd level	3rd level - examples
S1	Strategy	Investment	Strategic dynamics
S2		Innovation management	Strategic partnerships
S3		Business strategy	Creation of value
S4		Value creation	Competition / value creation
S5			Innovation strategy
S6			Existence of formulated digital strategy
S7			Documentation and communication of strategy
S8			Availability of sufficient resources
S9			Exploration and evaluation of new trends (strategic foresight)
S10			Product / service / process innovation
S11			Financial strategy
S12			Tech investment
S13			Business models
S14			Relevance to business strategy
S15			Orientation to long-term strategy
S16			Focus on realizing customer value
S17			Supply / supplier management
OA1	Organisational aspects	Employee	Expertise
OA2			Training
OA3			Employee skillset
OA4		Skill sets	Talent / skills required
OA5			Learning and change
OA6			Skill acquisition
OA7			Opening of employees to new technologies
OA8			Autonomy of employees
OA9			Critical thinking, problem framing, evaluating information, interaction with technologies, innovating creative using technologies, solving technical problems, technical adaptability
LM1	Leadership, governance & culture	Leadership & management	Willingness of leaders / digital transformation management
LM2			Organisational structure
LM3			Risk management
LM4			Capacity, forecasting and planning
LM5			Identify digital competency gap
LM6		Governance	Labor regulation for industry 4.0, suitability of technology to meet standards/regulations
LM7			Protection of IP
LM8		Culture	Knowledge sharing, open innovation, corporate culture
LM9			Innovativeness or innovation climate
CE1	Circular economy	Sustainability practices	Waste management
CE2			Life cycle product extension
CE3			Reducing Co2 emissions
CE4			Integration of SDGs into company's long-term strategy
CE5			
CE6			
CE7			
CE8			
CE9			
CE10			
CE11			
CE12			

With respect to digital skills and literacy, conclusions are highly contextualised. From a business context, Suparno et al. (2022), for example, outline the digital literacy needed for entrepreneurs and organisations, focusing on skills like managing online stores, updating digital sales information, and leveraging multiple digital channels for business expansion. Key competencies include discerning reliable information, expanding business networks, and establishing new digital connections.

From an SME digitalisation perspective, Bradač Hojnik & Hušek (2023) emphasise the necessity for firms to build digital skills to manage digitalisation projects and adopt technology effectively, suggesting that SMEs follow training programmes to foster these capabilities, while larger companies might leverage their internal resources.

A study focused on the Finnish SMEs in the manufacturing sector (Saari et al., 2021) provides a structured framework for enhancing digital skills which includes training in information management, competence in digital tools, remote work capabilities, and technical support, such as utilizing AR for manual tasks. Key steps for skill development include building familiarity with IoT, automation, and machine programming.

Michailidis et al. (2024) identify competency gaps among Greek livestock farmers concerning precision agriculture. While farmers are proficient

in integrating new technology into farm operations, challenges persist in technology adoption decisions, cost estimation, and troubleshooting new technologies, with an emphasis on harmonizing traditional and modern practices. These challenges are frequently more driven by operational limitations than by intrinsic resistance to change.

Further insights into relevant skills are provided by Kamariotou et al. (2022) based on their study into decision support in agrifood supply chains. This study reveals four critical dimensions for the success of digital transformation: alignment of digital initiatives with strategic objectives, analytical capacity to identify improvements, interdepartmental cooperation, and organisational adaptability to manage risks and respond to changes. Effective digital transformation requires alignment with business goals, clear communication across departments, and enhanced problem-solving capabilities.

Overall, these studies collectively underscore the importance of context-specific, tailored digital skills and structured training programmes to ensure successful digital transformations. Organisations benefit from well-defined digital literacy frameworks and structured approaches to support digital adoption across sectors, addressing specific needs in business management, manufacturing, agriculture, and strategic decision-making.

The Intersection Of Digital Maturity Models And Digital Skillsets

The thematic coding of digital maturity related main dimensions and sub-dimensions based on analysis of both DMM literature as well as digital skills related literature is shown in Figure 18: Digital maturity model main dimensions/sub-dimension coding. There are numerous observations to be made from this representation such as:

- ‘Strategy’ is important to both DMM (14) and digital skillsets (11) .
- While the main dimension ‘Culture’ occurs relatively more frequently in DMM literature (7), it appears less frequently in digital skillsets

literature (1). This aligns with ‘Culture’ as a subdimension of ‘Organisation’ which also occurs more frequently in DMM literature (14), and appears less frequently in digital skillsets literature (1)

- ‘IT systems’ was discussed more frequently in DMM literature (11) than in digital skillsets literature (3).
- ‘People and skills’ are equally referenced by both DMM literature (17) and digital skillsets literature (17).
- The dimension ‘Customers’ was not frequently encountered in either DMM literature (4) or skillset literature (4).

	Strategy	Organisation	Culture	Process & organisati	Knowledge	External environmer	Culture	Value chain/Ecosyste	Operations	Technology	Automation	Data management	IT systems	Innovation	Products	Customers	Partnerships/ Netw	Leadership	Governance	People and skills	Collaboration	Training program	Qualification	Work assignment	Work structure	Process digitalisation	Digital challenges	Digital opportunities	Collaboration	Transformation mar	Cloud & data	Digital environment	Insights	Monitoring & contrc	Digital business deve	Digital marketing	Structure	Competition	Value	Tasks	Relationship with us
Main-dimension	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sub-dimension	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MM count	14	20	14	11	5		7	7	12	26	6	3	11	13	9	4	3	6	5	17	14	4	4	1	3	14	2	1	7	9	11	7	4	11	8	2	5	1	1	1	2
SK count	11	3	1	4	9	1	1	3	6	22	2	4	3	12	6	4	2	3	4	17	7	7	3		13	4	2	5	2	4	5		2	6	5	3	2			3	
Total	25	23	15	15	14	1	8	10	18	48	8	7	14	25	15	8	5	9	9	34	21	11	7	1	3	27	6	3	12	11	15	12	4	13	14	7	8	3	1	1	5
Differential (MM-SK)	3	17	13	7	-4	-1	6	4	6	4	4	-1	8	1	3		1	3	1	7	-3	1	1	3	1	-2	-1	2	7	7	2	4	9	2	-3	2	-1	1	1	-1	

- While the sub-dimension ‘Big data’ occurs frequently in DMM literature (13), it appears less frequently in digital skillsets literature (2). This may relate to a lag between the advancement of a new technology, and articles on this topic.

03

EXPERT INTERVIEWS

Introduction

To gain a deeper understanding of the factors influencing digital transformation within the F&B industry, this section presents the findings from a series of interviews conducted with key stakeholders. These interviews provide a qualitative perspective, offering insights that complement the qualitative insights and theoretical frameworks previously discussed. By engaging directly with industry experts, managers of SMEs, and representatives from

institutions of higher education, we aim to capture diverse practitioner viewpoints relating to digital maturity and innovation.

The purpose of these interviews: first, to identify the specific themes, digital challenges, opportunities and perspectives of SMEs and educators/trainers related to the F&B sector; second, to explore the strategies and best practices currently being implemented to enhance digital capabilities.

Methodology

The research focused on universities, colleges, and institutions involved in delivering training programmes. The aim of the interviews was to understand how these organisations interpret the themes from Bumann (2019) framework, the challenges they encounter in practice, and the opportunities and threats they perceive. Furthermore, an inventory was made of the digital skills deemed important for the future. Additionally, the data collected from interviews is used to develop and refine best practices. To systematically evaluate and improve these practices, we apply a maturity model. This model provides a standardized framework that assesses the development stages of best practices, allowing organisations to identify the current state and areas for further improvement. By leveraging the maturity model, we ensure that best practices evolve effectively and are continuously optimised throughout their lifecycle.

Application of the thematic model in this research

By applying this thematic model, we evaluate each best practice derived from the interview data to determine its maturity level. This approach not only highlights areas needing enhancement but also provides a roadmap for continuous development. The evaluation enables organisations to take targeted steps

to advance their practices, leading to improved processes and outcomes that align with organisational goals. Maturity-level questions are used during the SME interviews.

Interview type and protocol

A semi-structured interview method was chosen to allow flexibility and provide respondents with the opportunity to share their experiences and insights. The interview protocol was based on the literature research in this study, which provides a recent overview of key focus areas regarding digital transformation and innovation. The protocol focused on interpreting these themes and inventorying digital skills.

At the end of each interview, respondents were asked to rate the importance of various digital skills and competencies they deemed most critical for the future. These ratings were collected on a scale from 0 (low) to 10 (high) and are analysed separately to provide a quantitative perspective on the skills assessment. The results of this analysis can be found in the results section.

Recruitment

The recruitment of participants followed a snowball strategy, where network partners from universities assisted in identifying relevant companies within the F&B sector and related industries. A total of 45 SMEs and 33 educators (teachers and researchers) at universities and training providers were interviewed. For universities and colleges, selection was based on their involvement in the F&B industry, business, and innovation. With respect to SMEs, the respondents were at the management level.

Conducting the interviews

The interviews were conducted online via Microsoft Teams and lasted an average of 45 minutes per session. If necessary, the content of the interviews was translated into English, either using translation software or manual translation. The interviews were recorded as audio files and subsequently transcribed.

Anonymity and ethical considerations

All participants signed an informed consent form to ensure the privacy and confidentiality of the data. The collected data was anonymized, and the transcripts were securely stored on a secured OneDrive.

Data analysis: deductive approach

A deductive approach was applied based the framework of Bumann (2019). MAXQDA, a qualitative data analysis software tool, was used for the interview analysis. Researchers examined the data to identify information that fitted within the existing categories or domains. In this study, Bumann's six domains were used as a guide. Examples for each domain was coded, and the analysis determined whether they had a positive or hindering impact on the

objective. A codebook was developed for data analysis, utilizing the deductive approach. The domains and focus areas from the literature framework served as the foundation for the initial set of codes, ensuring consistency and a structured approach in analysing the interviews.

This method allowed for a systematic review of the data while maintaining flexibility for further categorization based on the findings. For each code, specific patterns were identified based on recurring responses in the interview data. A response was included under a particular code only when at least four instances of agreement were noted among participants. Setting this threshold of four instances per code enhances the reliability of the findings by ensuring that the themes identified reflect not merely isolated remarks but of shared perspectives across multiple participants. This approach helps to reduce potential bias and emphasises patterns that are meaningful and consistent. Throughout this chapter, references may be made (e.g. (OA3, OA7)) which correspond to entries in Table 28: An overview on the identified DMM and their specific focus. In this way, seek to link practice interview findings to maturity themes.

Reporting and interpretation of results

The results were summarized and evaluated, with frequency overviews presented in tables. The frequency of specific code combinations was used as an indicator of relevance. The findings are compared with existing literature in the results chapter to identify overlapping elements and to discuss implications for future research and developments. This approach enables an integrated and evidence-based perspective on digital transformation in the F&B industry.

Analysis and results

The analysis begins by presenting the perspectives gathered from educators and trainers, capturing their initial insights and views on the themes under study. Following this, the narrative is structured around the key themes identified during the coding process, creating an interwoven storyline where the perspectives of SMEs and educators alternate. This format allows for a dynamic comparison, highlighting points of convergence and divergence between educators and SMEs, enriching the overall understanding of each theme and providing a nuanced view of the varied perspectives within the field.

Why is there interest in this topic in digital transformation?

Based on the responses gathered from educators on their interest in digital transformation within the F&B sector, several recurring themes emerge:

- **Industry-Relevant skills for future professionals:** A significant portion of respondents emphasised the importance of preparing students for the evolving demands of the F&B industry. With a strong focus on equipping students with digital skills and knowledge about emerging technologies, many see their role as vital to bridging the gap between academia and industry. Educators aim to ensure students are not only aware of digital advancements but also capable of applying them in real-world settings (OA3, OA7).
- **Transparency and traceability in supply chains:** Several respondents highlighted the necessity of digital tools in enhancing transparency and traceability across the F&B supply chain. This is especially relevant considering global challenges, such as resource volatility, and the need for accountability in product sourcing and distribution. Technologies like blockchain, IoT, and data analytics are frequently mentioned as essential for tracking food origin, ensuring authenticity, and improving food safety (OA5, T1, OP1).
- **Sustainability and efficiency:** Digital transformation is also seen as a critical factor in promoting sustainability within the F&B sector. Respondents noted the potential for digital solutions to streamline operations, reduce waste, and support sustainable practices such as true pricing, efficient logistics, and eco-friendly transport. This aligns with broader trends toward reducing environmental impact and meeting consumer demand for sustainable product (CE1).
- **Challenges in digital adoption:** Some respondents pointed to obstacles in implementing digital solutions within the sector, especially for smaller businesses or regional companies. Factors such as high costs, limited resources, and resistance to change are seen as barriers to digital transformation, particularly in sectors like agriculture where traditional methods are deeply ingrained. This challenge underscores the need for accessible and scalable digital solutions (S11, S14).
- **Innovation and competitiveness:** For educators and professionals alike, staying updated with digital trends is crucial to maintaining competitiveness. Some respondents mentioned that digital tools and data-driven insights can help smaller F&B businesses compete with larger corporations by improving efficiency, reducing costs, and fostering innovation. This is particularly important in an increasingly regionalized market, where local businesses seek to differentiate themselves from global players (S4, S5).
- **Integration with sustainable food practices:** Educators working with sustainable food practices highlighted projects like vertical farming and data monitoring as examples of how digital transformation can support eco-friendly initiatives. By integrating technology with sustainable practices, such as aeroponic gardens and digital tracking of crop conditions, respondents are exploring ways to enhance food production in a more environmentally responsible manner (CE3).

Curriculum content and teaching methods

Interviews highlighted the importance of ensuring that curricula and training programmes adequately engage with emerging technologies and that teaching techniques embrace both traditional and digital methods:

- Content on emerging technologies: Key content areas include IoT, AI, blockchain, data science, and automation. These topics are central to staying relevant in digital transformation (T1).
- Teaching AI and generative tools: Some educators are exploring the integration of AI tools in coursework, such as using ChatGPT to assist with assignments while ensuring accountability (T1).
- Fundamental knowledge over technical skills: While specific digital skills are necessary, there is an emphasis on understanding systems and frameworks, rather than only focusing on isolated technical abilities (OA5).
- Combining traditional and digital methods: A balanced approach between traditional teaching and digital tools is seen as beneficial. For example, combining classroom learning with digital tools like online resources, interactive platforms, and digital simulations (T1).
- Problem-based and customer-centric approaches: Educators emphasise problem-based learning, focusing on real challenges within the F&B sector. This approach helps students understand the specific needs of customers and the market (T1).

- Lifelong learning: Educators recognise the need for continuous learning to keep up with the rapid pace of change in digital technology. This mindset prepares students and professionals alike for a world where ongoing skill development is essential (OA7).
- Distinguishing trends from long-term changes: An ability to differentiate between short-lived trends and substantial, long-term transformations in technology is emphasised as a key skill for students (OA7).
- Practical implementation: Educators integrate sustainability and circular economy practices into the curriculum, emphasizing the practical applications of digital transformation in enhancing sustainability within the F&B sector (CE1).
- Sustainable business models: Projects often focus on creating sustainable businesses or processes, preparing students to meet current environmental and social expectations (S13).

Key factors addressed during interviews

The following section is structured around the main topics identified in the research and presents a blend of insights from both SMEs and educators. This narrative emerges from the key factors that play a significant role in shaping effective educational practices and outcomes. By combining perspectives from both SMEs and educators, the section offers a comprehensive view of the critical elements driving successful learning experiences, as well as the nuanced interplay of theory and practice within educational settings.

Strategy

SMEs shared their perspectives on implementing strategy within the context of digital transformation. Digital transformation requires more than the implementation of new technologies; it demands a well-defined strategy rooted deeply in an organisation's vision. For many businesses, digital transformation is not just a necessity to stay competitive but a strategic priority to create new value and growth opportunities. They provided practical examples, discussed specific challenges, and highlighted opportunities to strengthen strategic approaches.

Formalized digital strategy (S14, S15, S7)

Several respondents indicated that their business lacks a formal digital strategy, attributing this absence to resource constraints and limited

organisational capacity. One participant from a startup context stated, "Due to the limited number of employees, they do not have an official strategy yet. They try out everything that comes their way." This suggests a reactive approach, where digitalisation initiatives are exploratory rather than strategically driven.

Another respondent described digitalisation as "more intuitive than based on strategy," particularly emphasizing project selection based on immediate needs rather than long-term planning. Such responses indicate a common trend among resource-limited companies, where digitalisation is approached opportunistically rather than through structured planning.

One respondent noted, “For us, digital strategy means the gradual introduction of technologies into the various processes of our company,” emphasizing a step-by-step integration dependent on available resources.

This ad-hoc approach was further illustrated by a participant who explained, “We do not have a fixed strategy for two or five years.” These statements suggest a flexible, needs-based approach that prioritizes immediate operational improvements over long-term strategic alignment, a characteristic approach within SMEs where digital readiness varies widely.

Assessing the sufficiency of resources (S2, S11, OA1)

Achieving digital goals is a critical aspect of the digital transformation strategy. As organisations increasingly pursue digital innovation, aligning resources such as financial capital, skilled personnel, and technological infrastructure becomes essential to sustain momentum and address emerging challenges. Resource sufficiency directly impacts an organisation's ability to bridge capability gaps and respond to rapid shifts in technology and market demands. While some companies have well-defined budgets and specialised teams, many, especially smaller enterprises, experience constraints in funding, expertise, or time. Addressing these gaps often requires strategic planning, partnerships, and sometimes external funding sources. Effective resource management not only drives digital progress but also positions organisations to leverage digital transformation as a sustained competitive advantage.

A group of respondents indicated that their current resources are generally sufficient to meet digital objectives, with some adding that while resources are limited, they have adapted strategies to work within these constraints. For instance, one participant shared, “We have it set up well within our department. We have a 'Digital Officer' responsible for digital solutions, and we use external teams for large projects.”

In cases where businesses have access to specialised knowledge, this contributes significantly to achieving digital goals. For example, one company benefits from internal expertise, with “One of the co-founders having experience at SAP, supplemented by external consultancy support when needed.” Another participant highlighted

their approach of gradual expansion, mentioning, “Our resources are sufficient for current needs, but we plan to gradually expand our digital capabilities and focus on the effective use of current tools.”

This group often leverages external partnerships and outsourcing to manage larger digital projects without overwhelming their in-house teams. A participant noted, “For large projects, such as EMS or EPMS implementation, we hire external teams, usually on two-year contracts, as we don't need 100% capacity in-house.” Similarly, others have built adaptable digital cultures where employees are ready to take on new digital projects, ensuring smoother project integration across departments.

In contrast, many respondents reported significant gaps in resources, often due to limitations in time, funding, and skilled personnel. These gaps pose substantial challenges for advancing digital transformation. One respondent expressed frustration over resource scarcity, stating, “I don't think our current resources are sufficient to achieve our digital goals, primarily because we lack digital focus outside of marketing.” Another noted, “We don't fully have sufficient resources in terms of money, people, and technology for digital projects.” To address this, they are seeking partnerships with external digitization marketing firms to bolster their efforts. This respondent highlighted also that financial limitations prevent them from accessing advanced digital tools. As one company mentioned, “We would like to implement customer management automation tools like Exponea, but it's beyond our current budget.” For smaller companies, the lack of dedicated project management and digital skills also emerged as a common barrier, with one respondent sharing, “We don't have many IT-savvy people; our expertise lies in other areas, and we're trying to bring these parts together to move forward.” Beyond financial and skill limitations, the rigidity of bureaucracy and regional labour shortages were recurring themes. A respondent facing administrative challenges noted, “Bureaucracy and complicated controls make funding less efficient. If administration were simpler, it would help us progress digitally.” Finally, some companies mentioned that they lack even basic digital infrastructure, with one stating, “We have to teach employees how to set up Zoom or Teams meetings.”

Digital strategy as an efficiency-enhancing mechanism (S11, S16)

For certain respondents, digital strategy was primarily viewed as a tool to enhance operational efficiency and reduce costs. This perspective regards digital strategy as an enabler of cost-saving and productivity improvements. One business noted, “Digital strategy means implementing and improving processes that save time and money and increase production quality.” This approach reflects an emphasis on optimizing internal processes, often through the adoption of tools such as ERP systems.

Another participant underscored the importance of structured digitalisation for workflow planning: “Digital strategy is about connecting production with the store and customers so that the processes are clear, plannable, and controllable.” This response aligns with a process-centric approach to digital transformation, where technology facilitates operational clarity and control across production and sales channels.

Customer engagement and e-commerce as strategic priorities

A subset of respondents highlighted digital strategy as a means of enhancing customer engagement, particularly through e-commerce platforms and digital marketing. For these respondents, digital presence was crucial for maintaining customer visibility and brand engagement. One business owner noted, “For me, a digital strategy is about getting seen online and making my business visible.” This underscores the importance of digital channels in facilitating customer interaction, particularly in sectors with direct-to-consumer models.

They also described their digital marketing strategy as being “quite structured and theme-based,” with social media representing 80-90% of their marketing efforts. This example illustrates a customer-centric digital strategy, where e-commerce and social media serve as primary channels for brand communication and customer acquisition.

Comprehensive digitalisation of production and operations (S3)

More digitally mature businesses showcased a holistic approach to digital strategy, integrating advanced digital tools into production and operational processes. One participant described extensive investments in digital infrastructure: “We’re heavily investing in digitalising our factory floor, not just in production but also in waste management with automatic suction.” This response reflects a high degree of digital transformation, where digital strategy encompasses multiple operational domains.

Another response outlined specific digitalisation projects in production, such as automated cooling systems, photovoltaic power plants, and real-time monitoring of production equipment. This comprehensive approach suggests a strategic commitment to digital transformation as a central element of operational management.

Patterns in the adoption and management of digital strategies within organisations were collected and revealed five categories and levels of maturity.

	Maturity level	Total answers
1	Any digital strategy that exists is largely informal and is typically driven by individuals.	12
2	There is a basic digital strategy emerging for some projects. This approach is not consistently adopted.	14
3	There is a standardized digital strategy adopted across most projects.	3
4	A comprehensive digital strategy approach is in place across the organisation for all projects.	1
5	The approach to develop a digital strategy is agile and continuously reviewed and enhanced based on a combination of ongoing research, lessons learned, and business ecosystem feedback.	6

With respect to the types of technologies used, these are summarized in the table below:

Technology	Total answers
AI	11
IoT	14
Cyber-physical systems	5
Cyber security	4
Cloud computing	15
Big data	6
Autonomous robots	2
CRM	6
Horizontal and vertical integration	1

Other technologies mentioned during interviews are summarized in the following table:

Technology	Examples
Enterprise Resource Planning (ERP) and Inventory Management Systems	ERP system, SAP, inventory management system.
E-commerce and Order Management	Shopify, e-shop, order systems via phone or email, orders coming in via WhatsApp or email.
Social media and Communication Tools	Social media platforms like Facebook and Instagram, use of social media and newsletters, Instagram.
Specific Software and Tools	PhotoRoom, Canva, "Monday".
Financial Technologies	Bitcoin/cryptocurrency.
Other Technological Innovations	GPS, 3D scanning, digital mapping, packing automation, kitchen technology, equipment, iPads for training, simulation software, Power BI software.
General Office Applications	Excel organisation, Google Drive, MS Teams.

As part of the strategy in the context of digital transformation, "resources" represent a broad spectrum of assets, capacities, and support mechanisms that enable organisations to pursue growth, innovation, and efficiency. Resources is an important factor in relation to achieving digital strategy goals and can be sub-divided into the following areas:

Internal and external financial resources (S11)

Financial resources are foundational for companies aiming to invest in digital projects, covering areas from technology acquisition to infrastructure upgrades. While some companies fund these initiatives through loans or reinvested profits, many rely on grants and subsidies to offset costs. As one respondent explained, "When we started, we financed the beginning from our own resources. When these were exhausted, we used a bank loan." programmes like the SABE scheme and European funds, covering up to 75% of project costs, allow businesses to pursue substantial digital transformations without overstressing their budgets. "Without subsidies, large investments would simply not be possible," shared another respondent, highlighting the importance of these external resources for smaller enterprises or start-ups. Flexibility in budgeting was frequently mentioned as essential for funding digital projects. Some companies allocate a specific percentage of

their annual budget to digital investments, as seen in one organisation that reserves 3% for capital expenditure investments. Others adopt a more flexible, project-by-project approach. "If something is too expensive, I try to find alternative ways to achieve the same goal," said one respondent, illustrating a pragmatic approach that adapts spending based on feasibility and potential returns. This adaptable budgeting strategy enables businesses to pursue digital projects within their financial constraints.

Human Capital and skills development (OA1, OA6)

Human resources, especially skilled labour, are pivotal yet often challenging to secure. Many respondents cited difficulties in finding qualified personnel, particularly in sectors requiring specialised expertise or high levels of manual labour. As one participant noted, "The biggest resource challenge we face is finding employees." To address this, some companies implement targeted training programmes or collaborate with educational institutions, like Erasmus, to attract young talent. Digital projects are also seen as a means to offset staffing shortages. "We're trying to automate as much as possible to reduce the demand for general operatives," remarked one respondent, indicating that automation is often driven by the need to cope with workforce limitations.

Time management as a strategic resource (S15, LM4)

Time constraints emerged as a recurring theme, with companies struggling to balance daily operations and the demands of digital transformation. “The biggest problem is actually lack of time, and you can’t just solve that digitally,” said one respondent, reflecting a widespread concern. Some organisations attempt to reclaim time by streamlining processes, such as replacing Excel with dedicated software systems. However, the decision to allocate time to exploratory digital projects, like researching generative AI, often depends on financial and human resources. “Streamlining saves time,” noted one business owner, “allowing us to focus employees on higher-value tasks.”

Technological Investments: incremental and strategic (S12, S15)

Companies take varied approaches to technology investments, from implementing ERP systems to gradual, incremental upgrades. Smaller businesses often adopt a phased approach to upgrading essential machinery and systems, making these investments more manageable. One respondent shared, “We’ve connected production machines to our IT network and started logging data, but it’s still a big step to get all machines interconnected.” For such companies, flexibility in technological investment—such as integrating Siemens’ latest controls for partial automation—enables them to enhance efficiency without straining their budgets. As one respondent put it, “We’re gradually building our digital capacity without overwhelming our resources.”

Partnerships and knowledge networks

Strategic partnerships and access to knowledge networks are vital for companies seeking to leverage external expertise and resources. For example, one company’s involvement in the ‘Holobiome’ project allowed them to participate in advanced digital projects with minimal administrative burden. “Partners took care of the grant application,” noted the respondent, “which saved us time and allowed us to participate ‘in kind’.” Additionally, many companies rely on conferences, networking events, and government consultations to stay informed on industry best practices. “We attend conferences and visit other factories... these are our main tools for maintaining

and developing partnerships,” shared a participant, emphasizing the role of these networks in both funding and knowledge acquisition.

Adapting digital projects to brand values

While digital transformation is valued, certain companies prioritize brand-aligned, selective digitization over full automation. “For us, it’s important to show customers the craftsmanship in our work,” explained one dairy producer. Their approach involves limited digital integration, allowing customers to observe artisanal cheese production. “If we automated everything, it would lose the personal touch,” they added, reflecting a strategic choice to maintain brand values such as sustainability and authenticity over complete digital transformation. This method reinforces customer trust and differentiation in a market that often favours mass production.

Operational flexibility and project management challenges (LM2, LM4)

Effective project management emerged as a challenge, particularly for companies lacking specialised expertise in this area. Digital rollouts require careful planning, and companies often struggle with project timelines and resource requirements. One respondent described their ERP rollout experience: “We knew the number of licenses and devices, but planning the whole process was challenging since we lacked project management experience.” For companies like these, either investing in internal training or seeking external consultancy support becomes crucial to bridge the skills gap and ensure the success of digital projects.

Use of digital tools for efficiency (T1, OP1)

Digital tools tailored to specific business needs, such as e-commerce platforms and logistics solutions, were seen as valuable for operational efficiency. One participant, for instance, improved delivery reliability by partnering with Trunkrs for same-day delivery. “With Trunkrs, if a package can’t be delivered, it’s placed in the freezer and sent back to me,” they explained, “so I’m losing a lot less.” By selecting digital solutions that directly support operational goals, companies maximize returns on their limited budgets while enhancing customer satisfaction. Another respondent shared, “We use Shopify, Google Analytics, and other e-commerce tools to keep our digital infrastructure up-to-date without major capital investment.”

Education perspectives on strategy (T1, OA9)

Educators and trainers were asked to share their perspectives on teaching the subject of Strategy formulation in their educational programmes. This overview offers insights into how strategy is addressed, showcasing current practices and potential areas for growth.

- Case studies, examples, and simulations: Students work with case studies from the F&B industry (such as Butler Chocolates) and simulations like an airline simulation and potentially "Mike's Bikes" to practice strategic concepts. Companies like McDonald's, Nestlé, and Coca-Cola are used as examples of successful digital transformations.
- Practical projects and collaborations with companies: Collaborations with real companies such as the Handmade Soup Company and projects like Bistro Gastro help students develop and apply strategic visions in real-world scenarios. Other examples include:
 - Artificial Intelligence (AI): Integrated into business programmes to support decision-making and process improvement, with examples like McDonald's customer behaviour analysis and Coca-Cola's demand forecasting.
 - Blockchain: Used for traceability, as seen in IBM Food Trust, to increase supply chain transparency.
 - Internet of Things (IoT): Includes examples like Nestlé's inventory and quality monitoring systems.
 - Automation and robotics: Amazon Fresh uses robots for logistics; examples in student projects include autonomous mobile robotics for food service.
 - Big data and data analytics: Emphasis on analysing customer preferences and operational data to improve strategic decisions.
 - Digital marketing tools: Used to promote sustainable business models in student projects.
 - Digital payment systems: Starbucks' app as an example of enhancing customer experience and loyalty.
 - Project management tools: Microsoft Teams, Trello, and Menti for collaborative learning and real-time data interaction.
 - Sustainability and strategic focus: Students learn to develop strategies centred on sustainability, focusing on ecological impact, waste management, and operational efficiency.

Industry case studies are also used (e.g., Butler Chocolates, McDonald's) to contextualize digital strategy concepts. Example approaches include:

- Hands-on applications: Students build and analyse live dashboards with Power BI and Python, or create websites and promotional content using Adobe and Prezi.
- Interactive tools: Utilization of Slido, Menti, and digital whiteboards to enhance engagement and understanding of digital strategy concepts.
- Workshops and simulations: Conducted to address digital topics like MOOCs and Blockchain; practical simulations for real-world applications (e.g., robotic food service trials).
- Real-world projects: Projects such as robotic service trials and the Bistro Gastro project where students work on practical implementations of digital strategy in the food and hospitality sectors.
- Business operations: Examples from companies like Starbucks (mobile app), Amazon Fresh (automated logistics), and Coca-Cola (AI for demand forecasting).
- Supply chain management: Emphasis on IoT and blockchain for real-time monitoring and tracking, as illustrated by Nestlé's inventory system and IBM's blockchain for food traceability.
- Sustainability-focused technologies: Use of AI and digital marketing in zero-waste and sustainable business models.
- Autonomous robotics: Applications in logistics and food service, allowing students to engage with cutting-edge industry technology.
- Data-driven decision making: Teaching students to use data tools like Power BI for live analytics to inform business strategy.

Use of digital tools in strategy education

Tools supporting data-driven decision-making are important for SME F&B professionals to understand:

- Data-driven decision making: Teaching students to use data tools like Power BI for live analytics to inform business strategy.
- Platforms: Integration of digital tools like Microsoft Teams to deliver modules such as "Digital Transformation in Service Businesses. Strategy education combines traditional methods with modern technologies to stay relevant to current market needs.

Lack of specific digital strategy (S15)

- Digital strategy is often not explicitly addressed. While general organisational strategy and value chain are covered, specific digital strategies remain underemphasised.

Knowledge of long-term vs. short-term strategies (S15)

Planning horizons are often geared to the short-term (direct problem-solving) and lack the long-term perspective required for strategic planning.

Limited practical application and concrete examples (S2)

Strategy education often remains theoretical, without hands-on implementation. There's a need for a more practical approach and access to digital tools.

Limited coverage of digital technologies (T1)

While basic technologies like AI and machine learning are covered, there's little focus on sector-specific applications within the F&B sector.

Absence of consistent educational strategy for digital transformation (S1)

Strategy is often treated as a side topic within programmes, especially in modules focusing on broader data science or general management skills.

Organisation

Effective organisation is closely tied to managing workflows from design, planning, production to sales and delivery, seeking to enhance productivity and ensure smooth operations. Additionally, maintaining a coherent external image is crucial for building trust with customers and partners. A structured framework provides clarity on roles, responsibilities, and processes, supporting overall business efficiency. This section explores aspects of the organisation.

Structure and systems (LM2)

Many respondents view the organisation as a structured framework that provides clarity on roles, responsibilities, and processes. This framework includes organisational charts, reporting structures, and clearly defined roles for team members. For some, it involves setting up specific periods for different activities, such as production or paperwork, to manage time effectively and ensure tasks are executed efficiently. One respondent emphasised that "organisation means having a structured way to manage tasks and time."

As one respondent explained, organisation is about "having a clear plan and strategy for achieving our goals," highlighting that structure is fundamental for business efficiency and smooth operation. Another noted the importance of defining who is responsible for various roles and tasks, underlining how organisational structure supports the company's overall mission.

Integrating digital strategy with business operations (S1)

Several organisations integrate digital partnerships into their core operational strategies, seeking

consistency across sites or product lines. A participant from a manufacturing company noted alignment with large suppliers like HP and Avery Dennison to ensure seamless operations across facilities, stating, "This alignment helps us maintain supply chain assurance... if one plant faces an issue, another can produce the same product." Similarly, companies in the production and packaging industries form strategic partnerships to standardize technology and processes across locations, reinforcing operational stability through consistency in equipment and supplier relationships.

Processes and efficiency (LM2)

Effective organisation is closely tied to the management of workflows, from production to sales and delivery. Several respondents stressed that organisation involves optimizing processes to enhance productivity and ensure the smooth flow of operations. One respondent mentioned that "organisation in our business context means the effective arrangement of all activities and processes within the company," with a specific focus on delivering products that meet customer expectations.

Efficiency in managing internal processes, such as coordinating between departments like marketing, production, and sales, was also highlighted. One respondent stated, "It's about how we plan our work, execute it in a timely manner, and organize team communication." This focus on efficiency is particularly crucial in larger companies with multiple departments that need to work seamlessly together.

External perception and market positioning (S4, S2)

For some respondents, organisation also means how the company is perceived externally. Maintaining a coherent and unified image is essential for building trust with customers and partners. One respondent explained that "we are always perceived externally as one company," despite having separate divisions for different activities, such as production and event management.

Organisation as a Personal Mission (LM1)

A few respondents expressed a deeply personal connection to their organisation, viewing it as more than just a business. For them, the organisation is their life's work and a source of inspiration and purpose. One respondent mentioned, "It is my life, my meaning of life," highlighting how the organisation serves as a platform for personal fulfilment and achievement. Similarly, some respondents described their organisation as a "second home" or a "second family," underscoring the strong emotional ties they have to their work and the people they work with. This perspective reflects the dedication and commitment these business owners and leaders have toward their organisation, seeing it as an extension of their identity.

Customers

Customers are at the heart of digital transformation, as their needs, behaviours, and feedback drive businesses to innovate and adapt. Respondents emphasised the importance of understanding and responding to customer expectations, which not only shape product offerings but also influence the adoption of digital tools and channels. The following results represent the factors that play a role in this process.

Customer is leading (S16)

For many companies, customers represent the core of their business strategies, shaping decisions across various areas such as product development, marketing, and service delivery. One respondent mentioned that "acquiring new customers and customer satisfaction" is currently their main focus, while another emphasised that customers "are the most important factor for the company." This customer-centric approach includes plans to expand into new channels, with some companies moving from a B2C to a B2B focus, such as supermarkets.

Customer satisfaction and retention are critical priorities for many respondents. Several businesses shared a commitment to maintaining high standards, with one company noting, "Customers are incredibly important to us, second only to our employees." Another respondent explained how they "focus on winning and keeping customers, ensuring they are happy and satisfied," a sentiment mirrored across multiple companies. Satisfied customers are seen not only as repeat buyers but also as advocates who can drive

organic growth through word-of-mouth recommendations. Engagement with customers, particularly through direct feedback, allows companies to fine-tune their offerings. Businesses that regularly interact with end customers—such as those selling directly at markets or receiving feedback through Google reviews—often adapt their products based on customer preferences. For instance, one business introduced "two new flavours because customers demanded more choice," reflecting an agile response to consumer feedback. Another respondent echoed this sentiment, describing customers as "a mirror" that provides valuable insights, even if feedback is not always positive.

Businesses serve a range of customer segments depending on their operational models. Some respondents identify primarily with B2B partnerships, selling through established retail channels, while others focus on direct-to-consumer (DTC) models in both physical stores and online platforms. Specific examples include companies with B2C customers who buy cheese or attend product showcases and B2B partners, like distributors or restaurants, who purchase in bulk. There are also companies that reach specialised customer personas; for example, one targets "Germans who want to get the foods they had on their holiday in Portugal," while another respondent tailors offerings to a target group aged 30-50, transitioning away from an older demographic.

Indirect customer relationships and internal customer management (ES1, ES2)

Some companies do not interact directly with end consumers but instead focus on managing relationships with distributors or large commercial partners who handle end-customer engagement. For these businesses, sophisticated systems provided by partners help gather and analyse feedback. One respondent explained, “We work exclusively with large trading companies... that evaluate satisfaction, dissatisfaction, and respond to seasonal changes.” For manufacturers, internal customers—such as production teams or administrators—are also considered critical to maintaining smooth operations. One company highlighted the importance of adapting digital tools for these internal customers, especially those “least digitally literate,” to ensure effective internal workflows.

Social and community engagement (ES2, S16)

In addition to commercial sales, several companies engage in socially driven customer programmes, which help strengthen their brand’s reputation and build customer loyalty. For instance, one respondent discussed involvement in the “school milk program, where we distribute products to children in schools, contributing to educational efforts in healthy nutrition.” Another noted a commitment to reducing their carbon footprint by supporting regional school canteens and social facilities. These initiatives underscore the importance of social responsibility and community engagement as part of customer strategy, helping companies connect with customers on a deeper, value-driven level. Customers are seen as indispensable across these companies, impacting almost every aspect of their operations and future planning. As one respondent aptly summarized, “Customers are life to us because we are nothing without them.” This profound connection to customers reinforces the ongoing commitment to meet customer needs, enhance satisfaction, and cultivate long-term partnerships, whether through direct engagement or more extensive networks.

Current approach

In assessing how organisations manage customer data, responses highlight varied approaches to lifecycle management, from ad hoc processes to highly structured systems (Table 32: Approaches to strategy formulation (Table 32: Approaches to strategy formulation)). Many organisations are in

the early stages of developing policies, often applied selectively to sensitive data. However, a few organisations have implemented comprehensive data management practices, with procedures in place to log and address policy exceptions. Although some advanced organisations review their data management strategies regularly for improvement, the majority are still developing consistent, organisation-wide practices for handling customer data effectively.

Approach	Total responses
Ad hoc management	19
Beginning to define policies in some units	11
Standardized policies in most business units	5
Comprehensive policies with logged exceptions	4
Regular reviews and adaptive management practices	2

Limited data analysis and insights (OP7)

Some organisations primarily rely on a single customer data tool or ERP system, which provides basic consumer insights but is not used for extensive data analysis. For instance, one respondent noted that their data management includes data collection regulations but does not delve into detailed analysis. This approach limits the depth of customer insights and might hinder data-driven decision-making.

Reliance on standard e-commerce tools (OP3)

Another response indicated the use of standard e-commerce tools for customer data analysis. These tools likely cover essential metrics such as customer behaviour and purchase trends but might not offer the comprehensive, tailored insights that advanced analytics can provide. This approach reflects a practical but possibly limited strategy for customer data management.

Dependency on commercial partners for data management (OP3, ES2)

One organisation highlighted their reliance on large commercial partners for customer data handling. Since these partners have established systems for acquisition, processing, and feedback, the organisation does not independently manage or store customer data. Instead, they adapt their processes based on feedback from these partners, which allows them to benefit from sophisticated data insights without directly handling the data themselves.

Overview of approaches to teaching "customer" dimension in educational programmes

This overview combines insights into how customer-centric thinking is integrated into various educational programmes, exploring tools, methods, and practical applications used to teach aspects of customer interaction, data analysis, and satisfaction.

Core customer-centric

- Customer as central to success (S16): Across programmes, students learn early on that the customer's perspective is crucial for successful business models, whether in marketing, service industries, or tech sectors. The principle that "the customer is king" is reinforced, with the idea that understanding and meeting customer needs is key to innovation and business sustainability.

Tools and methods for understanding customer needs

- Customer journey mapping and personas (S16): Students learn to use customer journey mapping, empathy maps, and personas to better understand customer needs and experiences. This includes profiling, segmentation, and defining customer journeys in both B2B and B2C contexts.
- Digital Analytics Tools (T1): programmes use tools like Google Analytics, Facebook Analytics, and CRM systems to teach students how to analyse customer behaviour, preferences, and engagement. These tools offer insights into customer interaction and help students understand the impact of data on strategic decisions.
- Service Blueprints and Outcome Statements (OA9): Design thinking tools like service blueprints help students explore customer experience from multiple angles. Through outcome statements and the "Five W's" (who, what, when, where, why), students identify pain points, needs, and potential solutions for the customer.

Practical applications in customer education

- Real-world simulations and practical workshops (OA9): In programmes like hospitality and food service, students run simulations and work in training environments, such as restaurants or bars, to gather direct feedback from real customers. This hands-on experience teaches students how to adapt based on customer feedback and improve service quality.

- Product development feedback loops (T1, OA9): Students participate in feedback loops during product development showcases (e.g., food tastings, theme nights), using forms or digital feedback collection (QR codes linked to surveys) to gather insights on customer satisfaction. This practical learning enhances their understanding of iterative feedback processes.
- Applied market research (T1): programmes incorporate market research projects where students use data collection methods (e.g., surveys, expert interviews) to understand customer needs, validate product ideas, and assess market demand. This research often informs semester projects, where students work with NGOs or companies as "internal customers."

Customer data analysis and ethical considerations

- Data collection and visualization (T1): Data analysis is taught with a focus on effective data cleaning, management, and visualization. Tools like Excel, SPSS, and Power BI allow students to visualize customer data clearly and use it to draw actionable insights.
- Privacy and transparency (T3): programmes emphasise GDPR compliance and ethical data management practices, discussing topics such as customer consent, data ownership, and bias in data sets. This is especially relevant when customer data is used to influence strategic decisions or personalize services.
- Ethics of digital data (T3): Ethical considerations in data use are highlighted, with students learning to balance customer privacy against business needs. programmes teach students the importance of transparency and the customer's right to control their data, fostering trust and ethical data practices.

Digital transformation and customer experience in industry contexts

- Advanced data analytics in F&B and logistics(T1): In specialised fields like F&B and logistics, students learn how data analytics and AI impact customer experience. They use CRM and ERP systems for customer relationship management, demand forecasting, and process optimisation , which prepare them for industry-specific roles.
- Customer ecosystems and loyalty programmes(T1): Students explore how larger brands, like McDonald's and Starbucks, use digital ecosystems (e.g., apps and loyalty programmes) to enhance customer engagement. Smaller companies often lack such capabilities, providing a comparative analysis of customer engagement strategies in diverse business sizes.

Customer-centric innovation and design thinking (OA9, T1)

- Design thinking in innovation courses: Many programmes integrate design thinking principles, starting with customer needs to inspire innovation. By combining empathy mapping and direct customer feedback, students learn to innovate from the customer's perspective, addressing pain points with practical solutions.
- Customer data for future innovation: Students are encouraged to build customer databases to support long-term innovation, recognizing that regular data collection provides valuable insights. They learn strategies to retain this information, which can serve as a knowledge base for anticipating future customer needs and preferences.

Challenges and opportunities for future development (T1, OP2)

- Expanding customer data modules: Some programmes currently lack dedicated customer data modules, indicating a potential area for growth. Integrating CRM, data analysis software, and cross-functional electives could enhance students' customer-centric skills.
- Balancing theory with practical skills: There is a recognised gap between theoretical knowledge and practical application in some programmes, particularly where traditional academic approaches are emphasised over real-world skills. Increasing applied learning opportunities and industry partnerships could bridge this gap, aligning educational goals with market demands.

(Digital) Culture and People

Digital transformation is not solely driven by technology; it requires a set of personal qualities among employees and leaders to effectively embrace and implement change. This section explains the factors that are important for the interviewed SMEs.

Openness and curiosity (OA4)

A recurring theme among respondents is the importance of openness to new ideas and curiosity about digital trends. Employees who are curious and open-minded are better equipped to explore and understand emerging technologies, which can be vital for successful digital transformation. As one respondent put it, "Employees must have a personal interest in dealing with things and know what possibilities there are on the market." Additionally, qualities like "curiosity" and "interest in new developments" were highlighted as essential for fostering an innovative environment that embraces change.

Adaptability and flexibility (OA4)

Adaptability is frequently mentioned as a crucial quality for supporting digital transformation. The ability to adjust quickly to new processes and technologies helps companies navigate the constant changes in the digital landscape. One respondent emphasised the need for "flexibility, the ability to quickly adapt to changes," while another noted that adaptability "ensures employees can embrace new technologies and stay updated with the latest digital trends." These qualities enable employees to remain resilient and agile, which is critical in dynamic, tech-driven environments.

Initiative and self-motivation (OA4)

Many respondents stressed the importance of initiative and a proactive approach. Employees should not only be able to work independently but also show a willingness to learn and take responsibility for their growth. One respondent stated, "For me, it is absolutely fundamental that a person wants to work and learn. If there is no internal motivation, then there is no point in working with them." This emphasis on intrinsic motivation underscores the value of individuals who are driven to improve and contribute to digital transformation efforts actively.

Attention to detail and problem-solving skills (OA6)

In digital transformation, attention to detail and problem-solving abilities are key qualities. Employees who are detail-oriented can detect and address issues early on, preventing them from escalating. Several respondents noted the importance of "problem-solving skills," which help in navigating the challenges that come with implementing new digital tools and processes. This approach ensures that transformation efforts are precise, effective, and aligned with organisational goals.

Technological Interest and basic digital literacy (OA4, OA7)

A foundational interest in technology and basic digital skills were also mentioned as critical attributes. Having a level of digital literacy allows employees to navigate new systems and tools with ease, while a genuine interest in technology ensures they remain engaged. Respondents emphasised "technological interest" and "basic knowledge of digital tools" as essential for employees to support and contribute to digital initiatives effectively. Even basic digital literacy enables employees to participate in transformation processes more actively and with greater confidence.

Creativity and innovation (OA4)

Creativity is seen as an asset, as it fosters the development of unique solutions to complex problems that arise during digital transformation. Respondents highlighted the need for "innovative thinking" and "creative problem-solving" to optimise processes and address unexpected challenges. Employees who bring fresh ideas and approaches can significantly contribute to the success of digital transformation initiatives, particularly in industries where out-of-the-box thinking can create competitive advantages.

Collaboration and interpersonal skills (OA4)

In addition to technical skills, interpersonal skills and a collaborative mindset are vital for supporting digital transformation, especially in team-based environments. One respondent emphasised "collaboration," noting that working well with diverse teams and leveraging everyone's expertise leads to better outcomes. Interpersonal skills are particularly valuable in environments where digital transformation is a collective effort requiring input from various departments and expertise areas.

Resilience and perseverance, growth mindset (OA7, OA4)

Digital transformation often involves significant challenges and setbacks. Thus, resilience is an essential quality, as it enables employees to remain focused and motivated even when encountering obstacles. One respondent shared the importance of "resilience" to push forward despite challenges, underscoring the need for individuals who can endure setbacks and continue striving toward digital goals. Given the rapid pace of technological change, continuous learning is a crucial quality for supporting digital transformation. Employees must be committed to ongoing education and skill

development to stay current with industry trends and new tools. Respondents highlighted "continuous learning" to ensure employees keep up with digital trends, enabling them to contribute effectively to transformation initiatives over time.

Current approach (OA6)

In response to the increasing demand for digital skills, some organisations are implementing formal training programmes and structured initiatives aimed at systematically building digital competencies across their workforce. This section shows how support for digital skill development, formal training programmes, and structured initiatives.

Industry-specific training and certifications

Some companies have structured training programmes for specific roles. For instance, production and technology employees attend conferences on food quality, hygiene, safety, and machine operation. Employees working in quality control undergo annual audits, while sales representatives, technicians, and accountants receive training relevant to their functions.

Company-led training academies

One company mentioned setting up an in-house training program called the Watershed Printer Academy, aimed at training young people across different departments due to the lack of governmental apprenticeships. This initiative highlights a proactive approach to filling skill gaps and ensuring a steady pipeline of trained employees.

Onboarding programmes

A few companies incorporate digital skills development into their onboarding processes. New employees undergo structured onboarding, shadowing experienced staff, and receive initial digital skills training, particularly for data handling, marketing, and digital processes.

Self-learning and on-the-job training

Several companies rely on informal, ad hoc training, where employees learn digital skills as needed. In these settings, digital skills development is often reactive, with employees acquiring skills in tools like Microsoft Office 365, SharePoint, and ERP systems as specific needs arise.

Employee-initiated training

In some companies, employees approach management when they feel they need specific training. Training is then arranged on a case-by-case basis, typically through external resources or online tutorials.

Basic digital literacy support

For companies without formal programmes, digital skills training is minimal, often limited to basic tasks like operating spreadsheets or specific software required for the role. In some cases, employees are guided by experienced coworkers or learn through trial and error.

Digital tools and systems for daily operations

Some companies use digital solutions as part of daily operations, which indirectly supports digital skills. For example, one company implemented a ticket system on tablets for internal communication and issue reporting, helping employees become comfortable with digital workflows.

Experimentation with new digital tools

A few companies are exploring the use of advanced digital tools, such as Large Language Models (LLMs) like ChatGPT, with plans to provide prompt training across the organisation. This forward-looking approach suggests a commitment to integrating AI and enhancing digital proficiency.

Future Skill Development (OA1, OA2, OA3, OA4, OA5, OA6, OA7)

Limited or non-existent digital skills development (OA6)

In companies where digital transformation is not a priority, digital skills development is minimal or non-existent. For example, companies focused on manual or traditional production processes often do not see an immediate need for digital skills among employees, although some recognise the potential for future relevance.

Lack of formal programmes

Several companies explicitly stated they do not have formal digital skills training programmes, especially if they are small, rely on temporary workers, or lack a structured approach to digital transformation. These companies often view digital skills as non-essential for their current operations.

Support through external partners and online resources

- **Partnerships with training providers:** Some companies work with external partners, such as Codex, for training when new technologies are introduced, or updates are made. Training can be conducted online or in person, depending on the need.

- **Access to online learning:** For companies without in-house training, employees are encouraged to use online resources, such as video tutorials, to learn new applications or digital tools. In some cases, a digital dictionary was introduced to help employees understand new terms and concepts, supporting self-directed learning.

Intentions to formalize digital training

Some companies plan to enhance digital skills training in the future. This includes introducing structured digital literacy programmes and conducting surveys to assess current skill levels. One company noted that digital literacy is low among senior leaders, prompting the development of a digital dictionary to help bridge the knowledge gap.

Interest in expanding digital education

Although formal programmes are not yet in place, a few companies expressed a desire to expand digital education. They see value in training employees in digital tools relevant to their roles and are considering introducing structured learning in areas like AI and web development (Table 33: Approach to digital education).

Approach to digital education	Total responses
Training is not targeted at improving digital skills	10
Any training materials are developed in an ad hoc manner	12
Basic training is available for limited business practices and IT services	9
Standardized approach for developing standard training materials	5
Comprehensive approach to generating customizable training materials	2
Individual needs and learning flexibility central to continual review	2

Educational perspectives

Educational institutions recognise the need for cultural awareness, particularly in fields such as hospitality, business, and health sciences. programmes are designed to help students understand the global and local cultural landscapes they may encounter in their professional fields. For example, in hospitality programmes, students learn cultural nuances through presentations, interactive lessons, and discussions on differences in customs between Asian and Western contexts. International business courses focus on analysing organisational cultures across countries, using case studies that highlight the varying management styles of companies like Apple and Virgin.

Encouraging Experimentation and Innovation

Many institutions actively promote a culture of innovation through specialised labs, collaborative projects, and innovative course designs. programmes like "Imagineering" or entrepreneurship minors, combined with industry partnerships, create avenues for students to bring ideas to life. Multidisciplinary labs, including taste labs, digital labs, and co-creation spaces, enable students to work with advanced technology (e.g., VR glasses, IoT) and test projects within a realistic but supportive setting. These innovation spaces allow students to engage in practical, applied research, such as creating business models in collaboration with industry giants like Sligro.

Educational programmes emphasise the importance of collaboration and openness to innovation, using methods such as project-based learning and design thinking. These approaches not only teach students how to problem-solve but also encourage them to engage with challenges creatively and experimentally. Activities like icebreakers are strategically used to set a collaborative tone, which is then maintained throughout the program to help students think outside the box.

To stay relevant in a rapidly digitalising world, educational institutions increasingly incorporate digital tools and frameworks, fostering a culture of continuous improvement. Programmes centred on digital transformation employ tools like Microsoft Teams to enable collaboration across disciplines and enhance communication. Furthermore, students are encouraged to apply these tools in real-world contexts, such as innovation workshops and hackathons that bring together participants from multiple fields. However, not all students and faculty are familiar or comfortable with digital tools, leading to a slower adoption rate and limited funding and resources can restrict access to the latest technology, creating barriers to digital transformation.

Several issues were identified:

- Students are sometimes unaware of or underutilize available resources, such as labs and innovation hubs.
- Experimentation and risk-taking may lead to high rates of project failure, which, although educational, can be discouraging.
- Cultural understanding is often complex, as students must be able to adapt to diverse global business practices.
- There may be resistance to change in conservative industries, such as hospitality, where new market entrants like Airbnb were initially overlooked.

Opportunities identified include:

- Innovation labs and collaborative spaces provide invaluable real-world experience, enabling students to apply theoretical knowledge practically.
- Encouraging entrepreneurship and multidisciplinary collaboration fosters a culture of innovation, leading to successful spin-offs like Temper and real-world applications in various sectors.
- Cross-cultural understanding can position students as adaptable leaders prepared for diverse, international careers.
- Offering interactive, cross-cultural experiences (e.g., case studies and simulations) allows students to explore various cultural dimensions in a controlled environment.

Skills and Essential Personal Qualities for Digital Transformation

Personal qualities are critical in driving digital transformation, particularly in settings that demand adaptability and innovation. Commonly identified qualities include an open attitude to change, curiosity, and a collaborative mindset. Beyond technical skills, a willingness to embrace abstract thinking and an ability to see the bigger picture are key. This broad-minded approach helps individuals avoid solutions that may be technically sound but do not address the root problems effectively.

Several issues were identified:

- Digital transformation requires a mix of both technical and abstract thinking, which may be challenging to balance for some individuals.
- Maintaining a consumer-centred approach can be difficult, especially in fast-paced industries that prioritize rapid innovation.

Opportunities identified include:

- Emphasizing curiosity and adaptability can help professionals stay flexible and responsive to evolving technology.
- Sensitivity to consumer perspectives allows organisations to innovate while remaining considerate of diverse user needs, enhancing user adoption and satisfaction.

The role of collaborative and analytical mindsets (OA4, OA5, OA7)

Digital transformation benefits significantly from individuals who embrace teamwork and analytical thinking. This collaborative mindset enables cross-disciplinary problem-solving, especially in fields like SMEs, where employees often wear multiple hats. Analytical skills, such as the ability to interpret data and identify trends, help inform data-driven decisions crucial to digital transformation. Many SMEs benefit from strategic thinkers who bring a holistic view to innovation, especially those capable of recognizing when to bring in external expertise.

Several issues were identified:

- Collaboration may be hindered in organisations where employees are accustomed to working independently or lack interdisciplinary exposure.
- Analytical skills are often underdeveloped in individuals focused solely on technical aspects, leading to challenges in data interpretation and application.

Opportunities identified include:

- Cultivating an environment that encourages teamwork can foster a collaborative culture, which is essential for successful digital initiatives.
- Emphasizing data literacy and critical thinking within digital transformation programmes can empower individuals to make informed, strategic decisions.

Adaptability and continuous learning (OA7)

In a rapidly changing technological landscape, qualities such as adaptability, resilience, and a commitment to continuous learning are invaluable. Digital transformation is an ongoing process that demands the flexibility to adapt to new tools, systems, and methodologies. Individuals who view technology as an ally, rather than a replacement, are more likely to engage with and support digital transformation. An affinity for self-directed learning and developing new skills as needed supports the evolving demands of the digital landscape.

Several issues were identified:

- Not all individuals are comfortable with constant change, which can create resistance to digital transformation efforts.

- Continuous learning requires a high degree of self-motivation, which may be lacking in traditional learning environments.

Opportunities identified include:

- Encouraging a mindset of lifelong learning can help individuals stay agile and responsive to industry shifts.
- Providing structured opportunities for skill development, such as workshops and training sessions, can help bridge the gap for those less inclined to self-directed learning.

Encouraging Open-Mindedness and Innovation (OA5, OA7)

An innovative mindset, characterized by open-mindedness and the ability to think outside the box, is essential for digital transformation. Traits such as futurism and a desire to improve society help individuals drive forward-looking initiatives that align with digital goals. This innovative mindset often begins with cultural support from the organisation, encouraging individuals to take risks and experiment with new solutions. In environments where social skills are essential, such as hospitality, open-mindedness, and a willingness to communicate effectively are also crucial.

Several issues were identified:

- Developing an innovative mindset may be challenging in traditional or hierarchical settings that are less supportive of experimentation.
- Social skills, while essential for customer-facing roles, are often underdeveloped, particularly in technical fields where digital tools are the primary focus.

Opportunities identified include:

- Encouraging open-mindedness can create a culture of innovation, motivating individuals to explore creative digital solutions.
- Fostering social and communication skills alongside technical abilities helps individuals adapt digital solutions to meet the needs of diverse audiences effectively.

Partners

Organisations increasingly recognise the critical role of strategic partnerships in achieving digital transformation by accessing specialised expertise, leveraging new technologies, and maintaining agility amid shifting industry trends. Effective partnerships involve processes that allow continuous exploration and evaluation of emerging technologies, fostering innovation and adaptability. Collaborations with industry partners, universities, government agencies, and technology providers bring invaluable resources and expertise, supporting various aspects of digital growth, from funding and technical knowledge to innovative tools and solutions. By leveraging external support, businesses can better navigate the complexities of digital change, enhance technological capabilities, and remain competitive in an evolving market landscape. This section investigates diverse strategies and challenges in integrating partnerships into digital transformation agendas, providing insights into their impact and outcomes.

Independent development with limited partnership reliance (ES1)

Several smaller businesses emphasised autonomy in digitalisation, relying mainly on internal resources. For instance, one respondent explained, “We do as much as possible on our own, with everything based on internal processes.” Another noted the challenge of building in-house digital capabilities: “Above all, you can’t do everything yourself, but strategic partnerships are important, especially in young companies where hiring specialised talent is costly.” These businesses often turn to industry associations and media for insights into digital trends rather than forming direct partnerships.

Selective collaborations for specialised needs (ES1)

Many organisations strategically choose partners to fill specific skill or technology gaps. One business owner described working with local government bodies, stating, “We try to keep a good connection with local governments... and participate in programmes where we can provide test fields for research projects.” Another respondent cited a partnership with a logistics provider to enhance customer service, “For example, Polly.Help automated our FAQ section, and Trunkrs enabled same-day delivery for fresh fish.” This selective approach to partnerships reflects a targeted method to digital transformation, where companies engage partners only when unique expertise is required.

Companies in specialised industries, such as food production, often engage with sector-specific technology providers to modernize operations. One dairy producer detailed partnerships with

approximately 10 machinery suppliers, explaining, “We cooperate with suppliers of pasteurizers, centrifuges, cheese hoppers, and other specialised equipment for dairy production.” Such partnerships allow companies to access advanced technologies suited to their production processes, with one respondent noting annual visits to exhibitions to stay informed on industry-specific advancements, a practice that aids in choosing effective and cost-competitive solutions.

Leveraging government and local support for digital resources (ES1)

Some companies benefit from partnerships with local or national government agencies that support digitalisation through grants, training, and networking. One participant highlighted assistance from the Local Enterprise Office (LEO) and a mentor for securing funding, saying. Another respondent pointed out participation in public consultations offered by a company where various organisations discuss digitalisation strategies, underscoring how government partnerships provide guidance and financial support critical for smaller businesses with limited digital budgets.

Collaborative networks and knowledge sharing (ES1, T1)

For some, strategic partnerships serve as a conduit for knowledge-sharing and innovation. A respondent explained, “There is a large WhatsApp group with graduates where we exchange ideas on digitalisation challenges.” Another noted participation in regional initiatives, including collaborations with academic institutions like the Digital Society School, which provide insights into cutting-edge technologies and new research. These collaborative networks offer resources and learning opportunities, helping organisations stay updated without heavy investment in individual partnerships.

Current approach and issues

A few participants expressed challenges in navigating the partnership landscape, particularly SMEs with limited resources or digital expertise. One respondent highlighted the complexity of digital jargon: “Even with an engineering background, the terminology is overwhelming.” Additionally, the high cost of sophisticated digital systems, such as EDI (Electronic Data Interchange), was seen as prohibitive for smaller companies that cannot justify the investment given their scale. This highlights a barrier many SMEs face: while partnerships can offer competitive advantages, the associated costs and complexities can deter full engagement.

The question on digital project budgeting focuses on how budgets are planned, monitored, and adjusted to meet business needs, assessing the alignment and flexibility of digital budgets with overall business strategies.

Factor	Total Responses
Any budgets are ad hoc in nature	18
Defined budgets are emerging; typically, however, they are static and only partially aligned with overall business planning	8
Digital budgets are becoming increasingly flexible and more aligned with overall business plans	5
Digital budgets are dynamic and fully aligned with business plans across the organisation	2
Digital budgets are continually reviewed for improvement opportunities and are influenced by inputs from relevant business ecosystem partners	3

This distribution reveals that a significant portion of organisations still manage digital budgets on an ad-hoc basis, while only a small group operates with dynamic and fully integrated budget processes that are continuously reviewed and informed by inputs from ecosystem partners.

Educational perspectives

Educational programmes employ various methods to teach the concept of organisation, often tailored to specific industry requirements and student needs. In general, partnerships and collaborations play a significant role, with some institutions emphasizing real-world industry connections through internships, simulations, and cross-disciplinary projects. These programmes aim to provide students with an understanding of organisation that includes both internal dynamics and external partnerships.

- Collaborative Partnerships and internships (ES1, ES2): Many programmes incorporate partnerships within the learning process. Students learn to evaluate partnerships with industry players, understanding which collaborations align with organisational objectives. For instance, partnerships in the hospitality industry emphasise stakeholder relations with government and businesses. Internships and real-life case studies enable students to grasp the importance of collaboration, preparing them for practical, professional environments.
- Project-Based Learning (OA9): Students often work in teams across modules to practice collaboration and project management. For example, group assignments in business management simulate real-world organisational challenges, emphasizing roles and responsibilities, stakeholder management, and strategic planning. Instructors integrate simulations to reflect industry demands, where students must coordinate with external

stakeholders, teaching them time management and communication skills crucial for effective organisational operations.

- Digital Transformation and technological integration (OA3): Educational programmes also focus on digital transformation, with students learning about the shifts required at organisational levels to adapt to new technologies. This includes not only training employees but also transforming business processes. Some programmes incorporate real-world tools, case studies, and theoretical frameworks to demonstrate the importance of digital savviness within an organisation. Institutions emphasise that digitalisation isn't effective without aligning it with organisational goals and structures.
- Frameworks and theoretical concepts (OA9): programmes like business administration incorporate frameworks such as the Business Model Canvas, which helps students understand organisational elements like key resources, culture, value proposition, and strategic positioning. Other frameworks may include sociocracy and holocracy, which are explored to understand decision-making and hierarchy in modern organisations.

Issues in teaching organisations

The following concerns were identified within the organisation subject:

- Skill Gaps and technological challenges (OA4): As companies increasingly adopt digital solutions, a gap often exists between technical skills and the ability to apply those skills effectively. Students learn the importance of aligning technological initiatives with organisational needs, as otherwise, newly acquired skills remain underutilized.
- Stakeholder coordination (ES1): Engaging external stakeholders can be challenging, as industry professionals often lack the time to coordinate with students on projects. This gap in communication teaches students the importance of adapting to external constraints and setting realistic expectations in professional partnerships.
- Centralization and power dynamics (S17): In supply chains, centralized power can create dependencies that inhibit collaboration. This is especially noted in logistics education, where students learn how transparency and data sharing can improve cooperation, yet also introduce risks if dominated by one player. Knowledge about this subject is very limited available, especially about how the different powers in the supply chain are affecting on each other and how to organize this playfield.

Opportunities for enhancing organisational education

The following opportunities were identified:

- Simulation of organisational structures (T1): Using tools like the Business Model Canvas or simulations involving matrix or flat hierarchies, educators can provide a practical look at various organisational structures and how they influence roles, workflows, and digital transformation.
- Incorporating Digital Collaboration Tools (T1): With increasing remote work, introducing tools that facilitate digital collaboration, such as project management software, enables students to work across virtual environments, preparing them for future roles in globally connected teams.
- Industry Collaboration Models (T1): programmes focusing on sectors like F&B or logistics offer unique opportunities to teach open innovation. Through projects or guest lectures with industry leaders, students observe firsthand how organisational success is linked to external partnerships and innovation ecosystems.

Enhanced efficiency, cost reduction, and quality improvement (S10)

By working with software providers, consultancies, and corporate partners, companies have been able to streamline business processes, reduce physical effort, and improve efficiency. Also, several respondents highlighted that partnerships with universities, government agencies, and technology providers have contributed significantly to efficiency and quality improvements. For instance, one respondent noted how a collaboration with a French university improved production efficiency and product quality in their cider operations.

Access to advanced technology (T1)

Collaborations with corporate partners like Siemens and Misso Fabrik and local technology providers enable companies to adopt cutting-edge technologies, which may otherwise be inaccessible due to cost or expertise constraints.

Knowledge and skill development through partnering (OA4)

Partnerships with universities, foreign interns, and industry webinars allow companies to learn new techniques, develop relevant skills, and gain fresh insights into digital transformation practices.

Regional presence and community engagement (ES2)

Collaborations with local e-commerce platforms, manufacturers, and tourism organisations have supported companies in expanding their regional market reach and engaging with local customers

more effectively.

Increased competitiveness and cost savings (S10)

Partnerships with major retail networks, like Tesco, were cited as successful in enabling digital management of order processing, product updates, and pricing. By handling these tasks digitally, companies save time and reduce the costs associated with manual work and physical meetings, thereby improving competitiveness.

Long-term relationships and flexible local partnerships (S15)

Some respondents emphasised the value of strong, long-term relationships with business partners as a critical factor in their success. These partnerships provide stability, facilitate smoother communication, and enable companies to meet partner objectives effectively.

Local partnerships have been particularly successful for some respondents due to their flexibility and responsiveness. Monthly meetings allow companies to quickly implement changes and adjust pricing based on immediate needs. This level of flexibility, often absent in larger corporate partnerships, makes local partners a valuable asset. Partnerships with large corporate entities, although beneficial, were less flexible and slower to adapt. For instance, corporate partners require more time to implement changes due to complex structures and resource requirements, making them less agile compared to local partners.

Companies still in the early stages of partnership development found it challenging to evaluate the success of these collaborations. For example, businesses testing new products or expanding into digital processes could not yet assess whether the partnerships would yield long-term success, especially if growth and transformation were still ongoing.

Government and funding bodies (ES2)

Government organisations provided funding and industry expertise, which helped businesses meet their digital transformation objectives. Enterprise Ireland, for instance, played a key role by offering both financial resources and realistic expectations regarding project timelines. Partnerships that provided financial support, such as European funds or grants, were deemed successful by businesses that needed capital to maintain operations and invest in technology. This support was essential for companies that wanted to reduce reliance on manual processes and adopt digital tools.

Local enterprise offices (ES1)

Some companies received support from Local Enterprise Offices, benefiting from resources like courses and online trading vouchers. For example, one respondent noted that an LEO course on setting up a Shopify website was particularly helpful in advancing their digital capabilities.

Metrics for evaluation (S7)

Many respondents noted that they did not have specific metrics or evaluation processes in place to measure the success of their partnerships. While they recognised the positive impact, the lack of formal criteria and structured evaluation prevented some companies from fully assessing the effectiveness of these partnerships.

Examples of successful collaborations (OP7, S8)

- **ERP system implementation:** A respondent highlighted a successful partnership with a government, which not only provided financial support but also guided the company in setting realistic expectations for an ERP system rollout. Although the project took longer than expected, the collaboration was considered valuable due to the combination of funding and industry expertise.
- **Product financing:** A government assisted a business in securing a loan that allowed for bulk ingredient purchases, reducing stress, and enhancing financial stability throughout the year.
- **Partnership for digital operations:** A partnership with a multinational allowed one company to streamline order processing, pricing updates, and product listing within their system. This arrangement reduced the need for physical meetings and enabled the business to manage operations remotely, enhancing both speed and efficiency.

Examples of successful collaborations within educational partnerships

- **Internships and industry collaborations:** Partnerships with hotels and industry experts provide students with hands-on experience with the latest tools and trends, crucial for bridging academic learning with real-world applications.
- **Collaborative research and development (R&D):** Universities partner with industry and technology providers to fund research, develop infrastructure, and build relevant lab facilities for digital skills training.
- **Networking and events:** Regular networking events, guest lectures, and workshops with industry speakers provide students with exposure

to current industry trends and technologies.

- **Project-based partnerships:** Working on projects with industry partners, where students and faculty tackle real-world problems, often serves as a testing ground for innovations.

Challenges in strategic partnerships

- **Short-term, project-based collaborations:** Many partnerships are case-specific or project-based rather than long-term, making it difficult to build sustained relationships and continuity in learning.
- **Resistance in traditional sectors:** Smaller or more traditional companies (especially in hospitality) may resist partnerships involving large digital transformations or collaborative digital tools.
- **Alignment of goals:** Ensuring alignment between the university's educational objectives and the strategic goals of industry partners can be challenging, especially with smaller companies or those with niche strategies.
- **Lack of institutional structure for partnerships:** Often, partnerships are lecturer-driven or based on individual expertise, with a limited structured, institution-wide strategy for building and managing partnerships.

Opportunities in strategic partnerships

- **Enhancing curriculum relevance:** Partnering with industry allows universities to stay current with industry trends (e.g., AI, automation) and incorporate relevant tools and technologies into the curriculum.
- **Leveraging networks and ecosystems:** Encouraging students to identify and utilize partnerships within their ecosystems, using tools like the Business Model Canvas and context mapping, helps them become more resilient and adaptable.
- **Support for SMEs in digital transformation:** Partnerships help smaller companies and SMEs adopt digital tools through collective initiatives and shared resources, aiding in areas like digital marketing, supply chain management, and customer engagement.
- **Knowledge sharing through events and conferences:** Partnerships provide platforms for knowledge exchange, including through conferences, workshops, and visits to institutions that apply innovative solutions, enhancing student and faculty awareness of emerging trends.
- **Fostering innovation and sustainability:** Strategic partnerships provide opportunities to address sustainability, promote innovation, and develop new business models through collaboration on cutting-edge technologies and initiatives (e.g., food donation, waste management)

Undefined Key Factor Insights

In addition to the standard key factors, a unique category of responses emerged that does not align neatly with the predefined themes.

- **AI and data protection:** Some companies emphasised the importance of understanding the legal implications of using AI and adhering to data protection regulations. They expressed the need for employee training in data protection to ensure that customer data, for example, is not improperly shared with AI platforms like ChatGPT.
- **Compliance with evolving Laws:** There's a recognition that AI and data protection laws are evolving and must be monitored closely to stay compliant. This aspect of digital transformation is critical to avoid legal pitfalls.
- **Financial constraints and subsidies:** Several SMEs noted the financial challenges of implementing digital transformation, particularly in terms of accessing sufficient subsidies. Even when subsidies cover part of the costs, the remaining financial burden can be challenging for smaller companies, especially during growth phases when funds are needed for other priorities like equipment or staffing.
- **Strategic partnerships for innovation:** Some respondents discussed collaborations with organisations like the Smart Manufacturing Digital Hub (SMDH) Advisory Board and foreign universities. These partnerships help in benchmarking and applying new digital tools, but challenges arise when international frameworks are difficult to apply locally.
- **Use of cryptocurrency:** One company highlighted its integration with Bitcoin, allowing transactions in cryptocurrency, which aids in attracting like-minded partners. This unique approach underscores a forward-thinking strategy in digital payments.
- **Agricultural sector and genotyping:** For companies in the agricultural sector, advancements like genotyping and health monitoring devices for livestock were highlighted as next steps in digital transformation. These innovations promise to improve efficiency, reduce illness, and minimize antibiotic use, but require substantial initial investments.
- **Food industry and subsidy disparities:** Respondents in the food industry voiced concerns over subsidy disparities across EU countries. The lack of support for food processors compared to farmers creates competitive challenges with other EU countries, especially when it comes to digitalisation efforts.
- **Gradual market demand for digitalisation:** Some companies anticipate that the market itself will eventually drive the need for digitalisation, even if the initial investment is high and return on investment slow. This future-oriented outlook suggests a belief that digitalisation will become a necessity for survival, especially as labour shortages increase.
- **Family business and regional development:** Family-run businesses underscored their focus on preserving traditional methods and expanding regionally. For these companies, digital transformation is approached with caution, ensuring it does not compromise the family values and quality standards that define their brands.
- **Digital literacy discrepancy:** Some companies pointed out the paradox of employees being comfortable with technology in their personal lives but struggling with digital tools in the workplace. This highlights a gap in workplace digital literacy that may need to be addressed as digital tools become more integral to daily operations.
- **Adapting to changing workforce needs:** The responses included reflections on the importance of attracting young, digitally skilled employees. For some companies, digital transformation is not just about technology but about creating a modern workplace that appeals to a younger, tech-savvy workforce.

The following table provides an overview of the assessment of ten skillset dimensions relevant to the interviewed SME and Educators. Each dimension has been scored on a scale from 0 to 10, reflecting its perceived importance or relevance based on

the interview findings. The scores offer a quantitative perspective on the digital skills and capabilities that industry stakeholders consider crucial for the future.

Skillset Dimension	Score Educators	Score SME	Diff
System thinking (analysing complex systems to identify sustainable solutions)	8,5	7,7	0,8
Responsible practices (valuing sustainability and promote responsible practices)	8,3	7,9	0,4
Self-regulation (managing emotions, thoughts and behaviours)	7,7	7,6	0,1
Flexibility (adapting to changes and challenges)	9,0	8,3	0,7
Wellbeing (maintaining physical and mental health)	8,3	7,8	0,5
Communication (effective interpersonal and digital communication)	8,6	8,2	0,4
Collaboration (working effectively with others in both physical and digital environments)	8,5	7,9	0,6
Critical thinking (evaluating information and arguments critically)	8,2	7,8	0,4
Problem framing (identifying and defining problems to find suitable solutions)	8,4	7,9	0,5
Evaluating information (assessing the reliability and relevance of information)	8,1	7,6	0,5
Interaction through technologies (using digital tools for communication and collaboration)	7,9	7,5	0,4
Innovating creatively using technologies (leveraging technology to develop innovative solutions)	7,7	7,2	0,5
Solving technical problems (identifying and resolving technical issues)	7,3	7,5	-0,2
Identifying digital competence gaps (recognizing and addressing areas for improvement)	7,5	6,9	0,6
Technical adaptability (adjusting effectively to new technologies and digital tools)	8,3	7,5	0,8

In this comparison between the scores of educators and SMEs, the most significant differences are in skills related to holistic thinking and adaptability. Educators generally rate these skills higher than SMEs, suggesting that educators may see them as more critical for sustainable solutions and adaptability in dynamic environments. Notably, on all dimensions except one ("Solving technical problems" with a difference of -0.2), educators assign higher importance to these competencies than SMEs.

The five largest differences, ordered from largest to smallest, are as follows:

- System thinking (analysing complex systems to identify sustainable solutions): 0.8
- Technical adaptability (adjusting effectively to new technologies and digital tools): 0.8
- Flexibility (adapting to changes and challenges): 0.7

- Collaboration (working effectively with others in physical and digital environments): 0.6
- Identifying digital competence gaps (recognizing and addressing areas for improvement): 0.6

In contrast, the five smallest differences, also ordered from largest to smallest, indicate a shared value placed on specific skills by both groups:

- Valuing sustainability (promoting responsible practices): 0.4
- Communication (effective interpersonal and digital communication): 0.4
- Critical thinking (evaluating information and arguments critically): 0.4
- Interaction through technologies (using digital tools for communication and collaboration): 0.4
- Self-regulation (managing emotions, thoughts, and behaviours): 0.1

Maturity For Best Practices

The maturity model is a scale that evaluates the maturity of a best practice based on standardized levels. This model helps organisations understand where a best practice stands in its development and provides a framework for continuous improvement. In this research, the maturity model is applied to develop and assess best practices, ensuring they evolve systematically and effectively throughout their lifecycle. By evaluating the maturity level, we aim to identify areas for enhancement and guide the improvement process. With respect to Table 36: Overview of best practices, the SMEs interviewed and documented frequently display multiple best-practice examples. For example, a small-scale sushi restaurant has automated a link between a dynamic digital menu, the online order system, and the food preparation process ensuring that customers are only presented with options that can be produced and delivered in a timely fashion to the quality standards expected.

From a best practice maturity perspective, of the five levels described below, the identified best practices score at Level 4 or Level 5:

- **Level 1: Initial** - The best practice is carried out in an ad hoc and undocumented manner. There is little to no formal structure or standardization, and success relies on individuals or sporadic efforts.
- **Level 2: Repeatable** - Basic processes and procedures have been developed and are repeatable, but the practice is not yet fully standardized. Some guidelines exist, but they are not consistently applied.
- **Level 3: Defined** - The best practice is documented and standardized. There is a consistent approach that is followed throughout the organisation, and clear processes are in place for implementation and control.
- **Level 4: Managed** - The best practice is not only standardized but also actively monitored and measured. Performance is analysed to ensure consistency and efficiency. This level focuses on control and identifying areas for improvement.
- **Level 5: Optimised** - The best practice is fully integrated and continuously improved based on feedback, data, and changing circumstances. A systematic approach is used to innovate and adapt, ensuring continuous optimisation.

Area of best practice	Autonomous 'acre' project
Objective	Develop a sustainable, digitized approach to autonomous agriculture, aiming to reduce reliance on land revenue through strategic partnerships and innovative technology.
Description	The organisation, located in Campus Almkerk, operates regionally across multiple counties as a project bureau specializing in e-commerce and online services. Their focus is on digitization, leveraging cloud computing, big data, AI, and autonomous robots. Although a basic digital strategy is emerging, many projects are chosen intuitively rather than strategically. Current key projects include the 'autonomous acre' initiative and involvement in the 'Holobiome' project. Close relationships with local governments provide access to essential financial resources and subsidies.
Benefits / Outcomes	<ul style="list-style-type: none"> • Access to subsidy schemes (e.g., SABE), reducing dependence on land-based revenue. • Partnerships facilitate participation in research without the need for complex subsidy applications, saving administrative time. • Improved financial sustainability and positioning as a leader in digitized agriculture. • Active community engagement through events, fostering new partnerships and financial support.
Key Resources	<ul style="list-style-type: none"> • Subsidies from schemes like SABE. • Human resources, particularly in partnership-driven projects. • Strong relationships with local government agencies for financial and regulatory support. • Test fields provided 'in kind' for research purposes.
Main Stakeholders	<ul style="list-style-type: none"> • Government agencies (for subsidies and regulatory support). • Project-based clients such as hospitals and individual consumers managing allotments through the platform. • Research partners in projects like 'Holobiome' and other agricultural technology initiatives.
Organisational Culture	The company maintains a familial culture with an emphasis on healthy food and healthy soil. Employees are selected based on their dedication to these values, and the environment is designed to be relaxed, encouraging innovation through openness and curiosity.

Sustainable Digital Strategy Implementation



Objective	Develop and implement a sustainable digital strategy to support business operations and improve inventory management while remaining competitive in the market.
Description	The company operates regionally across multiple counties as a distributor in the beverage industry, primarily engaging in B2B wholesale. While there is an emerging digital strategy for some projects, the approach is not consistently adopted. They prioritize daily business operations over large-scale digital transformations and implement technology incrementally.
Benefits / Outcomes	<ul style="list-style-type: none"> Enhanced operational efficiency through improved inventory management systems. Strategic use of external consultancy enables technological growth without overburdening the internal team. Budget-conscious approach prevents unnecessary price increases, maintaining competitive market positioning. Incremental digital adoption allows the team to stay focused on core business operations while gradually improving digital capabilities.
Key Resources	<ul style="list-style-type: none"> Limited budget and ad hoc financial planning for digital projects. Small, adaptable team with internal expertise (e.g., one co-founder with SAP experience) complemented by external consultancy for digital development. Peer groups for flavour testing and feedback.
Main Stakeholders	<ul style="list-style-type: none"> B2B customers who distribute the company's beverages to end customers. B2C direct-to-consumer (DTC) channels for specific products. Freelancers and full-time employees contributing to operational and digital tasks.
Organisational Culture	The company fosters a practical, iterative approach to digital transformation, emphasizing the importance of gradual adoption and stakeholder involvement.

Digital Visibility And Local Collaboration For Small-scale Producers



Objective	Increase online visibility and direct sales through a focused digital strategy and leverage local collaborations to expand market reach and product offerings.
Description	The company focuses on online sales and visibility, using platforms like Instagram. The founder collaborates with local groups to access grants, markets, and product collaborations.
Benefits / Outcomes	<ul style="list-style-type: none"> • Enhanced brand visibility through digital marketing. • Expanded product range through local collaborations.
Key Resources	<ul style="list-style-type: none"> • Financial grants, loans, and local partnerships. • Customer feedback for innovation.
Main Stakeholders	<ul style="list-style-type: none"> • Direct customers at markets and online. • Local businesses like Boann Distillery.
Organisational Culture	The company values experimentation, gradually building digital and marketing skills.

Digital Transformation For Efficiency



Objective	Implement a digital strategy focused on transparency, efficiency, and security across the supply chain and production processes, aiming to enhance traceability and operational efficiency.
Description	The company works internationally, offering both brick-and-mortar retail and production facilities. The company is incorporating digitalisation as a means to improve transparency and security, especially in supply chain management and production safety. Current digital technologies in use include IoT, cloud computing, and CRM systems. Some machines have been updated with Siemens interfaces for improved integration, and data from connected machines are logged centrally.
Benefits / Outcomes	<ul style="list-style-type: none"> Improved operational efficiency through centralized data logging and upgraded machine interfaces. Enhanced supply chain transparency and quicker response capabilities for recalls or quality issues. Planned implementation of ChatGPT licenses at workstations for improved people management and support in digital tasks. Digital transformation supports compliance with industry standards and enhances customer confidence in product quality.
Key Resources	<ul style="list-style-type: none"> Limited budget with static allocations, not always aligned with broader business planning. Physical resources, particularly production machines, require upgrades to support digitization. Human resources, with a focus on training employees in digital tools and new technologies.
Main Stakeholders	<ul style="list-style-type: none"> End customers visiting brick-and-mortar stores. Industry partners supporting production and retail processes. Employees requiring training to adapt to new digital tools and interfaces.
Organisational Culture	The organisation prioritizes practical digital adoption, balancing modern technology with current operational needs. While younger employees adapt quickly, older employees require additional support for digital transformation efforts.

Process Optimisation And Strategic Partnerships For E- commerce Growth



Objective	Optimise operational processes and leverage strategic partnerships to enhance efficiency, especially in e-commerce and same-day delivery of perishable products.
Description	This is an international seafood manufacturer focusing on process optimisation and e-commerce as the primary growth channel. The company adopts a selective digital strategy, utilizing cloud computing, AI, autonomous robots, and cryptocurrency for payments. Strategic partnerships are key for reliable same-day delivery, reducing product loss compared to traditional logistics providers.
Benefits / Outcomes	<ul style="list-style-type: none"> Enhanced customer satisfaction and reduced product loss through reliable same-day delivery solutions. Improved operational efficiency by automating FAQ sections and optimizing e-commerce processes. Competitive advantage through cryptocurrency integration, attracting like-minded partners and customers interested in digital payment option. Strategic collaborations support business expansion into new services and products, including sustainable energy consultations and meat sales.
Key Resources	<ul style="list-style-type: none"> Time and financial resources are critical, particularly in exploring new digital solutions. External expertise from partners specializing in areas beyond the company's internal knowledge, such as logistics and energy transition. Dynamic digital budget aligned with organisational goals, allowing adaptability in investments.
Main Stakeholders	<ul style="list-style-type: none"> Eel companies, smokehouses, and wholesalers in Europe. Webshop customers who purchase seafood and other products. Strategic partners providing digital and logistical support.
Organisational Culture	The company values curiosity, flexibility, and a foundational knowledge of digital trends among employees. Collaborations are integral to its operations, especially in areas requiring external expertise, such as renewable energy initiatives.

Digital Transformation Initiative



Objective	Optimise internal processes through digitization and automation to save time, reduce costs, and improve personnel efficiency.
Description	The company, a national player in e-commerce and online advertising, focuses on digitizing internal work processes. It adopts a dynamic digital strategy that is continuously reviewed based on research, lessons learned, and feedback from the business network. The company works with technologies such as IoT, cyber-physical systems, and cybersecurity, relying on project-specific partnerships. The goal is to manage and digitize as many processes internally as possible, with external specialists engaged for expertise in IT and cybersecurity. The personnel policy promotes openness to technological innovation, with training developed on an ad-hoc basis.
Benefits / Outcomes	<ul style="list-style-type: none"> • Significant time savings through automated processes, resulting in lower personnel costs and more efficient workforce utilization. • Long-term partnerships provide stability within the company's ecosystem. • A hands-on approach where production orders are supplemented with additional information for improved planning. • Continuously optimizing digital budgets and data management increases efficiency. • Supporting employees to improve their digital skills reduces resistance to digital transformation.
Key Resources	<ul style="list-style-type: none"> • Local partners and digitization projects. • specialised external IT support. • B2B partnerships for sales support through phone and direct sales.
Main Stakeholders	<ul style="list-style-type: none"> • B2B clients and local industry partners. • External IT specialists for cybersecurity and digitization. • Business ecosystem partners providing feedback for strategic adjustments.
Organisational Culture	The company fosters an open culture that encourages technological curiosity and innovation. Employees are encouraged to be open to changes and to continually learn and adapt. There is a strong focus on collaboration and practical applications of technology, where successes and improvements are always appreciated.

Digital Experimentation



Objective	Implement basic digital processes to support retail and street vending operations while exploring ways to improve efficiency through data collection and informal digital initiatives.
Description	A small local dairy business with a limited digital presence primarily through social media and a basic website. The digital strategy is informal and driven by individual initiatives, who is researching ways to improve organisational efficiency as part of his academic work. Budget and time constraints limit their digital growth, with digital efforts being largely ad hoc and self-funded. Seasonal experimental projects, like the floating market, rely on municipal subsidies and volunteer efforts.
Benefits / Outcomes	<ul style="list-style-type: none"> • Some operational efficiencies achieved through basic digital research. • Occasional subsidies from local government to support seasonal projects. • Access to consumer feedback and expanded outreach through street vending and small events. • Greater connection to the community and integration into local initiatives like Amsterdam's 750th anniversary.
Key Resources	<ul style="list-style-type: none"> • Limited budget and personnel for digital efforts. • Occasional municipal subsidies for specific events. • Knowledge, time, and a few dedicated individuals driving digital projects informally.
Main Stakeholders	<ul style="list-style-type: none"> • Local restaurants and cafes purchasing their dairy products. • Municipal partners supporting community-focused events. • Universities providing academic insights for informal digital improvements.
Organisational Culture	Their values are flexibility, practical skills, and an interest in agriculture and healthy food. The culture is hands-on, with a focus on community involvement and adaptability, though digital skills are not prioritised. Personal connections and a practical approach guide their business, often resulting in limited strategic digital investment.

Practical Digital Integration And Efficiency In Small-scale Meat Production



Objective	Streamline production and improve efficiency through practical, internal digital systems tailored to meat production requirements.
Description	The company uses a limited approach to digitalisation by mainly focused on internal data collection systems and collaboration with biggest B2B customers digital platform for efficient business operations.
Benefits / Outcomes	<ul style="list-style-type: none"> • Increased efficiency with automated processes. • Cost savings through Tesco's digital platform.
Key Resources	<ul style="list-style-type: none"> • Financial resources from loans and grants. • Simple yet effective production systems.
Main Stakeholders	<ul style="list-style-type: none"> • Large retail partners like Tesco. • Internal employees for basic digital operations.
Organisational Culture	Values adaptability and efficiency, with practical training led by experienced employees.

Digital Transformation And Operational Efficiency In Dairy Production



Objective	Enhance production efficiency and product quality through targeted digital upgrades, supported by strategic partnerships and European funding.
Description	The company focuses on incremental digital transformation in dairy production, with projects including software upgrades and a photovoltaic power plant installation.
Benefits / Outcomes	<ul style="list-style-type: none"> Increased efficiency through automation. Improved sustainability with reduced electricity consumption.
Key Resources	<ul style="list-style-type: none"> European subsidies, loans, and personnel resources. Partnerships with equipment suppliers.
Main Stakeholders	<ul style="list-style-type: none"> Direct customers, equipment suppliers. Government and industry organisations.
Organisational Culture	The company emphasises collaboration and quality, with structured audits and certifications.

Support Digital Strategy For Agricultural Efficiency And Customer Engagement



Objective	Enhance operational efficiency and customer engagement through a structured digital strategy, leveraging data-driven decision-making and innovative partnerships.
Description	The data-oriented company employs a multi-faceted digital strategy, integrating IoT, cloud computing, big data, and cybersecurity into operations. Strategic partnerships support agricultural efficiency.
Benefits / Outcomes	<ul style="list-style-type: none"> Improved operational efficiency through digital data collection. Increased customer satisfaction via tailored experiences.
Key Resources	<ul style="list-style-type: none"> Financial and human resources. Partnerships with organisations.
Main Stakeholders	<ul style="list-style-type: none"> Direct customers, educational institutions. Government partners supporting digital transformation.
Organisational Culture	A collaborative environment encourages experimentation and innovation across departments.

Comprehensive Digital Strategy For Agricultural Efficiency And Customer Engagement



Objective	Enhance customer satisfaction and product-market fit through continuous experimentation and feedback collection, while gradually developing a structured digital strategy to improve operational efficiency
Description	The company operates with a focus on understanding and meeting customer preferences, particularly through product experimentation. The company gathers customer feedback at trade shows and other direct interactions to refine products, such as adjusting spice levels or exploring different jar sizes. While the company lacks a formal digital strategy, it has begun implementing digital tools for select projects and plans to expand these efforts as resources allow.
Benefits / Outcomes	<ul style="list-style-type: none"> Increased customer satisfaction through products tailored to customer feedback. Improved product-market fit by adapting to specific customer preferences and needs. Enhanced operational efficiency with gradual digital integration.
Key Resources	<ul style="list-style-type: none"> Digital tools for select projects, though resources are currently limited. Customer feedback collected through trade shows and direct interactions. Partnerships within the industry for broader market reach.
Main Stakeholders	<ul style="list-style-type: none"> Direct consumers and wholesale buyers. Industry partners supporting distribution. Internal team focused on product refinement and customer engagement.
Organisational Culture	The company values innovation and user-friendliness in its approach to digital transformation. The organisation prioritizes customer needs, with a flexible and adaptive culture that encourages continuous improvement based on customer feedback. Digital transformation is approached incrementally, focusing on practical, easy-to-use solutions.

Gradual Digital Transformation and Product Innovation in Nut Butter Production



Objective	Expand digital capabilities gradually to improve operational efficiency, manage inventory accurately, and explore international markets while innovating with new nut butter flavours and varieties
Description	Founded during the COVID-19 pandemic, the company began with a focus on locally produced nut butters. The company utilizes digital tools like cloud storage to manage inventory data, allowing for real-time access across the team. Although production remains manual, they aim to gradually automate as resources allow. The company engages in product innovation, creating unique products such as vegan salted caramel and white chocolate coconut almond butter to stand out in the market.
Benefits / Outcomes	<ul style="list-style-type: none"> Improved inventory management through cloud solutions, enhancing data accessibility. Product innovation that aligns with customer preferences and offers a unique edge in the market. Established presence in Slovak and select international markets, contributing to steady revenue growth.
Key Resources	<ul style="list-style-type: none"> Financial resources, primarily from personal funds and loans, with occasional support from family. Skilled production employees, hired from the food industry. Cloud technology for inventory management.
Main Stakeholders	<ul style="list-style-type: none"> Local and international customers purchasing through retail and online channels. Distribution partners within the country. Technology and IT service providers for cloud and data management.
Organisational Culture	The company values a practical, hands-on approach to digital transformation. The founders manage all operations, focusing on incremental growth and resource optimisation. Innovation in product development is encouraged, with experimentation around new flavors and vegan products. The company embraces an open and collaborative environment, fostering close relationships with both employees and customers.

Comprehensive Control of Direct-to-Consumer Sales and Digital Marketing



Objective	Strengthen customer relationships and ensure high quality by directly managing the B2C sales process through a web store, while optimizing digital marketing efforts.
Description	The company initially started with a production focus, selling through wholesale and retail. They shifted towards a B2C model, utilizing their own web store for direct contact with customers, which allows them to oversee quality and presentation fully. This approach increases margins, maintains product standards, and provides a personal customer experience. The company also plans to hire a marketing graduate to enhance digital marketing efforts.
Benefits / Outcomes	<ul style="list-style-type: none"> • Direct control over product quality and customer experience through B2C sales. • Higher profit margins compared to wholesale by reducing intermediary involvement. • Enhanced customer engagement through personalized marketing efforts.
Key Resources	<ul style="list-style-type: none"> • Self-managed web store for direct sales. • Customer feedback to adapt products and marketing strategies. • Potential marketing graduate hire to expand digital marketing efforts
Main Stakeholders	<ul style="list-style-type: none"> • Direct customers buying through the web store. • Wholesale partners still supporting part of the distribution. • Internal team handling production and digital marketing efforts.
Organisational Culture	The company emphasises creativity and responsiveness to customer needs, led by the founder who manages product innovation. Digital transformation is seen as a means to enhance customer interaction and sales, with a planned focus on hiring expertise to advance digital marketing. The culture values efficiency, quality, and customer-centricity.

Restaurant's Customer-Centric Service Model



Objective	Enhance customer satisfaction through personalized service, balancing digital tools with high-quality, personalized, face-to-face interactions in a small business setting.
Description	This locally operated restaurant relies on direct sales through in-house dining, with limited use of digital tools for operational efficiency. The business uses QR codes for menus and has basic digital ordering and table management systems, although it favours human interaction over automation. Resources are minimal, and most digital initiatives are implemented on a trial basis to determine effectiveness. The owners play a hands-on role, managing the business daily and focusing on creating a personal and engaging dining experience.
Benefits / Outcomes	<ul style="list-style-type: none"> • High customer satisfaction due to personalized service. • Flexibility in service adjustments based on direct feedback from customers and staff. • Limited but effective use of digital tools, reducing operational costs and enhancing the customer experience. • Customer loyalty driven by the restaurant's personal approach and atmosphere.
Key Resources	<ul style="list-style-type: none"> • Direct communication with customers for personalized service. • Limited digital resources tailored to enhance the dining experience without overwhelming automation. • Skilled staff trained to provide an engaging and high-touch service experience.
Main Stakeholders	<ul style="list-style-type: none"> • Restaurant customers who value the personal dining experience. • Staff who are integral to providing personalized service and adapting to customer needs. • Local suppliers supporting the restaurant's operational needs.
Organisational Culture	The restaurant prioritizes personal interaction and a hands-on approach. Staff are encouraged to build connections with customers, and digital systems are used minimally to preserve a unique dining experience. The culture values adaptability and maintaining high standards of service, focusing on quality over quantity.

Farm's Data-Driven Digital Transformation Strategy



Objective	Implement a comprehensive digital strategy that leverages data and technology to improve operational efficiency, enhance customer engagement, and support sustainable farming practices.
Description	The farm business employs a multifaceted digital strategy involving website upgrades, social media engagement on platforms like Facebook, Instagram, and LinkedIn, and the integration of IoT and cloud computing for data management. Strategic partnerships with the Department of Agriculture enable efficient data handling, including digital calf registration for national database updates. The company uses specialised programmes, such as a dedicated dairy management system, to support data collection and optimise processes in their new milking facility.
Benefits / Outcomes	<ul style="list-style-type: none"> Improved data accuracy and streamlined operations through digital tools. Enhanced customer engagement and brand presence via an active online strategy. Strengthened operational capabilities through strategic partnerships and use of IoT and cloud technologies. Increased ability to innovate, as shown through unique client experiences, such as a mountain walk with mythological storytelling for a conference.
Key Resources	<ul style="list-style-type: none"> Strategic partnerships with government (local) and National of Agriculture. specialised dairy management programmes. On-site management tools for data collection in the milking facility.
Main Stakeholders	<ul style="list-style-type: none"> Customers who provide revenue, enabling investment in digital technologies. Employees and management, focused on digital skills development and client engagement. Institutional partners, such as universities and industry organisations, for knowledge-sharing and event collaboration.
Organisational Culture	The organisation fosters a collaborative culture where creativity and innovation are encouraged. Employees are supported in developing digital skills, with structured onboarding and training programmes. The business is client-centred, tailoring activities to meet client needs, while the leadership team actively seeks feedback to improve future initiatives.

Collaborative Digital Strategy



Objective	Develop a flexible and collaborative digital strategy that supports customer engagement, enhances product development, and integrates digital tools into daily operations while balancing resource constraints.
Description	This food manufacturing company takes a collaborative approach to digital strategy, regularly engaging in market research, trade shows, and client interactions to gather new ideas. The company uses IoT, cloud computing, big data, and AI for various projects, though these tools are often applied in an ad hoc manner due to limited resources and project management expertise. Strategic partnerships, such as with Enterprise Ireland, provide financial support and access to collaborators, though these come with limitations. Experimentation in product development is encouraged, as seen in recent collaborative efforts to create a new product with red onion and chilies.
Benefits / Outcomes	<ul style="list-style-type: none"> Enhanced customer engagement through a hands-on, experimental approach to product development. Increased operational efficiency through selective use of digital tools and partnerships. Financial support for digital initiatives, particularly through partnerships with Enterprise Ireland. New product development inspired by customer feedback and hands-on experimentation.
Key Resources	<ul style="list-style-type: none"> Strategic partnerships with Enterprise Ireland for financial support and collaboration. Digital tools such as IoT, cloud computing, and AI to support manufacturing and data analysis. In-house market research and direct client feedback to inform product development.
Main Stakeholders	<ul style="list-style-type: none"> Direct customers who purchase products and provide feedback. Indirect customers and end consumers who ultimately use the products. Government and enterprise organisations, such as Enterprise Ireland, that provide financial support.
Organisational Culture	The organisation fosters a culture of innovation and flexibility, encouraging employees to engage in experimentation and hands-on product development. While formal digital training is limited, employees are supported in learning digital tools like Microsoft Office 365 and SharePoint as needed. The business values adaptability, and annual reviews help identify specific training needs for each employee.

Adaptive Digital Strategy



Objective	Develop a flexible digital strategy to support direct sales, e-commerce, and product innovation in a resource-constrained small business setting.
Description	This small cafe and coffee shop primarily operates through direct sales to customers, both in-person and via its e-commerce platform. Digital strategy development is informal and adjusted as needed, based on ongoing research and feedback from the business ecosystem. Due to limited financial and human resources, most digital initiatives are handled by the owner, who balances these tasks with responsibilities in sales, marketing, and product development. Product experimentation and diversification are key components, with a recent focus on expanding coffee offerings.
Benefits / Outcomes	<ul style="list-style-type: none"> • Direct engagement with customers through a flexible digital sales approach. Cost-effective digital solutions tailored to immediate business needs. • Continuous product innovation, including new coffee varieties and formats (e.g., cold brew, individually packed coffee). • Improved customer experience with multiple payment options in-store and online.
Key Resources	<ul style="list-style-type: none"> • Financial resources allocated as needed for digital projects. • Owner-managed digital and product development tasks due to limited human resources. • Small team trained on basic digital tools (e.g., Microsoft Office 365, SharePoint) for daily operations.
Main Stakeholders	<ul style="list-style-type: none"> • Physical customers, online shoppers, and wholesale clients. • Employees involved in daily operations and product innovation. • Government agencies and potential funders, though engagement with these is limited at present.
Organisational Culture	The cafe emphasises adaptability, attention to detail, and problem-solving skills in its small team. Employees are encouraged to develop digital skills as needed, and training is provided through online resources or directly by the owner. Annual reviews help identify additional training needs, ensuring that the team can keep pace with operational demands and contribute to the business's digital transformation goals.

Artisan Food Producer's Digital Engagement Strategy



Objective	Increase online visibility and customer engagement through a basic digital strategy focused on e-commerce, social media, and direct customer interactions in markets.
Description	This small artisan food business relies on e-commerce, a free website, and social media platforms like Instagram to increase visibility. The business owner collaborates with local partners, to explore innovative product combinations and gain access to grants and market information. Although digital strategy development is ad hoc, the business is open to new partnerships, as well as exploring automation if the scale of operations grows. Current operations are small-scale, with production primarily managed by the owner.
Benefits / Outcomes	<ul style="list-style-type: none"> Increased brand visibility through online presence and social media engagement. Enhanced product innovation through collaborations with local partners. Access to financial support for stock purchases and resource grants through government initiatives. Improved customer satisfaction through direct feedback at markets, influencing product development.
Key Resources	<ul style="list-style-type: none"> Local partnerships with organisations like Boyne Valley Flavors and Boann Distillery. Grants from Local Enterprise Office and government agencies for financial support. Basic digital tools (free website, social media) for customer engagement.
Main Stakeholders	<ul style="list-style-type: none"> General public, the primary customers, who provide feedback at markets and directly influence product offerings. Local partners who provide ingredients and collaboration opportunities. Government agencies offering grants and support through local programmes.
Organisational Culture	The organisation values experimentation and customer feedback, with the owner taking a hands-on approach to product development. Awards and customer appreciation motivate the owner to innovate, and support from family and government agencies encourages continued growth. Digital training is limited, with occasional courses available, though they may not align with the owner's schedule. Training materials are developed on an as-needed basis.

04

TRAINING PROGRAMME ANALYSIS (EXCERPT)

As consumer preferences shift and technological advancements reshape the industry landscape, SMEs must adopt digital tools and strategies to stay relevant and thrive. However, many SMEs face challenges in understanding how to effectively implement digital solutions, making tailored training programmes to address these gaps essential for their success.

To better understand where and how training programmes within the F&B sector helped drive successful SME digitalization efforts, 24 mini-cases were documented providing tangible examples of how various SME stakeholders can navigate their digital transformation journeys. Details on all documented cases are outlined in the following pages.

Recommendations and conclusions

This case collection on digital transformation training programmes for SMEs, particularly in the F&B sector, highlights essential skills and approaches needed for successful digital adoption within this space. Key takeaways from the case studies included the value of practical digital skills, strategic adaptability, and sustainable practices. Training programmes typically emphasize hands-on learning through workshops, case studies, and internships, allowing participants to apply digital tools, optimize operations, and build resilience against F&B industry changes, among other sectors. Key recommendations identified from the case study analysis include:

1. **Customize Training to Industry Needs:** Each industry faces unique challenges, particularly in areas like F&B, manufacturing, or retail. Tailoring training content to address these specific sectoral demands increases relevance and applicability, ensuring that SMEs acquire tools and knowledge that can be directly applied to their operational needs. For instance, programmes for F&B could focus on supply chain transparency, food safety, and sustainable packaging, while manufacturing might emphasize automation, robotics, and waste management.
2. **Focus on Practical, Hands-On Learning:** SMEs benefit most from programmes that emphasize real-world applications over theoretical concepts. Training should include workshops, simulations, and project-based

assignments that allow participants to apply skills directly. Case studies and interactive problem-solving sessions can help SMEs understand how to implement digital and sustainable practices effectively, preparing them for on-the-job challenges.

3. **Embed Sustainability as a Core Component:** Modern consumers and regulators demand sustainable practices, making it essential for training programmes to integrate sustainability across all learning modules. This can include waste reduction techniques, carbon footprint assessment, eco-friendly resource management, and sustainable supply chain practices. Embedding sustainability not only meets regulatory and market demands but also builds a strong brand reputation for SMEs in a competitive landscape.
4. **Incorporate Mentorship and Networking Opportunities:** Connecting SMEs with mentors, industry leaders, and peers creates a support system that extends beyond the training period. Networking can provide insights into best practices, emerging trends, and collaborative opportunities. Programmes can facilitate mentorship by pairing participants with experienced professionals or industry-specific advisors who can provide guidance on navigating digital and sustainability challenges.

5. **Offer Flexible Learning Formats:** SMEs often have limited time and resources for employee training, making it essential to offer flexible options such as blended learning, online modules, or self-paced formats. Flexibility allows participants to engage with the material at their convenience, increasing accessibility and participation, especially for small businesses that may not have the capacity to allocate full-time resources to training.
6. **Provide Clear ROI Metrics and Success Tracking:** SMEs are result-driven and benefit from understanding how training will impact their operations. Programmes should establish measurable goals and key performance indicators (KPIs), such as improvements in efficiency, cost savings, waste reduction, or increased revenue. Tracking progress helps SMEs evaluate the success of their training efforts and make data-driven decisions on further investments in digital and sustainable initiatives.
7. **Emphasize Change Management Skills:** Digital transformation and sustainability initiatives often require changes in SME culture, workflows, and employee behaviour. Training programmes should incorporate change management strategies to help SMEs effectively implement new practices. This could include communication skills, leadership training, and strategies for gaining employee buy-in, which are critical to ensuring smooth adoption and minimizing resistance to change.
8. **Encourage Continuous Learning and Upskilling:** Digital and sustainability landscapes evolve rapidly, making continuous learning essential. Training providers should offer follow-up courses, resources for self-paced learning, and up-to-date content on emerging technologies, regulatory changes, and sustainability practices. This would help SMEs maintain a competitive edge and adapt to future industry changes.
9. **Foster Partnerships:** These cases emphasize the collaboration between universities, industry professionals, and SMEs specifically, to implement transparent, secure and innovative practices within different operational aspects of the F&B sector (e.g., supply chain management, customer journey, etc.). Universities should foster partnerships to facilitate industry-relevant research and curriculum co-design, ensuring students acquire practical, real-world experience to help them overcome digitalization challenges in their careers.

These case study insights serve as a foundation for designing effective digital transformation training programmes that equip SMEs to innovate, adapt, and thrive in a competitive, tech-driven market. Implementing these recommendations would empower SMEs to integrate digital and sustainable practices effectively, fostering resilience and competitive advantage for sustainable, long-term growth of their enterprises.



05



STUDENT SKILL GAP ANALYSIS (EXCERPT)

Complementing the preceding training program analysis (see Training Program Analysis in the F&B Sector) a comprehensive skill gap analysis was conducted to assess the readiness and needs of students, educators, and SMEs regarding digital skills, tools, and methodologies.

This section outlines the findings of the skill gap analysis, highlighting the critical areas where digital skills and competencies need to be developed further through comparative analysis of the skills presumably possessed by

students and the level of importance of those skills as perceived by industry experts and academia. It also serves as the foundation for the subsequent activities of the DIGIFABS project, including the design of educational interventions such as summer schools, bootcamps, and publicly available training materials.

The full skill gap analysis is available in a separate output (entitled DIGIFABS – Student Skill Gap Analysis) as part of WP3 – Investigation.

Recommendations And Conclusions

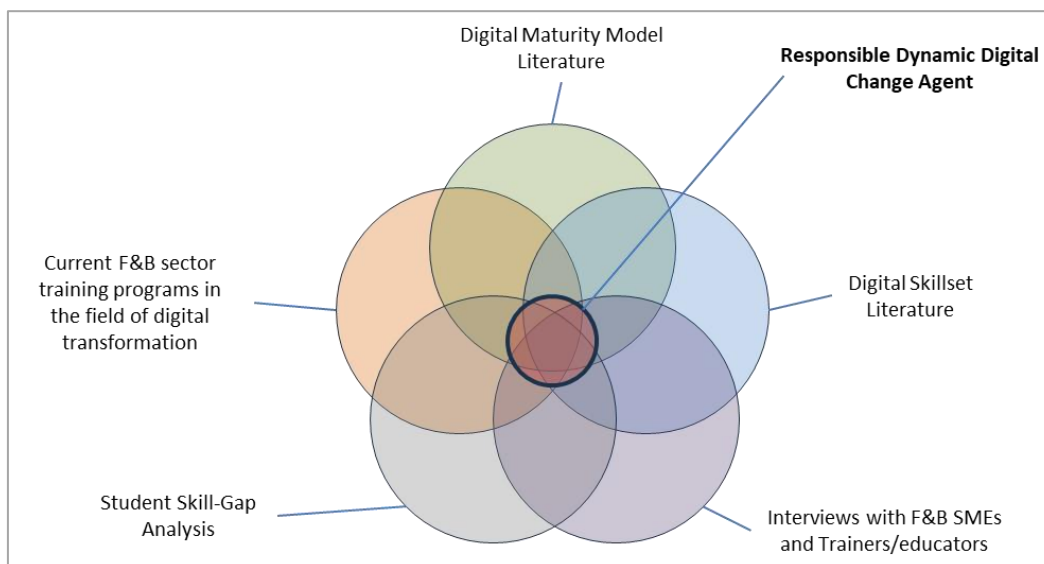
The survey analysis highlights critical gaps between students' self-assessed digital skills and the skills perceived as essential by F&B SMEs and Educators. While students demonstrate confidence in areas such as digital communication, technical adaptability, and wellbeing, notable deficiencies exist in flexibility, systematic thinking, and problem-solving abilities. This skill gap analysis is essential for the DIGIFABS project for several reasons:

1. **Identifying Priority Areas:** The analysis pinpoints critical competencies—such as strategic thinking, adaptability, and technical problem-solving—that require immediate focus to align students' skills with industry expectations.
2. **Evidence-Based Curriculum Design:** The findings provide a robust evidence base for shaping the content of the DIGIFABS summer school modules. This ensures the program directly addresses the identified gaps, fostering skillsets that are both practical and industry-relevant.
3. **Enhancing Program Impact:** By tailoring the training to bridge these gaps, the DIGIFABS initiative can better prepare students to serve as Responsible Dynamic Digital Change Agents (RDDCAs), equipped to lead digital transformation in SMEs.
4. **Supporting Strategic Objectives:** The skill gap analysis aligns with the project's overarching goal of fostering innovation, resilience, and sustainability within the F&B sector. Addressing these gaps directly enhances the capability of future professionals to contribute effectively to sector-wide digital transformation.
5. **Strengthening Stakeholder Engagement:** The analysis provides tangible data that resonates with educators, SMEs, and students, fostering trust in the program's ability to deliver meaningful and transformative educational outcomes.

The skill gap analysis is thus a cornerstone of the DIGIFABS project, informing the design and delivery of the summer school and bootcamp modules. It ensures that the program not only equips participants with the theoretical and practical knowledge needed for digital transformation but also aligns these skills with the specific needs of the F&B industry. This alignment is crucial for empowering students, educators, and SMEs to collaboratively address the challenges and opportunities of the digital era.

06

INTEGRATED CONCLUSIONS OF LITERATURE REVIEW AND INTERVIEW ANALYSIS



The Investigation work package (WP3) seeks to combine myriad inputs and perspectives in support of the aims of this project.

This research demonstrates that progress and improvement in digital innovation within the F&B sector cannot be achieved through a simple, linear roadmap with straightforward, concrete outcomes. Insights from interviews with SMEs and educators who are related to the F&B sector reveal that, on several topics identified in the literature, targeted interventions are already being implemented, and strategies for change are under consideration. By structuring certain workflows, organisations have created stronger platforms for discussion and integration of these themes compared to situations where these processes are not formalized.

The findings also highlight differing levels of maturity across companies on these topics, as evidenced in how various organisations approach and manage these areas. The analysis of skillsets further reveals contrasting perspectives among entrepreneurs, educators, and trainers on the importance and composition of essential skills. Interviews with educators show a mixed approach to the topics from the literature, yet they still identify several key factors that can serve as a foundation for increased focus on digital innovation and support the development of the Summer Schools and Bootcamps.

Overall, the research can be seen as a comprehensive inventory of factors and examples that provide a baseline for current thinking on these topics. Simultaneously, it offers a navigational tool or "map" to guide future exploration within the complex

domain of digital innovation in the F&B sector. This underscores both the opportunities available for growth and the challenges in unifying a process that incorporates these multifaceted factors into a coherent framework.

It is recommended that, prior to initiating any interventions based on the roadmap, a careful selection is made of the specific topics to be prioritised. This targeted approach allows organisations to focus resources effectively on areas with the highest potential impact. Additionally, the roadmap can serve as a valuable checkpoint throughout the process, helping to ensure that other developments or emerging priorities within digital innovation are not overlooked. This dual function of the roadmap—as both a guide for immediate action and a tool for broader strategic oversight—can help organisations navigate the complexities of digital innovation while remaining adaptive to ongoing changes in the sector.

The limitations of this research stem from its broad and exploratory nature. Due to the extensive range of topics identified, it is challenging to test each one directly and comprehensively with both SMEs and educators. Additionally, the time investment available from SMEs and educators was limited, necessitating a narrower scope than initially intended. This constraint means that while the study offers valuable insights, it does not fully capture the depth of each topic as it might in a more focused investigation. These factors should be considered when interpreting the results, as they suggest areas where further, more targeted research could deepen understanding.

Proposed Digital Maturity Model



Based on the DMM literature review and coding (See Chapter 7 Literature review of digital maturity models), and insights from interviews with SMEs and educators/trainers in the F&B sectors, we argue for a DMM that considers a maturity continuum, is applicable to different units of maturity, and that the model is sufficiently flexible to be relevant for SMEs operating in different areas of the F&B sector. These aspects are described below:

- DMM recognise a continuum whereby progression indicates developing competency. Examples of how maturity sophistication, often termed 'levels' or 'phases', are described, include:
 - When applied to data information: Initial, pathfinder, advanced, managed, and optimised (Sándor & Gubán, 2022).
 - When applied to smart products and services: Absence, existence, survival, and maturity (Akdil et al., 2018).
 - When applied to a firm's digital capability: Novice, beginner, competent, and expert (Hortovanyi et al., 2023).
- Across the reviewed DMM literature, the unit of maturity (UoM) to which a DMM model applies varies. Examples of UoMs include:
 - Processes: Design and engineering, production, maintenance, quality, logistics, and supply chain (Carolis, 2017).
 - Circular aspects: Product, process, business model, technology, and stakeholder (Uztürk & Büyüközkan, 2022).
 - Industry 4.0 readiness: Strategy and organisation, smart factory, smart operations, smart products, data-driven services, and employees (Hortovanyi et al., 2023).
- While there are overlaps between many DMMs, the models reviewed in the literature are highly context-specific, whereby a DMM such as that proposed by Huet et al. (2022) and adapted for smart beehives, contrasts to the model developed by Varbanova et al. (2023) which evaluates Industry 4.0 implementation factors in agri-food and manufacturing.

- DMMs are themselves multi-dimensional whereby, at a more granular level of detail, sub-dimensions are at different stages of development – some more advanced than others – and these maturity-dimension-sub-dimensions levels are in continual evolution.

Based on the preceding discussion, we propose 4 design considerations for a DMM for SMEs in the F&B sector (see Table 37: DMM design considerations).

Design consideration	Description
Level of maturity	Five digital maturity levels should be defined, each with an intuitive label and clear description. A higher maturity score indicates a higher level of competency.
Granularity	It must be possible for an F&B SME to apply the DMM to different UoMs within their organisation (e.g. employee level, role level).
Flexibility	The DMM should specifically address digital maturity and associated RDDCA skills in the F&B sector yet remain flexible enough to ensure applicability to the diversity of SMEs within this sector.
Applicability	SMEs must be able to adopt, adapt and apply the developed DMM to reflect their specific situation and requirements.

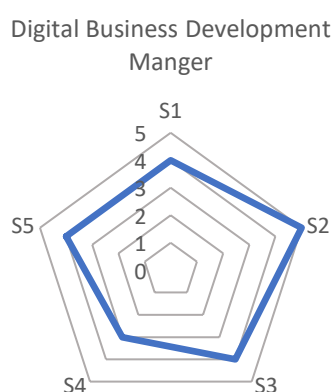
Applying the design considerations identified above, the proposed DMM provides a structured reference framework for benchmarking the digital skills of employees at SMEs in the F&B sector (see Table 38: Proposed digital maturity models for F&B SMEs). By defining distinct levels of maturity, enterprises can benchmark the current digital maturity status of employees, and of their organisation, measure engagement with responsible business practices, help SMEs stay agile and responsive to digital trends, and identify areas for improvement.

Level	Maturity phase	Description	Factors
1	Initial	Employees have minimal experience with digital tools and technologies and primarily rely on traditional and established methods. Employees are not explicitly engaged with responsible business practices.	Basic digital literacy, minimal use of digital communication tools, and limited with industry-specific software.
2	Emerging	Employees have started to develop basic digital skills and are beginning to use digital tools and technologies in their daily tasks, though their usage is still limited, ad hoc, and often guided. Employees are aware of responsible business practices and engage in an unstructured manner.	Basic proficiency in common software (e.g., Microsoft Office suite), initial use of digital communication platforms (e.g., email, messaging apps), a basic understanding of digital marketing concepts and digitalised business processes.
3	Competent	Employees possess a good level of digital skills and can independently use a variety of digital tools and technologies relevant to their roles. Employees contribute to digital initiatives within the enterprise and are regularly involved in advancing responsible business practices.	Adept at using industry-specific software (e.g., inventory management systems), regular use of digital marketing tools, able to analyse basic data for decision-making.
4	Proficient	Employees are highly skilled in digital tools and technologies allowing them to play a key role in implementing and optimising digital processes within the enterprise. Employees are structurally engaged with developing and embedding responsible business practices.	Advanced use of digital marketing and e-commerce platforms, strong data analysis skills, and ability to train and support other employees in the use of digital tools and technologies.
5	Mastery	Employees are digital leaders within the enterprise, driving innovation and continuously seeking out new technologies to enhance business operations. Employees advocate for and lead responsible business practices.	Expertise in advanced digital tools and technologies (e.g., AI, machine learning), strategic use of data for predictive analytics, and possess leadership skills in digital transformation initiatives.

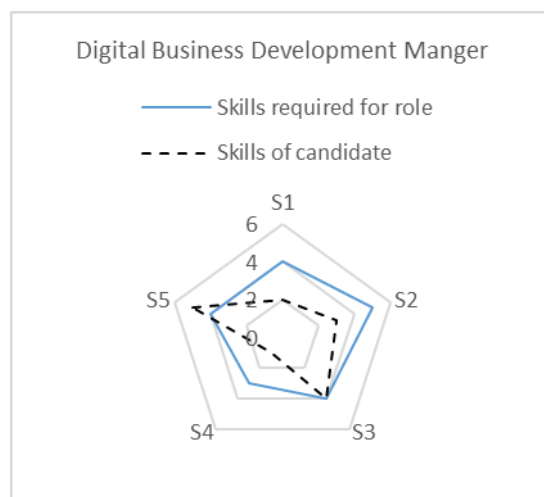
Preparation For Summer School And Bootcamps

The insights resulting from WP3 feed into the preparation for the Summer School and Bootcamps. The following example illustrates how to identify digital skillsets relevant to a specific theme and apply the proposed DMM.

- For this example, we select the dimension 'Process digitalisation' identified as a recurring concept in the literature reviews.
- Sub-themes of 'Process digitalisation' that recur most frequently in the reviewed literature are 'Collaboration', 'Transformation management', 'Cloud & data', 'Digital environment', 'Monitoring & control', and 'Digital business development.'
- Next, we review skills related dimensions (for example by reviewing Table 35: Skillset dimensions, or through review of interview transcripts summarises in section 10 Interviews with F&B SMEs and educators/trainers) seeking to confirm that these skills (characteristics) are also regarded as important in practice based in interviews with SMEs and educators/trainers. While terms do not correspond precisely, there is significant overlap to establish confirmation with skills in this table such as 'Innovating creatively using technologies' – as a skill required for 'Digital business development.'
- As a next step, as part of the Summer School development, a set of digital skills is identified for the role of Digital Business Development Manager. In this example, these there are 5 digital skills identified (S1...S5) required for this role. For each skill, a level of digital maturity is required to perform this role as represented in Figure 21: Skills required for Digital Business Development Manager role. As shown, S2 requires a DMM score of 5, while S4 requires a DMM score of 2.



- Using the identified skills sets for this role, we apply them to an individual who is a candidate to take on the role of Business Development Manager. This allows discovery of some divergence in the personal skillsets of the candidate versus the requirements of the role (Figure 22: Skills per role vs. Skills per candidate).



- In this example, we see that the candidate requires some skillset development for S2, while already possessing more than sufficient S5 skills.

The scenario above strives to integrate the various aspects of this research and apply the proposed DMM to identified skills (from literature and from practice) applicable to both a role and an individual within an F&B SME. Using this approach as a basis, tailored digital skillset development programmes can be developed and benchmarked.

Combining insights from the comprehensive literature review, interviews with F&B trainers/educators, an analysis of current F&B training programmes in the field of digital transformation, and a student skill-gap survey and analysis has – as the culmination of WP3 – Investigation – aided identification of RDDCA skill sets and laid the groundwork for the design of WP4 - Summer School and Challenge and WP - 5 Bootcamps.

07

APPENDIX

Abbreviations

Abbreviation	Description
AI	Artificial Intelligence
AHP	Analytic Hierarchy Process
AR	Augmented Reality
CPS	Cyber-Physical Systems
CRM	Customer Relationship Management
CSF	Critical Success Factor
DCMM	Digital Capability Maturity Model
DEMANTEL	Decision Testing and Evaluation Laboratory Method
DMM	Digital Maturity Model
DSS	Decision Support System
DT	Digital Transformation
DTC	Direct To Customer
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
F&B	Food and Beverage
FAQ	Frequently Asked Questions
FCE	Fuzzy Comprehensive Evaluation
GDPR	General Data Protection Regulation
GPS	Global Positioning System
HEI	Higher Education Institute
HR	Human Resources
ICT	Information And Computing Literacy
IS	Information Systems
ISP	Internet Services Provider
IoT	Internet Of Things
IT	Information Technology
IVI	Innovation Value Institute
LEO	Local Enterprise Office
MIS	Management Information System
MM	Maturity Model
MOOC	Massive Open Online Course
PRISMA	Preferred Reporting Items For Systematic Reviews And Meta-Analyses
RDDCA	Responsible Dynamic Digital Change Agent
SD	Systems Design
SDG	Sustainable Development Goals
SMDH	Smart Manufacturing Digital Hub
SME	Small And Medium Size Enterprise
SWOT	Strengths, Weaknesses, Opportunities, Threats
UoM	Unit Of Maturity
VET	Vocational Education And Training
VR	Virtual Reality
WP	Work Package

References

- Acerbi, F., Assiani, S., & Taisch, M., "A Methodology to Assess the Skills for an Industry 4.0 Factory," in IFIP International Conference on Advances in Production Management Systems, 2019, pp. 520–527, <https://doi.org/10.1007/978-3-030-29996-5>
- Aghamiri, S., Karima, J., & Cavus, N. (2022). Advantages of Digital Transformation Models and Frameworks for Business: A Systematic Literature Review. *International Journal of Advanced Computer Science and Applications*, 13(12).
- Akdil, K. Y., Ustundag, A., & Cevikcan, E. (2018). Maturity and readiness model for Industry 4.0 strategy. In A. Ustundag & E. Cevikcan (Eds.), *Industry 4.0: Managing the digital transformation* (pp. 63–82). Springer. https://doi.org/10.1007/978-3-319-57870-5_4
- Amaral, A., & Peças, P. (2021). SMEs and Industry 4.0: Two case studies of digitalisation for a smoother integration. *Computers in Industry*, 125. <https://doi.org/10.1016/j.compind.2020.103333>
- Arnaud, J., São Mamede, H & Branco, F. The relationship between digital transformation and digital literacy - an explanatory model: Systematic literature review [version 1; peer review: 1 approved]. *F1000Research* 2024, 13:253 <https://doi.org/10.12688/f1000research.146991.1>
- BEinCPPS, "D9. 4 - D9. 2a BE in CPPS Innovation Assets and Tools Deliverable characteristics Deliverable Peer review summary," 2018.
- Blatz, F., & Dietel, M. (2018). Conference proceedings, ICE/IEEE ITMC 2018 : 2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC) : Stuttgart 17.06.-20.06.18.
- Bradač Hojnik, B., & Huđek, I. (2023). Small and Medium-Sized Enterprises in the Digital Age: Understanding Characteristics and Essential Demands. *Information (Switzerland)*, 14(11). <https://doi.org/10.3390/info14110606>
- Bretz, L., Klinkner, F., Kandler, M., Shun, Y., & Lanza, G. (2022). The ECO Maturity Model - A human-centered Industry 4.0 maturity model. *Procedia CIRP*, 106, 90–95. <https://doi.org/10.1016/j.procir.2022.02.160>
- Brozzi, R., Rauch, E., & Riedl, M. (2021). Industry 4.0 roadmap for SMEs: validation of moderation techniques for creativity workshops Dominik T. Matt. In *Int. J. Agile Systems and Management* (Vol. 14, Issue 2).
- Browder, R. E., Dwyer, S. M., & Koch, H. (2024). Upgrading adaptation: How digital transformation promotes organisational resilience. *Strategic Entrepreneurship Journal*, 18(1), 128–164.
- Bumann, J., & Peter, M. K. (2019). Action fields of digital transformation – a review and comparative analysis of digital transformation maturity models and frameworks. *Digitalisierung Und Andere Innovationsformen Im Management. Innovation Und Unternehmertum.*, November 2019, 13–40.
- Calà, A., Boschi, F., Fantini, P., Tavola, G., & Taisch, M., "Architectural Blueprint Solution for Migrating Towards FAR-EDGE," *The Thirteenth International Conference on Mobile Ubiquitous Computing, Systems. (UBICOMM 2019)*, no. c, pp. 82–87, 2019.

Carolis de, A., "A methodology to guide manufacturing companies towards digitalisation," Politecnico di Milano, 2017.

Chen, Q., Zhang, W., Jin, N., Wang, X., & Dai, P. (2022). Digital Transformation Evaluation for Small- and Medium-Sized Manufacturing Enterprises Using the Fuzzy Synthetic Method DEMATEL-ANP. *Sustainability (Switzerland)*, 14(20). <https://doi.org/10.3390/su142013038>

Curley, M., Kenneally, J., & Carcary, M. (2017). IT-CMF—A Management Guide-Based on the IT Capability Maturity Framework (IT-CMF). Published by Van Haren.

Daminov, A., Miftakhov, E., & Mustafina, S. (2021, September). SaaS is the service for solving problems of chemical kinetics. In 2021 International Conference on Information Technology and Nanotechnology (ITNT) (pp. 1-4). IEEE.

Darnley, R., DiPlacido, M., Kerns, M., & Kim, A. (2018). Industry 4.0: Digitization in Danish Industry. Worcester Polytechnic Institute and Copenhagen School of Entrepreneurship: Worcester, MA, USA.

Denning, J., & Liyanage, K. (2022). Systematic Literature Review of Industry 4.0 Implementation Frameworks Focusing on Applicability in Manufacturing SMEs. *Advances in Transdisciplinary Engineering*, 25, 17–24. <https://doi.org/10.3233/ATDE220559>

Dossou, P. E., Laouénan, G., & Didier, J. Y. (2022). Development of a Sustainable Industry 4.0 Approach for Increasing the Performance of SMEs. *Processes*, 10(6). <https://doi.org/10.3390/pr10061092>

Ehlers, M. H., Finger, R., El Benni, N., Gocht, A., Sørensen, C. A. G., Gusset, M., Pfeifer, C., Poppe, K., Regan, Á., Rose, D. C., Wolfert, S., & Huber, R. (2022). Scenarios for European agricultural policymaking in the era of digitalisation. *Agricultural Systems*, 196. <https://doi.org/10.1016/j.agsy.2021.103318>

Ganzarain, J., & Errasti, N. (2016). Three stage maturity model in SMEs towards Industry 4.0. *Journal of Industrial Engineering and Management*, 9(5), 1119–1128. <https://doi.org/10.3926/jiem.2073>

Gilli, K., Lettner, N., & Guettel, W. (2024). The future of leadership: new digital skills or old analog virtues? *Journal of Business Strategy*, 45(1), 10–16. <https://doi.org/10.1108/JBS-06-2022-0093>

Hamidi, S. R., Aziz, A. A., Shuhidan, S. M., Aziz, A. A., & Mokhsin, M. (2018). SMEs maturity model assessment of IR4. 0 digital transformation. In *Proceedings of the 7th International Conference on Kansei Engineering and Emotion Research 2018: KEER 2018*, 19-22 March 2018, Kuching, Sarawak, Malaysia (pp. 721-732). Springer Singapore.

Hein-Pensel, F., Winkler, H., Brückner, A., Wölke, M., Jabs, I., Mayan, I. J., Kirschenbaum, A., Friedrich, J., & Zinke-Wehlmann, C. (2023). Maturity assessment for Industry 5.0: A review of existing maturity models. *Journal of Manufacturing Systems*, 66, 200–210. <https://doi.org/10.1016/j.jmsy.2022.12.009>

Hobscheidt, D., Kühn, A., & Dumitrescu, R. (2020). Development of risk-optimised implementation paths for Industry 4.0 based on socio-technical pattern. *Procedia CIRP*, 91, 832–837.

Hortovanyi, L., Morgan, R. E., Herceg, I. V., Djuricin, D., Hanak, R., Horvath, D., Mocan, M. L., Romanova, A., & Szabo, R. Z. (2023). Assessment of digital maturity: the role of resources and capabilities in digital transformation in B2B firms. *International Journal of Production Research*, 61(23), 8043–8061. <https://doi.org/10.1080/00207543.2022.2164087>

- Huet, J. C., Bougueroua, L., Kriouile, Y., Wegrzyn-Wolska, K., & Ancourt, C. (2022). Digital Transformation of Beekeeping through the Use of a Decision Making Architecture. *Applied Sciences (Switzerland)*, 12(21). <https://doi.org/10.3390/app122111179>
- IMPULS Foundation of VDMA, "Industry 4.0 Readiness Online Self-Check for Business," 2021.
- Kamariotou, M., Kitsios, F., Charatsari, C., Lioutas, E. D., & Talias, M. A. (2022). Digital strategy decision support systems: Agrifood supply chain management in smes. *Sensors*, 22(1). <https://doi.org/10.3390/s22010274>
- König, C. (2017). Lean 4.0 - Schlank durch Digitalisierung. Retrieved October 2024 from https://www.researchgate.net/publication/314081192_Lean_40_-_Schlank_durch_Digitalisierung
- Li, L. (2022). Evaluation of Digital Transformation Maturity of Small and Medium-Sized Entrepreneurial Enterprises Based on Multicriteria Framework. *Mathematical Problems in Engineering*, 2022. <https://doi.org/10.1155/2022/7085322>
- McDermott, O., Nelson, S., Antony, J., & Sony, M. (2023). Industry 4.0 readiness in west of Ireland small and medium and micro enterprises—an exploratory study. *Quality Management Journal*, 30(2), 105–120. <https://doi.org/10.1080/10686967.2023.2171325>
- Menzeffricke, J. S., Wiederkehr, I., Koldewey, C., & Dumitrescu, R. (2021). Maturity-based Development of Strategic Thrusts for Socio-technical Risks. *Procedia CIRP*, 104, 241–246. <https://doi.org/10.1016/j.procir.2021.11.041>
- Michailidis, A., Charatsari, C., Bournaris, T., Loizou, E., Paltaki, A., Lazaridou, D., & Lioutas, E. D. (2024). A First View on the Competencies and Training Needs of Farmers Working with and Researchers Working on Precision Agriculture Technologies. *Agriculture (Switzerland)*, 14(1). <https://doi.org/10.3390/agriculture14010099>
- Omol, E., Mburu, L., & Abuonji, P. (2023). Digital maturity action fields for SMEs in developing economies. *Journal of Environmental Science, Computer Science, and Engineering & Technology*, 12(3).
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *bmj*, 372.
- Pirola, F., Cimini, C. & Pinto, R., "Digital readiness assessment of Italian SMEs: a case-study research," *Journal of Manufacturing Technology Management*, vol. 31, no. 5, pp. 1045–1083, 2020, <https://doi.org/10.1108/JMTM-09-2018-0305>
- Rocca, R., Boschi, F., Calà, A., Fantini, P. & Taisch, M., "A Migration Methodology for Factories Digital Transformation," 2020, pp. 311–319.
- Saari, L., Kuivanen, R., & Poikkimäki, J. (2021). DigiMove Analysis for Manufacturing SMEs to Identify Their Current Status and next Digitalisation Steps. *IN4PL - Proceedings of the International Conference on Innovative Intelligent Industrial Production and Logistics*, 59–66. <https://doi.org/10.5220/0010642200003062>
- Sándor, Á., & Gubán, Á. (2022). A multi-dimensional model to the digital maturity life-cycle for SMEs. *International Journal of Information Systems and Project Management*, 10(3), 58–81. <https://doi.org/10.12821/ijispm100303>
- Santos, F. J., Guzmán, C., & Ahumada, P. (2024a). Assessing the digital transformation in agri-food cooperatives and its determinants. *Journal of Rural Studies*, 105. <https://doi.org/10.1016/j.jrurstud.2023.103168>

Schallmo, D., Lang, K., Hasler, D., Ehmig-Klassen, K., & Williams, C. A. (2020). An Approach for a Digital Maturity Model for SMEs based on Their Requirements.

Schuh, G., Anderl, R., Gausemeier, J., ten Hompel, M., & Wahlster, W., "Industry 4.0 maturity index. Managing the Digital Transformation of Companies," Munich: Herbert Utz Verlag, 2017.

Schumacher, S. Erol, and W. Sihn, "A Maturity Model for Assessing Industry 4.0 Readiness and Maturity of Manufacturing Enterprises," *Procedia CIRP*, vol. 52, pp. 161–166, 2016, <https://doi.org/10.1016/j.procir.2016.07.040>

Solis, B. (2017). The digital change agent's manifesto. How the people behind digital transformation lead change from within. Altimeter Prophet, 1-28.

Spaltini, M., Acerbi, F., Pinzone, M., Gusmeroli, S., & Taisch, M. (2022). Defining the Roadmap towards Industry 4.0: The 6Ps Maturity Model for Manufacturing SMEs. *Procedia CIRP*, 105, 631–636. <https://doi.org/10.1016/j.procir.2022.02.105>

Suparno, S., Saptono, A., Iranto, D., Disman, D., & Widhiastuti, R. (2022). Development of Small and Medium Enterprises during Covid-19 Period: The Role of Literacy, Attitude and Productive Economic Behavior. *Academic Journal of Interdisciplinary Studies*, 11(5), 98–113. <https://doi.org/10.36941/ajis-2022-0128>

Ustundag, A., & Cevikcan, E. (2018). Springer Series in Advanced Manufacturing Industry 4.0: Managing The Digital Transformation. <http://www.springer.com/series/7113>

Utami, W., Khrisnabudi, N. G., Farida, L., Apriono, M., Utami, E. S., Sudarsih, Gumanti, T. A., & Wulandari, D. A. R. (2020). Measurement of maturity of small medium agroindustry business processes in Jember, Indonesia. *Journal of Physics: Conference Series*, 1538(1). <https://doi.org/10.1088/1742-6596/1538/1/012031>

Uztürk, D., & Büyüközkan, G. (2022). 2-Tuple Linguistic Model-based Circular Maturity Assessment Methodology: A Case for Agriculture. *IFAC-PapersOnLine*, 55(10), 2036–2041. <https://doi.org/10.1016/j.ifacol.2022.10.007>

Varbanova, M., de Barcellosa, M. D., Kirova, M., De Steur, H., & Gellynck, X. (2023). INDUSTRY 4.0 IMPLEMENTATION FACTORS FOR AGRI-FOOD AND MANUFACTURING SMEs IN CENTRAL AND EASTERN EUROPE. *Serbian Journal of Management*, 18(1), 167–179. <https://doi.org/10.5937/sjm18-39939>

Zhu, A., Bian, B., Jiang, Y., & Hu, J. (2020). Integrated tomato picking and distribution scheduling based on maturity. *Sustainability (Switzerland)*, 12(19). <https://doi.org/10.3390/SU12197934>

Follow Our Journey



www.digifabs.eu



Co-funded by
the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them