SME Digitization: How do Micro, Small, and Medium-Sized Firms Digitize

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Abstract

Information technology (IT) and digitization have profoundly transformed the economy. However, research on the IT implementation of small and medium-sized enterprises (SMEs), a key component of the economy, is limited or treats all SMEs as homogeneous. This paper studies how SMEs are differentially digitizing by analyzing their digitization architecture. We apply clustering to find interesting observations on the digitization architecture of over 60,000 micro, small, and medium-sized businesses in the United States. The preliminary results shed light on the digital architecture of SMEs, the differences in digitization among SMEs, and inform the digital technology suppliers that cater to SMEs.

Keywords

Digitization, SMEs, IT implementation, IT architecture.

Introduction

Digitizing businesses has profoundly transformed the economy (Brynjolfsson et al., 2021). The pandemic accelerated this trend (Nadella, 2020), especially for smaller businesses (Mandviwalla & Flanagan, 2021). Small and medium-sized enterprises (SMEs) are an important part of the global economy and increasingly rely on IT (Hanadi & Aruna, 2013). However, most Information Systems (IS) research on digitization has concentrated on larger corporations, with only a few studies focusing on SMEs (Premkumar, 2003). In the last few years, studies on SME digitization have emerged in management and other fields (Becker & Schmid, 2020; Canhoto et al., 2021; Kilimis et al., 2019; Marcysiak & Pleskacz, 2021). However, the black box of digitization is hardly ever removed; we take an architectural view to better understand it. To the best of our knowledge, no other research has studied the disparities in the digitization of SMEs from an architectural standpoint, which is the primary focus of this study. Moreover, the existing literature typically treats SMEs and their technology implementation and use as homogeneous (Hönigsberg et al., 2022). In contrast, (Mandviwalla & Flanagan, 2021) show that different types of SMEs differ from one another in their digitization. Therefore, our research aims to identify how SMEs are implementing digitization. Specifically, what is the digitization architecture of SMEs? Is it the same across all SMEs, or does it vary?

To answer these questions, we investigate the extent of technology implementation and its impact on the revenue of over 60,000 micro, small and medium-sized enterprises in the United States. This research is significant because if a particular type of technology is implemented differently in micro versus medium-sized firms, it will impact the applicability and generalizability of SME digitization research. In particular, the discussion of architecture enables new possibilities for future research and theory development. Next, we present the theoretical background related to SMEs, SME digitization architecture, and apply clustering to analyze the extent of digitization in micro, small, and medium-sized businesses.

Theoretical Background

SMEs

As of 2021, there are 32.5 million SMEs in the United States, accounting for 99.9% of all enterprises in the country (SBA, 2021). Research has found that small and large businesses have diverse organizational structures, employees, IT budgets, and architectures. Zaridis & Mousiolis (2014), for example, stated that SMEs have a relatively limited number of employees and a simpler organizational structure compared to larger firms. Decisions in SMEs are often concentrated in the hands of a few individuals, unlike the many layers of larger firms. While this may provide flexibility and agility, it may also lead to a lack of long-term planning (Ates et al., 2013), especially in implementing technology architecture, such as the optimal mix of technology implementation. Furthermore, there are differences in the literature on distinguishing micro, small, and medium-sized firms from one another. For example, some characterize small firms as those with fewer than 500 employees (Longenecker et al., 2013); others define medium-sized firms as those with 50-250 employees (Berisha & Pula, 2015). Perhaps because of the above challenges, existing literature typically treats SMEs and their technology implementation and use as homogeneous (Hönigsberg et al., 2022). This is a problem in understanding SME digitization. Especially since the accelerated focus on digital transformation during the pandemic showed that smaller business digitization is different from larger firms and amongst small firms of various sizes (Mandviwalla & Flanagan, 2021), in this paper, we step back and focus on the differences among the architectures needed to achieve successful digitization in SMEs and whether these differences also operate differentially in micro, small, and medium-sized firms.

IT Architecture

IT architecture has been extensively studied in IS, such as layering, modularity, and re-programmability (Yoo et al., 2010), and in the context of digital transformation and innovation such as social, mobile, analytics, cloud, and Internet of Things (SMACIT) (Sebastian et al., 2017), and key digital technologies (Vial, 2019). However, the focus has been primarily on larger firms. For example, applying modularity principles to mapping the IT architecture allows larger companies to break down processes into fine-grained functional units that can be recombined to build a new process (Tafti et al., 2013). Yet, it is unclear if it is fine-grained modularity or something else that will improve our understanding of how architectures drive successful SME digitization and what this digitization looks like. Moreover, it is also unclear if standard function-based classifications (e.g., software, hardware) are relevant. These default classifications will focus on basic technologies such as printers rather than interesting architectural patterns that drive SME digitization. Therefore, in the next section, we focus on the architecture of SME digitization.

Digitization architecture

To investigate how SMEs implement digitization, we integrate prior research to characterize *digitization architecture* (see Figure 1). The digitization architecture is based on the layered architecture of (Yoo et al., 2010), SMACIT of Sebastian et al. (2017), and the building blocks of the digital transformation process of Vial (2019). In the context of digital innovation and transformation, Yoo et al. (2010) categorize technology architecture into four layers: *device*, *network*, *service*, and *content*. The *device* includes a physical-mechanical layer (e.g., hardware) and a logical-capability layer (e.g., operating system). The logical capability layer connects the physical-mechanical layer to other levels. The physical transport layer (cables, radio spectrum) and the logical transport layer (e.g., TCP/IP) are both parts of the *network* layer. The network and device layers provide the infrastructure to achieve digitization. The *service* layer includes digitization applications. Preliminary analysis shows that services, including software, account for about 73% of SMEs' IT budgets. Therefore, to investigate this critical layer, we further decompose the service layer into SMACIT. SMACIT technologies are typically associated with digital innovation and transformation by scholars (Legner et al., 2017). Finally, based on Vial (2019), we add platform and enterprise software to include the building blocks of digital transformation. Data such as text, sound, photos, and videos are exchanged under the *content* layer. We excluded the content layer, given our focus on architecture. Moreover, the extensive capabilities of software today make it impractical to separate items such as text and images.
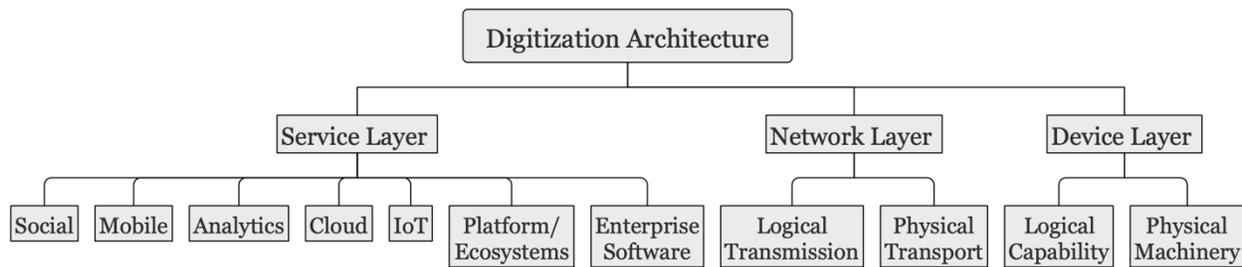
Figure 1. Digitization Architecture

Note that some of the technologies listed in the service layer, such as cloud computing, also have a network aspect, while IoT has a hardware aspect. However, what is interesting about these technologies from the digitization perspective is their ability to 'servitize' (Lusch & Nambisan, 2015) rather than their role as standalone hardware or software. In other words, even though these technologies incur an individual cost on the respective budget line, it is how they create business value that impacts digitization. Overall, the three layers of device, network, and service separate and identify the architectural design levels to achieve the modularity and re-programmability associated with digitization and transformation (Yoo et al., 2010).

Methods

Data

We use the Computer Intelligence Technology Database (CITDB) to investigate SME digitization. CITDB, used in prior IS research (Cheng et al., 2021), includes IT implementation and revenue data on SMEs in the United States. This paper focuses on the extent of technology implementation and the revenue of 60,284 SMEs in 2020.

Segmentation of SMEs

In the US Small Business Administration, all organizations under 500 employees are often characterized as SMEs (SBA, 2021). However, we posit that firms with only a few employees will implement digitization differently than ones with several hundred employees. We reviewed previous literature on the segmentation of SMEs and adopted an approach that is most used in the US rather than Europe or Australia context. We use the number of employees to delineate SMEs, in which a micro firm is 1-9 employees, a small firm is 10-99 employees, and a medium-sized firm is 100-499 employees.

Clustering

For each company, we counted the percentage of sites with a particular technology installed and further aggregated them according to the segmentation of companies. We then average the rate within each digital technology category in the architecture. We performed K means clustering with K=3, which helped identify the characteristics of IT implementation in each segment of companies. We checked the maximum installation rate in each IT category and divided it by 3 to calculate the threshold for low, medium, and high installations, thus classifying the company's IT implementation into low, medium, and high.

Findings

The clustering approach resulted in large between-group differences and small within-group differences, which helped us to explore the differences among SMEs. We extracted the patterns revealed by clustering and summarized the SMEs into three groups: **digital laggards** (low-level implementation in most categories), **digital leaders** (high-level implementation in most categories), and **digital analyzers** (high-level implementation in analytics and cloud solutions).

	Cluster	Service							Network		Device		Count	%
		social	mobile	enterprise	analytics	cloud	platform	IoT	logical	physical	logical	physical		
Medium	1	M	M	L	L	L	L	L	L	L	L	L	11768	73
	2	H	H	H	H	L	H	H	H	H	H	H	5487	22
	3	M	M	M	H	H	L	L	L	L	M	M	1136	5
Small	1	M	M	L	L	L	L	L	L	L	L	L	28984	84
	2	H	H	M	M	L	H	H	H	H	H	H	4162	12
	3	L	L	L	H	H	L	L	L	L	L	L	1434	4
Micro	1	M	M	L	L	L	L	L	L	L	L	L	1417	76
	2	H	H	H	H	L	H	H	H	H	H	H	307	17
	3	L	L	L	H	H	L	L	L	L	L	L	129	7

Table 1. IT Implementation among SMEs

Specifically, cluster 1 in medium-sized companies (73%), small companies (84%), and micro-companies (76%) have similar IT implementation, showing that most SMEs are still at a low level of IT implementation in the network layer, most of the service layer, and the device layer – we call this the digital laggards. Cluster 2 in medium-sized companies (22%), small companies (12%), and micro-companies (17%) have similar IT implementation, showing that several SMEs have a high level of IT implementation, especially in the network and device layer. Though, even in this digital leaders cluster, they generally have a low-level use of cloud technology. Also, small companies with high implementation have lower enterprise software and analytics technologies. Finally, a minor portion of SMEs (Cluster 3) focuses on the use of analytics and cloud technology, but the installation rate of other technologies is low – we call this cluster the digital analyzers. Among them, medium-sized companies focus more on the device layer and some other services. For companies to be resilient, they may have to have a baseline of technical competence or knowledge. We use these labels to imply that leaders may take advantage of first movers and that laggards may suffer from effective use of technology, while we remain more curious about analyzers, which will be one of the focuses of future research.

Further, to explore opportunities for further study, we also investigate how the characteristics of different SMEs' digitization impact firm performance. We extended the clustering approach by incorporating revenue – further differentiating micro, small, and medium-sized enterprises based on high- or low-level revenue and clustering again. The results reveal that medium-sized companies with greater revenues have a higher installation of technologies in the device and network layer, as well as in enterprise software, analytics, platforms, and IoT in the service layer. In contrast, small-sized and micro-sized companies with greater revenues have a higher installation of technologies in all categories except for the cloud. This suggests that smaller firms may need a broader scope for their digitization than medium-sized companies.

Conclusion and Research Plan

Overall, our study provides novel evidence about SMEs' digital architecture. The preliminary findings reveal that the digitization architecture of SMEs is not homogenous and varies amongst different groups of firms. While most SMEs (digital laggards) have low levels of digitization, there is a leading group (digital leaders) that implements all but cloud technologies at a high level, and a group (digital analyzers) that focuses highly on cloud technologies and analytics only. Further investigation of the conditions (e.g., industry, location, and environment) under which companies that fit into these groups operate will help us understand why and how they are digitizing. These results can contribute toward developing a comprehensive theory of how SMEs digitize. Further, our findings suggest that while medium-sized firms can be more judicious in picking areas of digital growth, small and micro firms may need a broader scope. The findings also have implications for practice. The results can benchmark and identify best practices for digitization. Moreover, technology providers can fine-tune their offerings on lagging and/or growth indicators. For instance, an SME trending towards becoming a digital analyzer will have complementary needs in cloud and analytics. In the next steps, we expect to further refine and improve our work by:

1. Identifying and accounting for limitations in the scope of data and considering the inclusion of additional data sources to support the research.
2. Expanding the interpretation and analysis of results and how they can be further utilized.
3. Enhancing the use of clustering in an observational causal inference study to further unravel the relationships between digitization architecture and performance outcomes in SMEs
4. Considering additional dimensions (e.g., industry, region, environment) to the study and exploring implications such as predicting strategic direction, profitability, and purchase decisions.

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