EXPLORING DIGITAL NEEDS IN THE CENTRU REGION, ROMANIA: A COMPARATIVE CROSS-SECTORAL STUDY

Claudia OGREAN
Lucian Blaga University of Sibiu, Romania

Bogdan-Constantin PIRVU
Lucian Blaga University of Sibiu, Romania

Mihaela HERCIU
Lucian Blaga University of Sibiu, Romania

Abstract:

The article reports and discusses (some of) the results of an exploratory research carried on by Futures of Innovation Technologies European Digital Innovation Hub (FIT EDIH) to assess the digital needs in Centru Region, Romania. It focuses on three areas of interest: (smart) manufacturing, e-health, and smart city, distinct analyses being performed on the two main pillars supporting a smart city: local public authorities (LPAs) and small and medium enterprises (SMEs). The research aimed at (1) diagnosing the organizations' current state of digitalization and finding out what their overall approach to digital transformation is; (2) understanding the organizations' needs in terms of both technologies/applications of interest in the near future and organizational areas where digital transformation is most needed and useful; (3) assessing the organizations' interest in the services provided by FIT EDIH to support digital transformation – by main categories. An online survey, comprising four tailored questionnaires (specifically designed for each type of organization), was administrated via the FIT EDIH platform. Data were collected from a total of 321 respondents/organizations, representing: Manufacturing (93), E-Health (38), Smart City - LPAs (45), and Smart City - SMEs (145). The results shed some light on the challenges and opportunities the four types of organizations in Centru Region - Romania face on their path towards digital transformation – an investigation area not tackled by previous research. In terms of contributions/implications: (1) the study advances research by contributing to the understanding of digital transformation priorities in less explored regions and sectors; (2) practically, it supports organizations in prioritizing digital transformation, informs technology providers about sector-specific needs, and enables FIT EDIH to offer targeted support, thereby fostering regional innovation and accelerating digital adoption; (3) for policymakers (at regional, national and European levels) it provides data-driven insights to prioritize investments, foster public-private collaboration, and design evidence-based digital strategies.

Key words: *digitalization needs, e-health, FIT EDIH, smart manufacturing, smart city - SMEs, smart city - LPAs, survey*

1. Introduction

Digital transformation has recently taken the lead in navigating the complex interplay between development and competitiveness, acting both as a catalyst for development and as a driver of competitiveness, while reshaping organizations, industries, and communities. (Mićić, 2017; Jianghuai, Rui, & Yingwu, 2021; Zhao, et al., 2022; Zhang, Qiu, & Cao, 2023; Gouveia et al., 2024). Multifaceted and dynamic, digital transformation is "a fundamental change process, enabled by the innovative use of digital technologies accompanied by the strategic leverage of key resources and capabilities, aiming to radically improve an entity* and redefine its value proposition for its stakeholders (*An entity could be: an organization, a business network, an industry, or society)" (Gong & Ribiere, 2021).

In Europe, "the digital transformation is one of the EU's priorities" (EU Monitor, 2023), which aims for "a successful digital transformation of Europe's economy and society by the end of the decade" (European Commission, 2021, Sep 15). As key pillar of EU's strategic approach, digital transformation is facilitated by the EU through initiatives such as the Digital Europe Programme, whose general objective is "to support and accelerate the digital transformation of the European economy, industry and society, to bring its benefits to citizens, public administrations and businesses across the Union, and to improve the competitiveness of Europe in the global digital economy while contributing to bridging the digital divide across the Union and reinforcing the Union's strategic autonomy, through holistic, cross-sectoral and cross-border support and a stronger Union contribution" (EU, 2021). The European Digital Innovation Hubs (EDIH) are the entities to play a crucial role within this framework, as "a single entity or a coordinated group of entities with complementary expertise and a not-for-profit objective to support on a large scale the digital transformation of (1) companies, especially SMEs and small mid-caps, and/or (2) public sector organizations conducting non-economic activities. EDIHs provide services such as testing before investing, training and skills development, support to find investments, networking and access to innovation ecosystems" (European Commission, 2021).

Despite significant global advancements, such as the consistent increase in worldwide spending on digital transformation technologies and services from $0.96 trillion in 2017 to $2.20 trillion in 2023 (Statista, 2024), which more than doubled in just six years, there are less explored countries and regions, like Romania and the Centru Region, Romania, that face unique challenges and opportunities when it comes to adopting digital technologies, and therefore, capitalizing on them. The most recent Digital Decade Country Report 2024: Romania (European Commission, 2024) reveals that Romania's digital landscape shows notable gaps compared to the EU average: "fewer than 27% of Romania's SMEs meet the criteria for basic digital intensity, i.e., using at least 4 of the 12 selected technologies in the Digital Intensity Index", well below the EU average of 57.7%. Key digital tools like ERP systems (22.6%), social media (15.3%), and online sales (12%) are adopted at lower rates than the EU averages (43%, 31.5%, and 19,1% respectively). Enterprises utilizing cloud, AI, or big data remain at just 28.7%, significantly under the EU average of 54.6%. ICT security measures are widely implemented by enterprises with 10 or more employees (86.5% as reported), yet only 7% of businesses have cyber insurance. Digital

skills are a pressing issue, with only 27.7% of Romanians having at least basic digital skills (compared to EU average of 55.6%), and a low percentage (2.6%) of ICT specialists in employment (compared to EU average of 4.8%). Its scores for digital public services for citizens (52.2) and digital public services for businesses (50) are significantly lower than the EU averages of 79.4 and 85.4. e-Government service usage is only 24.6%, far below the EU average of 75%. Additionally, Romania's e-Health maturity score (59) is well below the EU average (79), and access to e-Health records remains limited, with significant gaps in health data availability and timeliness (European Commission, 2024).

Previous research has highlighted the critical role of digital transformation in fostering economic growth and regional development (Götz, 2021; Tan et al., 2022; Zheng, Zhang, & Fan, 2023). Studies on digital innovation in sectors like manufacturing (Del Giudice et al., 2021; Parhi et al., 2022), healthcare (Kluge, Azzopardi-Muscat, & Novillo-Ortiz, 2022; Stoumpos, Kitsios, & Talias, 2023), and urban governance (Khisro, 2021; Jonathan, Perjons, & Rusu, 2024) emphasize the transformative potential of technologies like IoT, AI, and cloud computing. Recent studies also highlight the critical role of regional digital innovation hubs, and particularly of EDIHs, in bridging the gap between technological advancements and regional digital needs (Gaiani, & Ala-Karvia 2023; Zamiri et al., 2023; Georgescu, Tudose, & Avasilcăi, 2023).

Literature specific to Romania's digital landscape is sparse, with most studies focusing on the national level (and usually in a broader, comparative context) - rather than regional, sector-specific or cross-sectoral challenges (i.e., how organizations across different sectors are navigating the digital transformation journey) (Lincaru et al., 2018; Rivza et al., 2019; Marinas et al., 2021; Ogrean, & Herciu 2021; Brodny, & Tutak, 2022; Rusu et al., 2023; Virlanuta et al., 2024).

The current study focuses on three key areas of interest in the Centru Region - Romania: (smart) Manufacturing, e-Health, and Smart City - for Smart City, distinct attention being given to two critical stakeholders: Local Public Authorities (LPAs) and Small and Medium Enterprises (SMEs). These areas correspond to FIT EDIH's main application domains (https://digitalinnovationhub.fit/) – which are correlated with the Centru Region's 2021-2027 RIS3 Smart Specialization Strategy (ADR Centru, 2021). FIT EDIH is the only European Digital Innovation Hub in Centru Region – Romania Funded under Digital Europe Programme.

The need for this research derives from the lack of data-driven insights into the specific digitalization needs of organizations in Centru Region, Romania. By addressing this gap, the study aims to support organizations in identifying and prioritizing their digital transformation efforts, guide technology providers in tailoring their solutions, and help policymakers design effective interventions.

2. Research Methodology

The research is an exploratory one, its goal being subsumed to FIT EDIH's aim "to increase the digital maturity level of 141 SMEs and Public Service Organizations (PSOs) in 3 main application domains, correlated with the Centru Region's 2021-2027 RIS3 Smart Specialization Strategy: (1) Smart City, (2) Manufacturing, (3) eHealth"; "Regional Digital

Needs Discovery" is the cornerstone to achieve this aim, with online surveys, focus groups, and individual interviews being the main tools involved in collecting, funnelling and clustering the regional digital needs (FIT EDIH, 2022). Therefore, an online survey, comprising four "Needs assessment questionnaires" - one for each type of targeted organizations (Manufacturing, e-Health, LPAs, SMEs) - was launched and is available (on ongoing bases) on FIT EDIH website (https://digitalinnovationhub.fit/). This article reports and discusses the first results of the online survey, with data collected between 1.07.2023 and 1.11.2024.

The goal of the survey was to enable FIT EDIH to identify and understand the specific digital needs the organizations (SMEs and LPAs) in the Centru Region, Romania have; this includes finding the competitiveness related challenges they face (derived from the unproper integration/valorization of digitalization), and the expectations they have of a digital transformation process capable to successfully address the critical success factors. In this way, FIT EDIH will be able to more effectively tailor its service offerings - by refining and customizing both the content and communication - and therefore to substantially contribute not only to increasing the digital maturity level of the organizations in the Centru Region, Romania, but also to improving their overall competitiveness.

For the purposes of this article, five questions have been selected from the four questionnaires, as follows:

(1) to diagnose the organizations' current state of digitalization and find out what their overall approach to digital transformation is – the questions are:

Q1: "For carrying out daily activities in your organization, you mostly use:"; and

Q2: "If considering your organization, the digital transformation process:".

The first question, a single-answer one, serves as a quick test to assess how familiar the surveyed organizations (and their employees) are with using technology on daily basis; the answers cover three generic tools: *Paper, Office Suite (e.g., Word, Excel)*, and *Cloud/Platforms (e.g., ERP, CRM)* – roughly indicative for three major levels of digital integration (N.B. the provided response options are slightly different across the four questionnaires, to allow sector-specific analysis – e.g., *Specific Public Institution-Dedicated Applications* for LPAs or *Excel* for e-Health).

The second question, also a single-answer one, aims at understanding the organizations' approach to digital transformation – i.e., if they already started the process or not; if yes – how the process is unfolding – planned/structured or more like on an ad-hoc basis/unstructured; if not – how they envision and relate to the digital transformation of their organizations – as a strategic imperative (urgently calling for planning, structure, and action), as something to be done eventually (when specific combinations of internal and external factors will ask for), or as something not needed and/or not understood in terms of value added for the organization (N.B. the provided response options are identical across the four questionnaires).

(2) to understand the organizations' needs in terms of both technologies/applications of interest in the near future and organizational areas where digital transformation is most needed and useful – the questions are:

Q3: "The technologies/applications of interest to your organization in the near future (1-3 years) are:"; and

Q4: "The departments/areas where digital transformation is most necessary and useful for your organization are:".

The third question, a scale-based one, intends to find out which digital technologies/applications are most in-demand across the four sectors, as well as to inform respondents/organizations about the (availability and usability of the) most popular digital technologies/applications. A list of more than a dozen digital technologies/applications (varying from basic to advanced) was provided, each with a hover-over text that offered an explanation, clarification or example – e.g., "*Company social media page* – on Facebook, Twitter, LinkedIn, Instagram, to advertise the business and disseminate news about it"; "*Cybersecurity solutions* – tools designed to increase the security of the organization's IT infrastructure"; "*Additive manufacturing systems* – creating complex products through 3D printing". To measure the level of interest for each technology/application, the respondents were asked to rate them on a four-points scale (*Not at all - To a small extent - To a moderate extent - To a great extent*). (N.B. the provided technologies/applications are slightly different for LPAs, to allow sector-specific analysis – e.g., "*Creating/intensifying the social media footprint for better communication with citizens*").

The fourth question, a multiple-answer one, soughs to get insights into which organizational areas/departments are perceived as the most critical digitalization wise / for digital transformation. Restricting the answers to three choices (out of nine – for Manufacturing, e-Health, and SMEs – or eight – for LPAs) is allowing respondents to prioritize the organizational areas/departments in terms of the inefficiencies/bottlenecks they create because of their lack of digitalization, as well as in terms of the perceived improvement potential/efficiency gains the digitalization of these areas may bring. The technologies listed (and the explanations/examples provided) in the previous question may help the respondents in their assessments and rankings (by also considering the contribution of some previously neglected/unknown technologies/applications).

(3) to assess the organizations' interest in the services provided by FIT EDIH to support digital transformation - by main categories – the question is:

Q5: "To what extent are the following categories of services - provided by FIT EDIH to support the digital transformation - useful for your organization?".

The fifth question, a scale-based one, serves both as corollary (from the respondents' perspective) and guidance (from the FIT EDIH's perspective). Asking the respondents to rate the four generic categories of services (*Identify suitable technology providers; Test technologies before investment; Develop digital skills; Support for access to finance*) on a four-points scale (*Not at all - To a small extent - To a moderate extent - To a great extent*) will equipe them with actionable steps to be followed once their exercise on thinking about digitalization will be over (the questionnaire will be submitted). On the other hand, finding out which service categories respondents/organizations find most relevant/beneficial will help FIT EDIH to prioritize offerings that align with their needs and optimize its impact on regional digitalization / digital transformation efforts while fostering tailored innovation pathways.

3. Data Analysis and Results

A total of 321 questionnaires (representing 321 distinct organization) were filled out and submitted between 01.07.2023 and 01.11.2024. The distribution of responses by organization type is as follows: Manufacturing (93), E-Health (38), Smart City - Local Public Authorities (LPAs) (45), and Smart City - SMEs (145).

3.1. Organizations' Current State of Digitalization and Their Overall Approach to Digital Transformation

The first set of analysis examines the **resources/tools** that are most commonly used by the organizations in the four sectors to carry out daily tasks and processes. It is based on the distribution of responses to *Q1: "For carrying out daily activities in your organization, you mostly use:"* (N.B. to capture the unique characteristics of each sector, the response options provided varied slightly – e.g., *paper-office package-cloud/platforms* for Manufacturing, *paper-excel-cloud/platforms* for e-health) **(Figure 1)**.

Figure 1. Most used tools for carrying out daily activities (%)
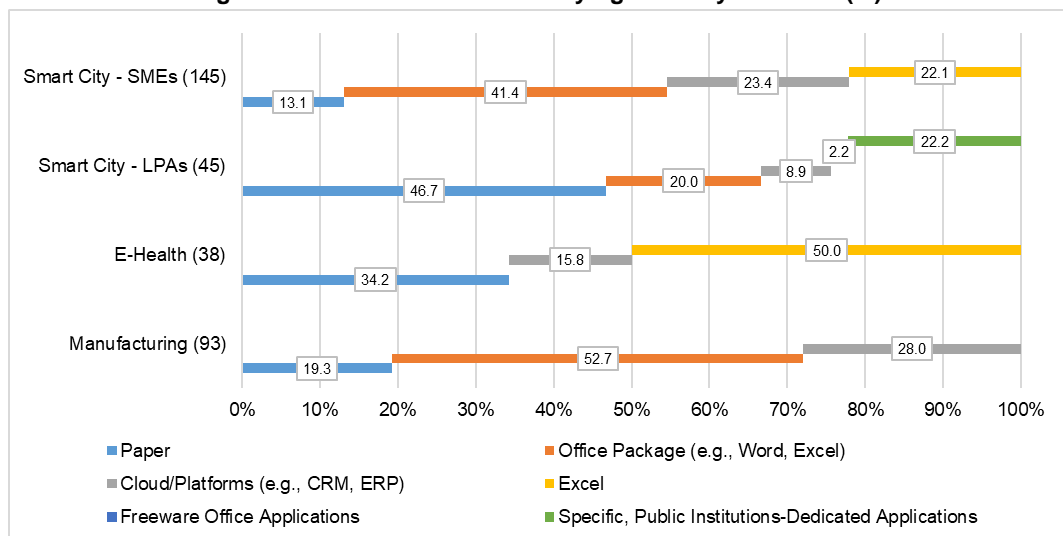
As shown in Figure 1, more than half of the respondents (49, or 52.7%) in **Manufacturing** organizations mainly use Office Package (e.g., Word, Excel), over a quarter of them (26, or 28.0%) prioritize the use of Cloud/Platforms (e.g., CRM, ERP) in their daily activities, while roughly two in ten (18, or 19.3%) still depend on Paper for carrying out their day-to-day activities. The results indicate that Manufacturing organizations prioritize basic productivity tools (Office Package) for daily operations, reflecting a focus on familiar solutions. However, a shift toward integrated digital technologies (Cloud/Platforms) is notable, indicating potential for upgrading. The continued use of Paper suggests either resistance to change or inefficiencies that could be improved with further digitalization. This

distribution highlights a sector in transition, where rather traditional tools coexist with emerging digital opportunities.

As for the **e-Health** sector, half of the respondents (19, or 50.0%) use Excel, just over a third of them (13, or 34.2%) still use Paper, while nearly one sixth (6, or 15.8%) use Cloud/Platforms. The results suggest that Excel is the dominant tool in the e-Health sector, most likely because of its extensive use for managing patient data and administrative tasks. The relatively high reliance on Paper indicates a slow pace of digital transformation, with health organizations still reluctant to fully embrace advanced digital solutions, as reflected by the low adoption of Cloud/Platforms. This mixture highlights the sector's challenges in transitioning to more integrated solutions.

In the **LPAs**, on the other hand, nearly half of the respondents (21, or 46.7%) use Paper, a bit more than two in ten (10, or 22.2%) use Specific Public Institution-Dedicated Applications, another two in ten (9, or 20.0%) use Office packages (paid), almost one in ten (4, or 8.9%) use Cloud/Platforms, and a very small minority (1, or 2.2%) use Freeware Office Applications. The results indicate that Paper remains the dominant medium/tool in LPAs, highlighting a delay in digitalization compared to other sectors. The use of Specific Public Institution-Dedicated Applications and Cloud/Platforms (31.1% combined) suggests both efforts and progress in adopting advanced digital solutions. Office Packages (paid and free) are used by a relatively low segment of organizations (22.2% combined), reflecting slow progress toward digital integration in LPAs' daily operations.

As regards the **SMEs**, about four in ten respondents (60, or 41.4%) use Office Package, and slightly more than two in ten (32, or 22.1%) use Excel, almost one quarter (34, or 23.4%) use Cloud/Platforms, while just over one in ten (19 or 13.1%) rely on Paper. The results show that Office Packages and Excel are the most commonly used tools in SMEs (63.5%), reflecting the sector's preference for affordable, easy-to-implement solutions. Cloud/Platforms adoption is notable but could be higher, given the benefits they may provide in scalability and data management. The relatively low reliance on Paper indicates that SMEs are progressing more quickly in digital adoption compared to other sectors, suggesting an increasing openness to integrated, digital solutions.

The next analysis explores how the organizations in the four sectors **approach the digital transformation process**, based on the distribution of responses to *Q2: "If considering your organization, the digital transformation process:"* (N.B. same response options were provided, regardless of the sector) (**Figure 2**).

Figure 2 reveals that in less than a third (32.3%) of the **Manufacturing** organizations the digital transformation process has started – for about two in ten (20, or 21.5%) the process being rather unstructured (taking place ad hoc, in reaction to various perceived opportunities/threats), while for only about one in ten (10, or 10.8%) the process being carried on based on a comprehensive and coherent plan. However, a significant segment of respondents (26, or 27.9%) exhibits a sense of urgency towards the digital transformation process and admits the need for a structured approach - when answering that the digital transformation process "is necessary and should be initiated urgently (this year) - based on a comprehensive and coherent plan". About a similar portion (30.1%) declare either that the process will be addressed "on a case-by-case basis - depending on perceived concrete needs and available resources" (22, or 23.6%), or that "it's necessary, but it's not urgent" (6,

or 6.5%). The remaining one tenth of respondents (9, or 9.7%) do not understand the process's relevance ("I don't know what or how it could help us"). The results suggest that many manufacturing organizations are in the early stages of digital transformation, with a significant portion adopting unstructured, reactive approaches due to resource constraints or a lack of strategic planning. Despite this, a notable segment recognizes the need for urgency and a structured plan, while others prefer a more gradual, need-based approach. The remaining respondents may lack sufficient understanding of digital transformation's benefits, indicating potential knowledge gaps or resistance to change within the sector.

Figure 2. Organizations' approach to digital transformation (%)
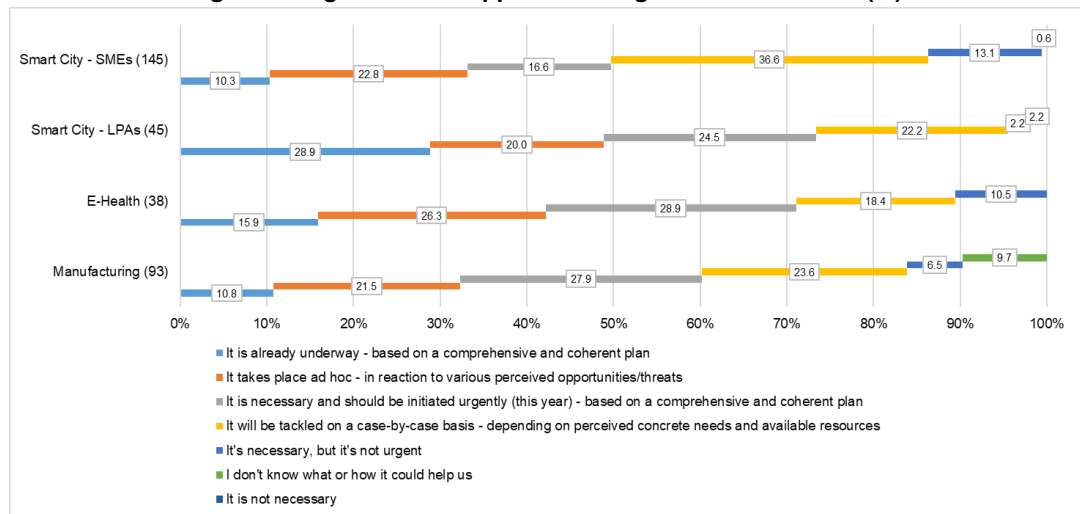
If considering the **(e-)Health** sector, about four in ten respondents (42.2%) indicate that the digital transformation process has started in their organizations – either as a planned process (6 respondents, or 15.9%), or unstructured (10, or 26,3%). Another three in ten respondents (11, or 28.9%) feel the process as being necessary and urgent, while a similar segment (28.9%) declare either that the process will be "tackled on a case-by-case basis - depending on perceived concrete needs and available resources" (7, or 18.4%), or that "it's necessary, but it's not urgent" (4, or 10.5%). The results indicate that in the e-Health sector, digital transformation has begun in a significant portion of organizations, but with a mix of structured and unstructured approaches. While many respondents recognize the necessity and urgency of digital transformation, others prefer addressing it on a case-by-case basis or view it as important but not urgent. This variation suggests differing priorities, resource availability, and organizational readiness for comprehensive, strategic digital transformation.

Almost a half of respondents (21, or 48.9%) in **LPAs** claim that the digital transformation process has started in their organizations – with structured actions prevailing (13 respondents, or 28.9%) over ad hoc initiatives (9 respondents, or 20.0%). Another quarter of them (11, or 24.5%) recognize the need and urgency of the digital transformation process, while another two in ten respondents (10, or 22.2%) declare they will take a case-by-case approach to it. The remaining portion (2 respondents, or 4.4%) is equally split between those considering the process necessary, but not urgent (1, or 2.2%) and those

that do not understand the process's relevance (1, or 2.2%). The results indicate that nearly half of respondents in LPAs report that digital transformation has started, with structured actions more common than ad-hoc initiatives. While many recognize the need and urgency for transformation, others prefer a case-by-case approach or consider it necessary but not urgent. A small portion either does not understand its relevance or sees it as unnecessary, highlighting varying levels of awareness and readiness across the sector.

As for the **SMEs**, near to a third of the respondents (48, or 33.1%) report that the digital transformation process has started in their organizations – with ad-hoc approaches prevailing (33, or 22.8%) over the planned ones (15, or 10.3%). About one-sixth of the respondents (24, or 16.6%) consider that the digital transformation process "is necessary and should be initiated urgently (this year) - based on a comprehensive and coherent plan". Over one third of the respondents (53, or 36.6%) declare they will opt for a case-by-case approach to the digital transformation process, while a little more than one-tenth (19, or 13.1%) consider the process necessary, but not urgent. Lastly, a small fraction of a percent (1, or 0.6%) argues that digital transformation "is not necessary". The results suggest that many SMEs have initiated digital transformation, but most are taking ad-hoc, reactive approaches due to limited resources or lack of comprehensive planning. While some respondents view it as urgent and necessary, a larger portion prefers addressing it based on specific needs and available resources. The small number who find it unnecessary may reflect a lack of understanding of its benefits or resistance to change.

3.2. The Path Towards Digital Transformation: Technologies of Interest and Critical Organizational Areas

The first set of analysis here examines the relevant **technologies/applications** that organizations are focusing on or planning to adopt in the near future as part of their digital transformation journey. It is based on the distribution of responses to *Q3: "The technologies/applications of interest to your organization in the near future (1-3 years) are:"* (N.B. 1. explanations and/or examples were provided for each suggested technology/application, to ensure proper understanding – e.g., for IT infrastructure: *internet, local servers, workstations, internal network*; 2. for the LPAs, the response options provided in terms of technologies/applications are slightly different, to capture the sectors' characteristics – e.g., *Internal portal and city manager applications*) **(Figure 3)**.

As highlighted in Figure 3, for the **Manufacturing** organizations, the proposed technologies/applications can be grouped, considering their relevance, into the following categories: **(a)** high interest technologies/applications - critical for the organizations in the near future (above 70% of respondents indicating moderate to great extent interest) - namely *IT Infrastructure* (79.6%) - essential for supporting digital operations and ensuring scalability, security, and efficiency, *Company Website* (76.3%) - key for improving online presence, customer engagement, and digital marketing, *Company Social Media Page* (73.1%) - crucial for building brand awareness and engaging with customers; **(b)** moderate interest technologies/applications – that are important but less urgent (above 50% but below 70% of respondents indicating moderate to great extent interest) – namely *Tools for Remote Work* (62.4%) - necessary for maintaining productivity and team connectivity in hybrid work

environments, *Data Management Systems* (61.3%) - key for improving operational efficiency, forecasting, and strategic planning, *Computer-Aided Design* (55.9%) - important for designing products and prototypes in manufacturing, *Cybersecurity Solutions* (55.9%) - critical for protecting digital infrastructure and sensitive data from cyber threats, *Cloud Technologies* (54.8%) - offering scalability and flexibility, supporting data storage and remote work, *Robots and Automated Machines* (54.8%) - helping to reduce labor costs and improve production efficiency in manufacturing; **(c)** emerging interest technologies/applications **–** that are still in the exploratory phase (above 40% but below 50% of respondents indicating moderate to great extent interest) – namely *Internet of Things (IoT)* (49.5%) - which improves manufacturing processes through real-time monitoring and predictive maintenance, *Internal Portal for Employee Issues* (45.2%) - that enhances employee productivity and satisfaction by streamlining administrative tasks, *Simulation and Digital Twin* (40.9%) - which creates virtual replicas of physical assets for analysis and performance optimization, *Big Data & Data Analytics* (40.9%) - which helps in leveraging large data sets for more informed decision-making; **(d)** low interest technologies/applications **-** seen as experimental or long-term (below 40% of respondents indicating moderate to great extent interest) – namely *Artificial Intelligence* (34.4%) - viewed maybe as a future technology due to complexity, cost, and uncertain return on investment, *Additive Manufacturing systems* (29.0%) - primarily used for prototyping and small-scale production, but with limited mainstream adoption, *Augmented Reality (AR) / Virtual Reality (VR)* (25.8%) - valuable for training or simulation but not widely adopted due probably to cost and hardware requirements, *Blockchain* (19.4%) - seen as a niche technology with limited application in manufacturing for now.

Figure 3. Technologies/applications of interest in the near future (1-3 years) (%)
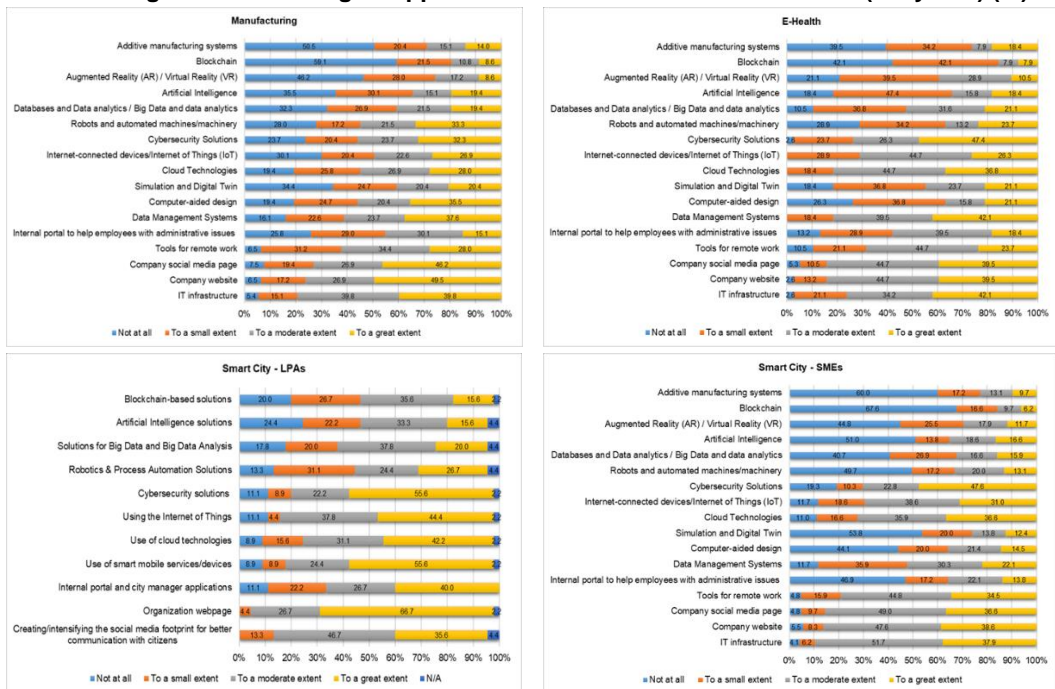
For the organizations in the **E-Health** sector, the proposed technologies/applications can be grouped, considering their relevance, into the following categories: **(a)** high interest technologies/applications - critical for the e-health sector in the near future (above 80% of respondents indicating moderate to great extent interest) – namely *Company website* (84.2%) - vital for patient engagement, information dissemination, and providing online health services, *Company social media page* (84.2%) - crucial for building brand presence, educating patients, and enhancing communication, *Data Management Systems* (81.6%) - essential for organizing and securing vast amounts of patient data to improve decision-making and care, *Cloud Technologies* (81.6%) - providing scalable solutions for data storage, remote access, and efficient patient care management; **(b)** moderate interest technologies/applications – that are important but not immediately urgent (above 60% but below 70% of respondents indicating moderate to great extent interest) – namely *IT Infrastructure* (76.3%) - forming the backbone of digital health services, ensuring operational efficiency and secure access to health data; *Cybersecurity Solutions* (73.7%) - critical for safeguarding sensitive patient data and ensuring compliance with healthcare regulations, *Internet-connected devices/Internet of Things (IoT)* (71.1%) - improving patient monitoring, diagnostics, and care coordination through connected devices, *Tools for remote work* (68.4%) - important for telemedicine, virtual consultations, and remote patient management, supporting a flexible healthcare environment; **(c)** emerging interest technologies/applications – technologies being explored for potential value (above 40% but below 60% of respondents indicating moderate to great extent interest) – namely *Internal portal to help employees with administrative issues* (57.9%) - facilitating efficient administrative processes, improving employee productivity and experience, *Databases and Data Analytics / Big Data* (52.6%) - supporting decision-making, predictive analytics, and optimizing healthcare outcomes through data insights, *Simulation and Digital Twin* (44.7%) - allowing virtual modeling of healthcare systems and patients, helping improve treatment planning and operational processes; **(d)** low interest technologies/applications – seen as experimental or less relevant in the short term (below 40% of respondents indicating moderate to great extent interest) – namely *Augmented Reality (AR) / Virtual Reality (VR)* (39.5%) - useful for medical training and rehabilitation, but not yet widely adopted in routine healthcare practices, *Computer-aided design* (36.8%) - primarily used in the design of medical devices or equipment, with limited general application in e-health, *Robots and automated machines* (36.8%) - with some potential for surgeries and patient care, but still limited adoption due to cost and complexity, *Artificial Intelligence* (34.2%) - promising for diagnostics and operational efficiency, but in early stages of adoption, due to complexity and resource requirements, *Additive Manufacturing* (26.3%) - mainly used for medical device prototyping, with limited adoption in mainstream healthcare practices, *Blockchain* (15.8%) - emerging technology with potential for secure patient data management, but not yet widely implemented in the healthcare sector.

If looking at the **Smart City - LPAs** organizations, the proposed technologies/applications can be grouped, considering their relevance, into the following categories: **(a)** high interest technologies/applications - critical for the local public authorities in the near future (above 80% of respondents indicating moderate to great extent interest) – namely *Organization webpage* (93.3%) - essential for providing citizens with easy access to

government services, information, and updates, *Creating/intensifying the social media footprint for better communication with citizens* (82.2%) - key for improving communication with the public, fostering engagement, and disseminating information, *Using the Internet of Things* (82.2%) - helping improve city management through real-time monitoring of infrastructure, traffic, utilities, and public services, *Use of smart mobile services/devices* (80.0%) - supporting citizen access to services, improving operational efficiency, and encouraging citizen engagement through mobile applications; **(b)** moderate interest technologies/applications ‒ that are important but not yet at the forefront of immediate focus (above 60% but below 80% of respondents indicating moderate to great extent interest) – namely *Cybersecurity solutions* (77.8%) - crucial for protecting sensitive citizen data, government systems, and ensuring trust in digital services, *Use of cloud technologies* (73.3%) - providing scalability and flexibility for data storage, digital service delivery, and remote access for both staff and citizens, *Internal portal and city manager applications* (66.7%) - improving internal communication, administration, and decision-making within local authorities for more efficient management; **(c)** emerging interest technologies/applications ‒ technologies that are still in the exploration phase for potential applications (above 50% but below 60% of respondents indicating moderate to great extent interest) – namely *Solutions for Big Data and Big Data Analysis* (57.8%) - helping in better decision-making, improving services, and resource allocation by analyzing large datasets generated by the city, *Robotics & Process Automation Solutions* (51.1%) - enhancing public service efficiency, reducing costs, and automating routine tasks within local authorities, *Blockchain-based solutions* (51.1%) - having potential for secure, transparent public records management, contracts, and citizen engagement, though not yet widely adopted; **(d)** low interest technologies/applications ‒ seen as experimental or less relevant in the short term (below 50% of respondents indicating moderate to great extent interest) – namely *Artificial intelligence solutions* (48.9%) - holding potential for predictive analytics, process automation, and decision support, but being still in an exploratory phase for public authorities.

As concerns the **Smart City – SMEs** organizations, the proposed technologies/applications can be grouped, considering their relevance, into the following categories: **(a)** high interest technologies/applications - critical for the SMEs in the near future (above 80% of respondents indicating moderate to great extent interest) – namely *IT Infrastructure* (89.7%) - essential for building a robust and scalable foundation to support business growth and digital transformation, *Company website* (86.2%) - vital for improving online presence, engaging customers, and facilitating e-commerce or service offerings, *Company social media page* (85.5%) - key for brand promotion, customer interaction, and digital marketing strategies; **(b)** moderate interest technologies/applications ‒ that are important but not immediately urgent (above 60% but below 80% of respondents indicating moderate to great extent interest) – namely *Tools for remote work* (79.3%) - necessary for maintaining business continuity and productivity in hybrid or remote work environments, *Cloud Technologies* (72.4%) - offering scalability, flexibility, and cost-efficiency, especially for SMEs looking to expand digital operations, *Cybersecurity Solutions* (70.3%) - crucial for safeguarding business operations, protecting sensitive data, and maintaining customer trust, *Internet-connected devices/Internet of Things (IoT)* (69.7%) - enhancing operational efficiency through real-time monitoring, predictive maintenance, and process automation;

(c) emerging interest technologies/applications ‒ technologies being explored for potential value (above 35% but below 60% of respondents indicating moderate to great extent interest) – namely *Data Management Systems* (52.4%) - important for organizing business data, streamlining decision-making, and improving overall operational efficiency, *Internal portal to help employees with administrative issues* (35.9%) - aiding in improving internal processes and enhancing employee experience by simplifying administrative tasks, *Computer-aided design* (35.9%) - relevant for product design and development in manufacturing SMEs, though less urgent for other sectors, *Artificial Intelligence* (35.2%) - used for automation and decision support, but still in the exploration phase due to complexity and costs; **(d)** low interest technologies/applications ‒ seen as experimental or less relevant in the short term (below 35% of respondents indicating moderate to great extent interest) – namely *Robots and Automated Machines* (33.1%) – with limited adoption due to high costs and complexity, but may becoming more relevant in manufacturing SMEs, *Databases and Data Analytics / Big Data and data analytics* (32.4%) - while valuable, SMEs may still be in early stages of data integration and analytics, *Augmented Reality (AR) / Virtual Reality (VR)* (29.7%) - niche technology, mostly used for training or customer engagement, with limited immediate use for most SMEs, *Simulation and Digital Twin* (26.2%) - primarily relevant in large-scale operations or manufacturing, with minimal immediate need for most SMEs, *Additive Manufacturing* (22.8%) - mostly for specialized use cases like prototyping, with limited application for SMEs outside of manufacturing, *Blockchain* (15.9%) - still emerging, with limited current practical applications in most SME operations, though it may hold future promise for secure transactions.

In connection with the above, the next analysis explores the **critical organizational departments/areas** that need attention for a successful digital transformation process – as perceived by the respondents. It is based on the distribution of responses to *Q4: "The departments/areas where digital transformation is most necessary and useful for your organization are:"* (N.B. for the LPAs, the response options provided in terms of are slightly different, to capture the sectors' characteristics) **(Figure 4)**.

Figure 4. Organizational areas where digital transformation is most necessary and useful (three options per respondent, frequency)
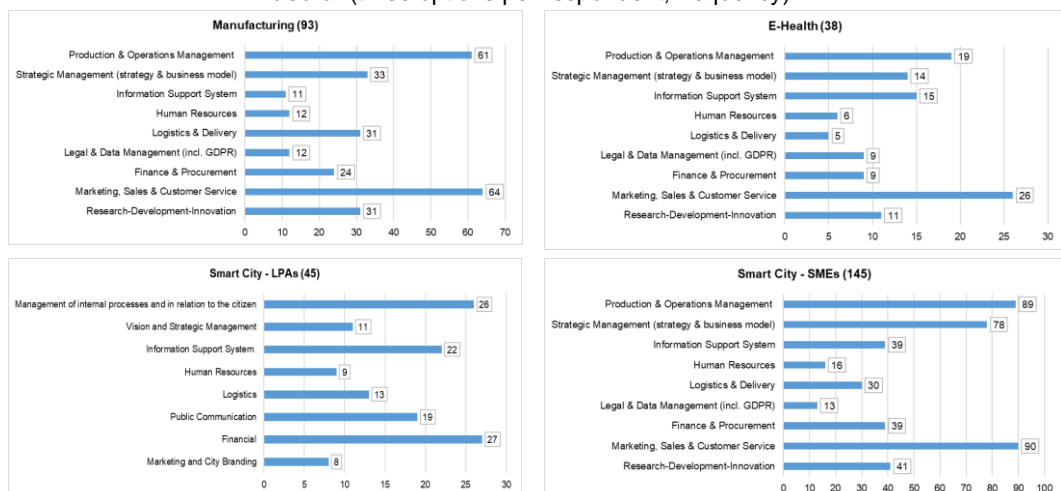
The findings in Figure 4 reveals that for the **Manufacturing** organizations: **(a)** high-priority areas for digital transformation (accounting for over 20% of responses each) are *Marketing, Sales & Customer Service* (22.9%) - indicating a strong need for digital tools to enhance customer engagement, sales, and marketing strategies - and *Production & Operations Management* (21.9%) - reflecting the focus on optimizing manufacturing processes and operations for efficiency and cost reduction; **(b)** moderately prioritized areas (receiving 10-15% of responses) are *Strategic Management (strategy & business model)* (11.8%) - highlighting the need for digital transformation to improve decision-making and business model adaptability, *Research-Development-Innovation* (11.1%) - suggesting a focus on using technology to enhance innovation and product development, and *Logistics & Delivery* (11.1%) - indicating a moderate need for digital tools to improve supply chain and delivery efficiency; **(c)** lower-priority areas (with less than 10% of responses) are *Finance & Procurement* (8.6%) - suggesting that while digital transformation is useful, it is not a top priority, *Legal & Data Management (incl. GDPR)* (4.3%) - reflecting a relatively low emphasis on digital tools for compliance and legal processes, *Human Resources* (4.3%) - indicating limited focus on digitizing HR functions, and *Information Support System* (3.9%) - suggesting this area is seen as less critical compared to others.

As for the **e-Health** sector: **(a)** high-priority areas for digital transformation (accounting for over 20% of responses) are *Marketing, Sales & Customer Service* (22.8%) - reflecting a significant need for digital tools to improve patient engagement, communication, and service delivery; **(b)** moderately prioritized areas (receiving 10-20% of responses) are *Production & Operations Management* (16.7%) - indicating the need for streamlining healthcare operations and optimizing service delivery, *Information Support System* (13.2%) - highlighting the importance of strengthening IT systems to support day-to-day healthcare operations, *Strategic Management* (12.3%) -suggesting a growing focus on using digital tools to enhance decision-making and organizational strategy; **(c)** lower-priority areas (with less than 10% of responses) are *Research-Development-Innovation* (9.6%) - reflecting moderate interest in leveraging digital tools for research and innovation in healthcare, *Finance & Procurement* (7.9%) - suggesting limited but relevant focus on digitizing financial and procurement processes, *Legal & Data Management* (7.9%) - indicating a relatively low priority for compliance and data management tools, *Human Resources* (5.3%) - showing minimal emphasis on digitizing HR functions in the sector, *Logistics & Delivery* (4.4%) - reflecting the lowest priority, as logistics is not a central concern for many E-Health organizations.

For the **Smart City - LPAs** organizations: (a) high-priority areas for digital transformation (accounting each for over 15% of responses) are *Financial* (20.0%) - reflecting the critical need to digitize financial systems and processes to improve efficiency, transparency, and compliance, *Management of Internal Processes and Citizen Relations* (19.3%) - highlighting the importance of streamlining internal workflows and improving digital interactions with citizens to enhance public services, *Information Support System* (16.3%) - indicating a strong focus on modernizing IT infrastructure and support systems to enable effective operations and communication; **(b)** moderately prioritized areas (receiving about 10-15% of responses) are *Public Communication* (14.1%) - suggesting the need for better communication platforms and tools to engage with the public, *Logistics* (9.6%) - indicating

interest in optimizing supply chain and logistics management to support LPAs operations; **(c)** lower-priority areas (with less than 10% of responses) are *Vision and Strategic Management* (8.1%) - highlighting the need for digital tools to support strategic planning and vision alignment, though it is not a top priority, *Human Resources* (6.7%) - indicating limited focus on modernizing HR processes in LPAs, *Marketing and City Branding* (5.9%) - suggesting that promoting the city or municipality through digital tools is not seen as a major area for transformation.

If considering **Smart City – SMEs** organizations: **(a)** high-priority areas for digital transformation (accounting for over 20% of responses) are *Marketing, Sales & Customer Service* (20.7%) - indicating a strong focus on improving customer engagement, sales processes, and marketing strategies using digital tools, and *Production & Operations Management* (20.5%) - reflecting a critical need for streamlining operations, automating processes, and optimizing production workflows; **(b)** moderately prioritized areas (receiving 10-20% of responses) are *Strategic Management (strategy & business model)* (17.9%) - highlighting the importance of using digital solutions for organizational strategy and decision-making to enhance competitiveness; **(c)** lower-priority areas (with less than 10% of responses) are *Research-Development-Innovation* (9.4%) - indicating some interest in leveraging digital tools for innovation and R&D efforts, *Finance & Procurement* (9.0%) - showing moderate focus on improving financial and procurement processes through digitalization, *Information Support System* (9.0%) - suggesting the need for enhanced IT systems, though it is not a top priority, *Logistics & Delivery* (6.9%) - reflecting limited emphasis on digitizing supply chain and delivery processes, *Human Resources* (3.7%) - indicating low priority for digitizing HR processes in SMEs, and *Legal & Data Management (incl. GDPR)* (3.0%) - suggesting compliance and legal processes are not seen as major areas for digital transformation.

### 3.3. Perceived need for FIT EDIH digitalization services

The analysis evaluates the (perceived) **need for** and **usefulness of FIT EDIH digitalization services** among potential beneficiaries, based on the distribution of responses to *Q5: "To what extent are the following categories of services - provided by FIT EDIH to support the digital transformation - useful for your organization?"* (**Figure 5**).

Considering the (four) **main categories of services** FIT EDIH is providing to support the digital transformation of SMEs (in Manufacturing, e-Health, and Smart City) and Public Sector Organisations (LPAs), the following findings in Figure 5 highlight the (perceived) **value/usefulness** of these services for the respondents:

In **Manufacturing** organizations, the greatest utility is given to the services in *Support for access to finance* category (97.8% of respondents expressing moderate to great interest) – which indicates a great interest for digitalization but also suggests that financial constraints are a significant barrier for manufacturing companies in enabling digital transformation, as it may call for large investments. *Testing technologies before investment* (91.4%) services category is also highly valued – which reflects a cautious and calculated approach to digital transformation, based on risk mitigation and informed decision-making. Less importance, but still at a very high level, is given to the services categories *Identify*

suitable technology providers and *Develop digital skills* (89.2% each) – which suggests a high need for guidance in identifying the right partners for digital technology adoption, on one hand, and a strong recognition of the importance of a digitally skilled workforce, on the other hand. However, a bit surprizing is that while the first three categories of services are valued each by more than 60% of respondents "to a large extent", the *Develop digital skills* category is only valued by less than 50% of the respondents (48.4%) "to a large extent", which may signal a nuanced dynamic in the manufacturing sector's priorities (e.g., more focus on technology than on people, or underestimation of skill gap).

Figure 5. Need for FIT EDIH digitalization services
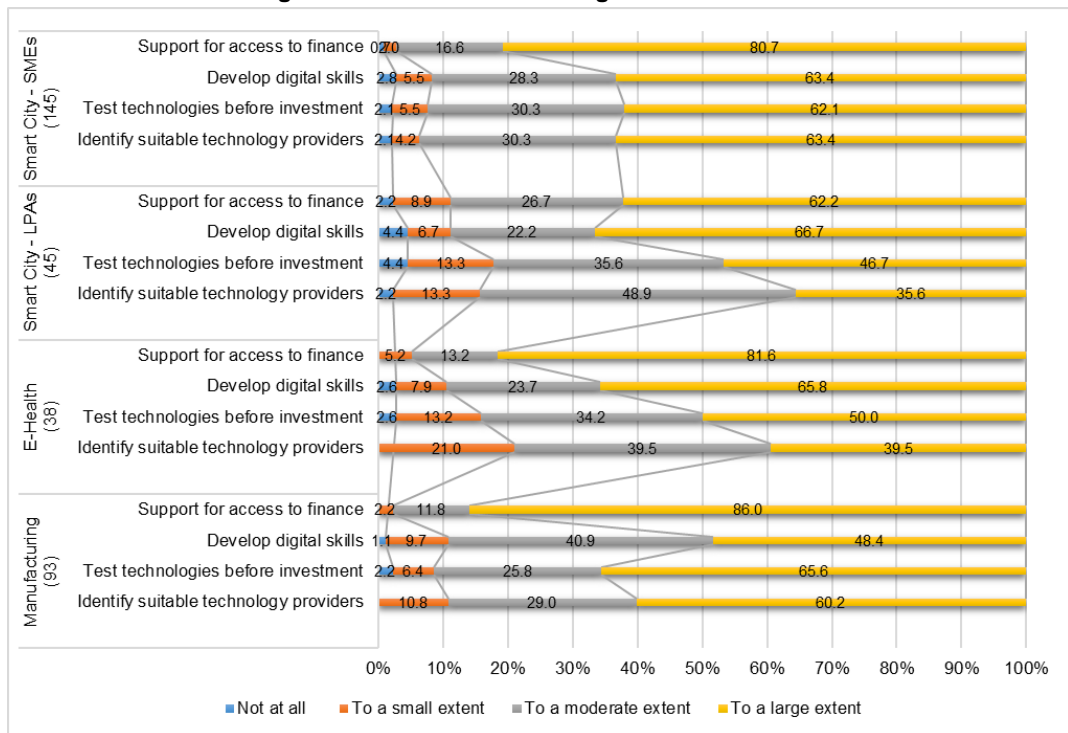
In **e-Health** organizations, the greatest utility is given to the services in *Support for access to finance* (94.7%) category – which highlights high awareness about the need for digital transformation, as well as high perceived importance of these types of services in overcoming resource limitations. *Develop digital skills* category of services also gets strong attention (89.5%) – which reflects the sector's growing need for human resources able to effectively leverage emerging digital technologies. Significant interest also gets *Test technologies before investment* (84.2%) category of services – which underscores the sector's need to ensure reliable adoption of digital technologies. The interest in *Identify suitable technology providers* (78.9%) category of services is slightly lower, with 21% expressing minimal interest – which could indicate a perceived mismatch between the sector's unique (niched and "standardized") needs and the "general" service offerings of some "new" digital technology providers.

In **Smart City - LPAs** organizations, the greatest utility is given to the services in *Develop digital skills* and *Support for access to finance* categories (88.9% each) – which underscores LPAs' need to build internal capabilities and secure resources for implementing smart solutions. The *Identify suitable technology providers* (84.4%) and *Test technologies before investment* (82.2%) categories of services also receive strong interest – which highlights the importance of informed decision-making in selecting and deploying digital tools. The relatively lower emphasis on the latter two categories of services could suggest that LPAs are more focused on ensuring their staff readiness (although the sector registers the largest portion of respondents - 4.4% -valuing "Not at all" the *Develop digital skills* category of services) and securing funding for digitalization, while the technology sourcing and testing processes may not be as rigorously prioritized (possibly due to pre-existing networks or context-specific barriers).

In **Smart City - SMEs** organizations, the greatest utility is given to the services in *Support for access to finance* category (97.2%) – which reflects the sector's reliance on funding to overcome financial constraints in adopting digital solutions. The services categories *Identify suitable technology providers* (93.8%) and *Test technologies before investment* (92.4%) also attract significant interest – which suggests high awareness about their capacity to help SMEs navigate complex technology landscapes and minimize risks in digital technologies' adoption decisions. Although with the lowest score, the *Digital skills development* (91.7%) category of services is of high value for SMEs – which underscores the importance these organizations give to employees' readiness in leveraging digital tools effectively.

4. Discussion and Conclusions

The results shed some light on the challenges and opportunities the four types of organizations in Centru Region - Romania face on their path towards digital transformation – an investigation area not tackled by previous research.

The quick test applied to assess the **current state of digitalization** (how familiar the surveyed organizations and their employees are with using technology on daily basis) revealed the following challenges and opportunities: for the Manufacturing organizations: their continued reliance on Paper (19.3%) indicates resistance to change and suggests inefficiencies; on the other hand, the shift toward Cloud/Platforms (28%) highlights potential for adopting integrated digital tools to streamline operations. For the E-Health organizations: their heavy reliance on Excel (50%) and Paper (34.2%) signals a slow pace of digital transformation; although, the adoption of Cloud/Platforms (15.8%) is an opportunity to modernize both patient data management and administrative tasks. For the LPAs organizations: dominance of Paper (46.7%) underscores significant digitalization delays; on the brighter side, the use of Specific Public Institution-Dedicated Applications and Cloud/Platforms (31.1% combined) signals progress in digital integration. For the SMEs organizations: the moderate Cloud/Platforms use (23.4%) limits scalability and efficiency; however, low Paper reliance (13.1%) and increasing adoption of digital tools signal readiness for further digital transformation.

The analysis of the organizations' overall **approach to digital transformation** allowed for the following challenges and opportunities to be identified: for the Manufacturing organizations: predominance of unstructured and reactive approaches (due to limited strategic planning and resource constraints); lack of awareness in some organizations (which hampers progress); recognition of the urgency to adopt structured, comprehensive plans creates a pathway for advancing digital transformation. For the E-Health organizations: varied readiness levels, with some organizations hesitant to commit to digital transformation or viewing it as non-urgent; reactive approaches, impeding cohesive progress; recognition of necessity and urgency provides momentum for adopting strategic and tailored digital solutions. For the LPAs organizations: reliance on ad-hoc efforts and uneven awareness across organizations (which delays transformation); persistence of resource and knowledge gaps; potential for sector-wide progress (signalled by the expressed sense of urgency and need to adopt structured approaches). For the SMEs organizations: reactive and need-based approaches dominate, reflecting resource constraints and limited strategic foresight; recognition of urgency among some organizations offers a chance to promote scalable and efficient digital transformation solutions.

On understanding the **organizations' needs** in terms of both technologies/applications of interest in the near future and organizational areas where digital transformation is most needed and useful – the following results are worth mentioning: The **high interest technologies/applications**, critical in the near future (as perceived by respondents) are: for the Manufacturing organizations: *IT Infrastructure*, *Company Website*, and *Company Social Media Page* (above 70% of respondents indicating moderate to great extent interest in each); for the organizations in the E-Health sector: *Company website*, *Company social media page*, *Data Management Systems*, *Cloud Technologies* (above 80%); for the Smart City - LPAs organizations: *Organization webpage*, *Creating/intensifying the social media footprint for better communication with citizens*, *Using the Internet of Things*, *Use of smart mobile services/devices* (above 80.0%); for the Smart City – SMEs organizations: *IT Infrastructure*, *Company website*, *Company social media page* (above 80%). On the other hand, the **high-priority areas** for digital transformation (as perceived by the respondents) are: for the Manufacturing organizations: *Marketing, Sales & Customer Service* and *Production & Operations Management* (accounting for over 20% of responses each); for the e-Health organizations: *Marketing, Sales & Customer Service* (over 20%); for the Smart City - LPAs organizations: *Financial*, *Management of Internal Processes and Citizen Relations*, and *Information Support System* (over 15%); for the Smart City – SMEs organizations: *Marketing, Sales & Customer Service* and *Production & Operations Management* (over 20%).

On assessing the organizations' **interest in the services provided by FIT EDIH** to support digital transformation (by main categories) – the following results are worth mentioning: the greatest utility (as perceived by the respondents) have the following: for the Manufacturing organizations: *Support for access to finance* and *Testing technologies before investment* (over 80% of respondents expressing moderate to great interest for each); for the e-Health organizations: *Support for access to finance* and *Develop digital skills* (over 89% each); for the Smart City - LPAs organizations: *Develop digital skills* and *Support for*

access to finance (over 88% each); for the Smart City - SMEs organizations: *Support for access to finance* and *Identify suitable technology providers* (over 93% each).

In terms of **contributions/implications**, the study **advances research** by contributing to the understanding of digital transformation priorities in less explored regions (Centru Region, Romania) and sectors (manufacturing, e-health, and smart city). Moreover, by distinguishing between LPAs and SMEs within the Smart City concept, on the one hand, and between Manufacturing (SMEs) and Smart City – SMEs, on the other hand, allowed the study to provide more valences of value to the analysis, while better capturing the specificities and context dependencies of the different organization types in their paths towards digital transformation. **Practically**, the study supports organizations in prioritizing digital transformation (by identifying sector-specific technologies/applications, as well as critical organizational areas for targeted digitalization efforts), informs technology providers about sector-specific needs, and enables FIT EDIH (and/or similar actors) to offer targeted support, thereby fostering regional innovation and accelerating digital adoption. For **policymakers** (at regional, national and European levels), the study provides data-driven insights to prioritize investments (by allocating funding to critical areas, to maximize their impact on regional digitalization), design evidence-based digital strategies (that address the unique digital transformation needs of diverse sectors and organization types), and foster public-private collaboration (between public authorities, SMEs in different industries, and digital innovation hubs to accelerate digital transformation at the regional level).

As for the **limitations** of the study, they are mainly due to the business (rather than academic) nature of the empirical research performed – i.e., focus on practicality over theory (leading to inconsistencies in the questionnaires' design, in order to accommodate different professional languages/jargons); restricted scope of inquiry (leading to a narrow focus on practical issues, while overlooking systemic and/or complex analyses); lack of sample representativeness (leading to difficulties in generalizing the findings to a wider population); potential response biases (leading to inaccurate responses, that may have altered the results). Future research may address these limitations.

Acknowledgement

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