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SERVICES FOR SCIENCE AND EDUCATION

Challenges and Opportunities for SMEs in Supply Chain Digital Transformation

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ABSTRACT

Digital transformation of supply chains has been successfully achieved by larger companies, but small-to-medium enterprises (SMEs) have shown much less progress. This study examined the state of digital transformation in a region with a significant number of SMEs, the ongoing challenges and opportunities these companies face, and the degree of support for potential training offered by a business school. A survey was developed to determine challenges related to supply chain operations, digital technologies in use, plans for future innovations, current employee skill levels, and support for employee training by a local business school. The survey revealed cybersecurity risk, demand forecasting, hiring/retaining talent, and customer behavior/expectations as supply chain challenges. Cloud computing and supply chain network optimization were the only technologies widely used. Digital skills were lacking and planning for digital limited, but there was overwhelming support for employee training. SME-particular issues and experiences related to progress toward digital transformation have not been widely researched. This study addressed these issues and provided insights that are useful for SMEs in the regional economy, as well as for SMEs around the world who seek digital transformation. Results underscored the importance of employee training in digital transformation and the need for a proactive supportive role by third-party entities such as higher education institutions. SMEs, which are 99% of all enterprises, are for the most part not participating in digital business. This issue has serious consequences for business communities around the world, who are missing out on opportunities to grow, expand, and remain competitive.

Keywords: Digital transformation strategy formulation, People, Processes, and Technology Framework, Digital supply chain technologies.

INTRODUCTION

Supply chain transparency, visibility, control, efficiency, and supplier and customer relationships are even more important in the post-pandemic world [22] [39] [76] [78]. MIT's David Autor referred to the pandemic as an "automation-forcing event", because companies rushed to adopt digital technologies that would enable them to remain engaged and connected remotely with their many stakeholders [43, p. 1]. With resources, research and development departments and an abundance of trained employees, large companies have made great strides toward digital transformation, while small-to-medium companies (SMEs) are much less successful at doing this. Medium-size business reported a 28% increase in technology strategy/investment as a result of the pandemic, and small businesses reported a 12% increase [70]. These figures are encouraging, but modest when compared to large business increases of 40% on technology strategy/investment during the same time period [70]. At the same time,

the need persists for supply chain employees with the skills to use them effectively [8] [30] [16] [38] [87], making upskilling and reskilling current supply chain employees and/or hiring new talent an area of serious concern, particularly for SMEs. This paper explores the adoption of digital supply chain technology in a particular region that consists of five Indiana counties centered on the Ohio and Wabash Rivers and Henderson County, in Kentucky. Evansville is located 60-miles south of the median center of the U.S. population, resulting in lower transportation costs and easy access to almost every U.S. market [32]. This area includes (according to Gartner.com's definition [27]. 14 large companies (more than 1,000 employees), 27 medium-sized companies (100-1,000 employees), and close to 8,000 small companies (less than 100 employees). Insights into reskilling/upskilling needs in this specific area come from studies by Talent 2025 [80], an initiative sponsored by the Evansville Regional Economic Partnership [25], whose research has determined that regional manufacturing industry is strong and increasingly automating processes [89]. However, at the same time, current manufacturing employees lack the skills they need to transition to a digital workplace, the future workforce is not being adequately prepared for success in the digital workplace, and many employees risk losing their jobs to changing workplace skill needs [89]. In light of the large number of (SMEs) in the area of interest who may be experiencing particular challenges with digital transformation of their supply chains [5] [69] [86], this study seeks answers to the following research questions:

1. What operational challenges do companies face related to the supply chain?
2. What types of digital technologies are companies using to support supply chain activities?
3. What preparations are companies making for a digital future?
4. Do employees currently have the skills they need for supply chain digital transformation?
5. What are company attitudes toward employee training opportunities offered by a local business school?
6. In which stage(s) of digital transformation do the surveyed companies appear to fit?

Investigation of the above questions is guided by an updated version of the People, Process, Technology model of IT innovation, which identifies people, process, and technology as the core aspects of a business that are impacted by information systems innovation [35] [42]. Strategy has been added as a fourth dimension to the model, due to the importance of a well-planned approach to guide digital transformation of the supply chain.

The paper begins with a literature review that discusses research into SMEs and digital transformation, followed by discussion of the updated PPT model used to guide the study, details about each of the four dimensions in the model, the methodology used, findings, discussion of results, limitations of this study, conclusions, and future research directions.

LITERATURE REVIEW

SMEs and Digital Transformation

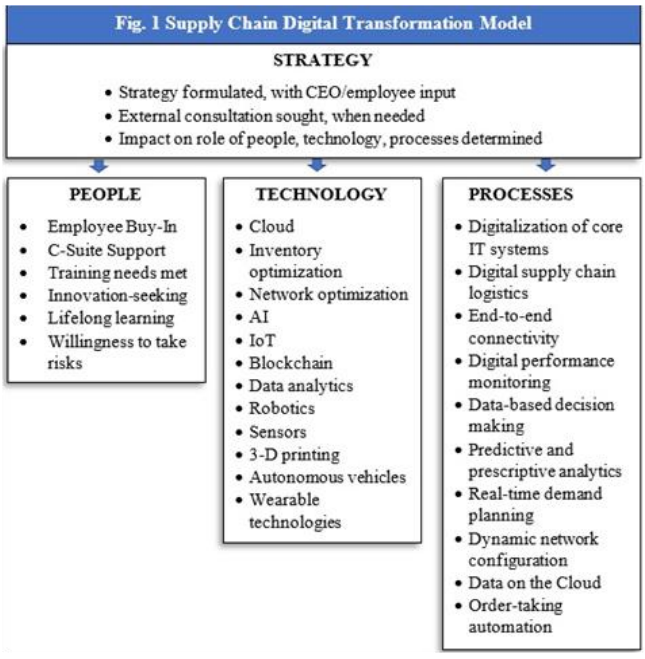
Over the past few years, many large companies have begun using digital technologies to transform their business processes, connections with stakeholders, visibility, use of data, and the breadth of their business footprint. In contrast, most small-to-medium companies (SMEs) have not yet entered the world of digital business. SMEs represent 212.98 million of the 213.65

million [15], or 99.68% of the total number of companies in the world. The fact that more than 99% of all companies are not benefiting from participation in digital business has serious consequences for many economies around the world and their business communities, who are missing out on opportunities to grow, expand, and remain competitive. This situation threatens the livelihood of millions of SMEs and their employees, in the United States and throughout the world. The stern warning of CISCO System Executive Chairman John Chambers at the BoxWorks Convention in 2015 still rings true, "At least 40% of all businesses will die in the next 10 years… If they don't figure out how to change their entire company to accommodate new technologies" [12, para. 1].

Until recently, the specific characteristics of SMEs that distinguish them from large companies and can impede their success at digital transformation were ignored in economic and business research [41] [85]. Now, as the ever-expanding gap in digital business adoption between large and small enterprises has become impossible to ignore, interest is growing in finding ways to support SMEs on their digital journeys [5] [41] [69] [85] [86]. Of course, each SME, with its particular cultural, economic and organizational environment, is different and deserves attention. To this end, recent studies have focused on SMEs in specific regions and countries [14] [5] [41] [82] [86]. This study contributes to the global body of knowledge about SME efforts toward digital transformation by focusing on digital transformation of supply chain activities in companies in a particular area in the lower Midwest in which the vast majority of companies (97.2%) are SMEs.

A PPT Approach to Supply Chain Digital Transformation

The PPT approach to business change, which evolved from a four-dimension framework proposed by Leavitt [42] and was later revised by MIT's Michael Hammer identifies three important pillars within an organization that must be considered in any efforts to achieve success in organizational change such as digital transformation—people, processes, and technology [35].



Several researchers also support the importance of strategy formulation as a standalone entity that can provide a company-wide look at the risks and opportunities from digital transformation [11] [37] [50]. The author has Strategy Formulation, as the first crucial step in the digital transformation process (See. Fig. 1.)

The following sections discuss each of the four dimensions in the above supply chain digital transformation model used in this study—digital transformation strategy, people, processes, and technology.

Strategy for Supply Chain Digital Transformation

Strategy formulation requires developing an organizational vision, taking a broad look at overarching goals for digital transformation, and developing a roadmap for achieving it. The strategy must be developed by leadership and key employee representatives, and/or information technology staff, communicated to employees at all levels, and embraced by them [61] [79]. Strategy must be more than just adding various technologies, but rather is a comprehensive model for how to change the way a business operates and how relates to its stakeholders, both internal and external [53] [79]. It is an iterative process that is ongoing, even after digital transformation has been implemented [14]. Digital strategy transformation efforts must include establishing new governance structures like departments, roles, and activities, in order to avoid internal political tensions that may hinder innovation and change. Chanias *et al.* [14] emphasize that, above all, a digital transformation strategy must be business-oriented and customer-centric; and it must involve the entire organization. They also argue against having a company's IT department lead the strategy development process, because IT personnel may lack a holistic business view of the role technology will play [14].

Strategy formulation is perhaps the most difficult step for many organizations, particularly smaller to medium organizations with limited resources and research and development support [5] [69] [86]. Every company's particular vision, strengths and constraining circumstances are different, and there is no one standard format for strategic formulation of a digital transformation strategy. Lacking technical skills and knowledge about digital transformation and with limited financial means, many SMEs seek assistance from consultants, researchers, governmental agencies, or universities in the strategy development process. Fortunately, external entities like this can often provide support at little cost ([5] [69]. Governmental assistance is offered in the form of grants and technology extension programs; SME training cost reductions/subsidies, and apprenticeship programs; assistance in improving SME cybersecurity; forging connections SMEs with researchers and networking partnerships; creating a supportive regulatory system and digital infrastructure; and instituting long-term government frameworks and governance arrangements that address the specific needs of SMEs. Non-profit economic development organizations and professional organizations support organizational empowerment through grants and training opportunities; and universities offer low-cost training and organizational development support through research and student involvement in digital transformation projects [63].

Strategy formulation also includes a decision about the type of digital business model desired for a company, based on its own vision, expertise level, and company culture. There are numerous types of business models [20], and each company should adopt and customize the

type of model that best fits and implements its corporate vision. Weill and Woerner's [88] Digital Business Framework identifies four different possible digital business models, primarily based on their relationship to customers: Suppliers; modular companies, like PayPal, that are plugged into the digital platforms of other companies; omnichannel business like Nordstrom, Citibank, and Walmart that enable customers to access their products in multiple modalities; and eco-systems, like Google, Apple, and Facebook, that seek to be the go-to place for their customers. Another interesting business model [81] uses digital technology usage level and readiness of the business model for digital operations to identify four possible models: 1) disruptors, like digital startups, which have extensive digital knowledge, but a flexible business model; 2) business model-led companies, like large corporations, with a holistic vision for going digital, but a cautious, deliberate approach; 3) technology-led companies, who pick and choose technologies for particular purposes; and 5) proud to be analog companies, who use as little technology as possible because it does not fit their business model.

People

Although top leadership usually makes the final decision to go digital, owners/managers/ CEOs and employees should work in tandem on strategy formulation and find solutions to knowledge and skill shortcomings they may face in achieving digital transformation. Employee digital skill levels are an area of serious concern and are considered by some to be the most important barrier to successful digital transformation [13] [24]. Many organizations are finding the need to upskill and reskill employees and/or to add new talent [56] [72].

The increased popularity of eLearning has led to a myriad of eLearning corporate training providers [73]: online education providers like Coursera for Business, Udemy, Skillshare, MasterClass, EdX, Udacity, [39], KnowledgeCity and PluralInsight; social platforms like LinkedIn Learning, Twitter, YouTube, Instagram, Facebook; consultants like The McKinsey Academy, Accenture, the Supply Chain Academy; non-profit professional organizations like Association for Supply Chain Management, the Council of Supply Chain Management Professionals, and the Institute for Supply Management: and publishers like Pearson and O'Reilly [73]. Additionally, prominent corporations are now developing and offering their own "corporate university" training programs, such as Unilever University, Amazon's Technical Academy and Associate2Tech; and IBM's Basic Blue for IBM Leaders [26]. There are also opportunities for digital learning such as employee boot camps, hackathons, and massive online courses [90] as well as collaborations with universities, incubators, and governmental agencies. Company leaders should also keep in mind changes in employee expectations for the workplace, including flexibility in scheduling, mobile work, desk sharing, and digital workspaces, all of which can decrease infrastructure cost and attract digitally savvy talent [72] [90]. Large companies that had an early start on digital transformation have already hired top digital talent and can afford to pay digital-trained recruits generously, making hiring and retaining talent a challenge for SMEs with more limited budgets [82].

Many SMEs are led and/or run by the company's owners; thus, the particular attitudes of the owner have a significant impact on if, when, and how digital transformation is even sought and/or successfully implemented [69]. Some owners are satisfied with the way their company is going and do not seek ways to innovate and expand it [69]. Others feel a responsibility to support the community through providing employment and do not want to take risks that could

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disrupt this role [69]. The company owner/manager may also have limited professional knowledge about management, which can result in unilateral vs. group decision making, limited accountability for mistakes, and little strategic planning [69].

Successful digital transformation requires strong digital leaders who can manage complexity, inspire employees, and spearhead the development of digital solutions [7] [28] [37]. Organizational culture is crucial in creating an environment in which employees feel empowered, valued, and able to use their creativity on innovations and process improvements. In general, traditional hierarchies are moving toward leaner, flatter organizational structures that allow greater agility and faster decision making [90]. Cross-functional teams (developers, IT experts, designers and product owners) can be formed to work together on innovations [28] [75]. As described earlier, building a strategic plan for digital transformation requires this kind of collaboration in order to be successful. Employees should feel safe to experiment and to learn from mistakes, and they can do this most successfully in an atmosphere that encourages ongoing lifelong learning [72].

Compared to large companies, SMEs are much more flexible, less bureaucratic, less constrained, and can often able to make decisions more quickly [74]. The potential benefits of digital transformation to SMEs are significant. With a digital platform, an SME can have exposure to markets, search for funding and potential talent, and engage with inexpensive online services that can aid in digital transformation projects [53]. Yet, research and reviews of digital transformation have often failed to distinguish between the culture of an SME as opposed to that of a large company in the context of digital transformation [51]. SMEs have a number of company culture characteristics that can impact their potential move toward digitalization. Production processes can lack work-sharing among employees and machinery and do not benefit from economies of scale. Research and development activities are not formalized in a specific department and are not part of an innovation strategy. Additional stumbling blocks experienced by SMEs include a shortage of digital skills and talent, cultural resistance to change, and a lack of the following--commitment to a budget for innovation, necessary technologies, digital mindset, a digital roadmap, and insights about digital transformation [86].

Processes

Digital transformation has the impact of connecting a company in real-time with its stakeholders-both internal stakeholders like employees and external stake holders like suppliers and customers [2] [53]. With a digital platform, order taking, order processing, and data storage can be automated and streamlined. Important documents like contracts and legal documents can be secured through cryptography in Blockchain. Customer information can be gathered and used to predict consumer behavior and to assist in customizing services and other types of customer engagement that are important for maintaining customer relationships [2]. Consumers are more demanding than ever before, and to meet customization requirements, products are outsourced to external suppliers that are often far flung across the globe [49].

From order taking to fulfillment, supply chains have been impacted by digital transformation [47]. Starting with planning and visibility, control towers provide real-time optimization for planning; advanced analytics provide accurate forecasting; and, as described earlier, inventory management systems use mathematical algorithms to determine the most probable excess

stock and shortage levels and to enable demand forecasting and planning [17] [48] [59] Sales and customer service are enhanced by sensor-driven goods replenishment, demand-driven supply chain operations, and user-friendly customer platforms. After sale benefits from predictive supply/demand diagnostics, remote servicing, and predictive spare-parts management. The procurement process supports supplier collaboration through suppler platforms and spend analytics programs [33] Production is enhanced by connectivity with suppliers, employees, and customers, with many routine jobs now being completed by robots, drones, driverless machines, and/or by employees using wearable devices that capture data that is available in real-time to stakeholders [2]. Logistics is enhanced by dynamic network optimization tools, which use mathematical models to reduce network complexities and optimize asset locations across the supply chain (sourcing, inventory, transportation, warehousing [46] [59]. As shipments leave the factory or warehouse (sometimes in driverless vehicles) smart inventory alerts enable employees and customers to know exactly where a shipment is. Throughout the supply chain operation, performance management that used to be performed weekly or monthly is now done in real-time, enabling performance issues to be solved quickly [59].

Digital transformation revolutionizes the enterprise-customer relationship and empowers customers, who with a few strokes on the keyboard can move to the website of a competitor if not satisfied with the service, products, pricing, or other aspects of their interaction with a company's digital platform. At the same time, SMEs that embrace digital transformation find that as soon as an online presence is established, they see increases in their customer base and visibility in general. Digital companies place a high value on knowledge about their customers, including customer identity, purchase history with the enterprise as well as with competitors, customers' purchase decision-making process, and how to satisfy a customer's business goals or personal goals for purchases from the company [88]. Changing customer behavior and the increasing popularity of digital channels force organizations to offer seamless interaction across multiple channels—on digital ordering platform, Facebook page, blog, as well as clearly articulated standard procedures for handling offline sales/transactions. By collecting customer data and using customer insights to predict customer behavior, companies can offer tailored and personalized products and services that create a better customer experience [7] [29] [75].

Changes in the way data is collected, stored, analyzed, and proactively used are central in digital transformation. Data has been characterized as "the new oil". Data now has strategic value and can be available in real-time to all stakeholders in a company, both internal and external [31] This increases transparency with partners and trust among stakeholders. Data analytics provides information that contributes to a company's business intelligence and enhances planning and strategic decision making [29]. Data analytics can be applied in all business functions--operations, marketing, finance, supply chain, and strategic planning [8]. Web and social analytics provide information about customers, thus enabling predictions about their future behavior/interactions with the company that maximizes customer service. Contracts, bills of lading, and other documents can be stored on Blockchain, which ensures the security of this information and makes it available to all of the parties involved [9]. The increasing availability of Big Data from many sources (IoT and other sensors, unstructured social media, news feeds, weather, and blockchain-enabled networks) creates opportunities for real-time transparency that businesses can use to enhance decision making and customer service. As

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described earlier under Technology, descriptive analytics can reveal where a company is currently and what has happened in the past; diagnostic analytics examines why things happened the way they did; predictive analytics can predict the future more accurately, and prescriptive analytics help determine the optimally desired outcome.

Technology

The myriad of digital technologies now available have transformed business processes in countless ways. However, for businesses seeking digital transformation, there is a crucial caveat: any technology adopted must be integrated within the business, its management, and the company's strategy; and depends greatly on management/employee skills, to enable the creation of value that is possible with digital transformation. For this reason, an SME's managers and employees must understand technologies and how to employ them to achieve the company's digital vision [82]. Kane *et al*. [37] point out that, while large companies that were successful in digital transformation often had highly formalized strategies, SMEs often make the mistake of focusing on specific technologies and what they can do instead of considering the role this new capability will have in achieving the company's vision. The following paragraphs briefly describe the digital technologies that are used by enterprises for digital transformation.

Robotics, Automation, and Sensor Technologies are used to speed up and ensure accuracy in routine, repetitive manual tasks. Automatic sensory and identification technologies enable robots to sense, identify, and react to, other devices [3] [18] [47] [65]. Real-Time Locating Systems (RTLS) can identify and track the location of objects within a building or other enclosure, track products and supplies through an assembly line, locate pallets in a warehouse, track temperature and humidity, and send them to the cloud [3] [71].

Autonomous, self-driving vehicles equipped with sensors provide data about the environment around them, work together to complete tasks, and provide visibility [4] [48] [52] [83] [57] [91].

Data Analytics analyzes datasets of large size, real-time or near real-time data which are often unstructured and derived from crowdsourcing, Internet applications, point of sale, and other sources [23] [6] [62] [68]

The Internet of Things includes physical devices, vehicles, home appliances, and other items that are embedded with electronics, software, sensors, actuators, and network connectivity that enable them to connect and exchange data [18] [47] [49] [55] [83].

Inventory Optimization tools use mathematical algorithms to determine the most probable excess stock level and shortage level, cost-effective postponement strategies, optimization of inventory components, enhanced supplier intelligence, and demand forecasting and planning [17] [48] [58] [67] [71].

Supply Chain Network Optimization tools use mathematical modeling to reduce network complexities and optimize asset locations across the supply chain (sourcing, inventory, transportation, warehousing) [46] [59] [77].

Artificial Intelligence (AI) combines several other technologies in the simulation of human intelligence and the rapid solution of complex problems: machine and deep learning, reasoning, voice recognition, augmented reality, cognitive computing, natural language processing, and translation; [23] [19] [54] [64].

Wearable Technologies are application-enabled computing devices, worn or attached to the body, that accept and process input from the Internet or other devices [36]. Workers equipped with wearable technology do not need to input information and can capture, hands-free, leads and sales updates via voice messages [1].

Cloud computing and storage use a network of remote servers to access shared resources like data servers, storage, applications, and other services [21] [45].

Blockchain is a continuously growing list of digital records that are linked, secured through cryptography, and continuously updated. Blockchain can be used for transaction processing, records management, and other data-driven tasks [10] [23] [34] [49].

In Additive (3-D) Manufacturing, special CAD software relays messages to a printer, which prints the desired shape in thin layers that are repeatedly printed on top of each other and fused together until the shape is complete [40] [48] [60] [66].

METHODOLOGY AND FINDINGS

Methodology

This study examined adoption of digital technology to support supply chains in a particular area of the lower Midwest in the United States. A survey was developed to measure the operational challenges related to supply chain operations faced by companies, digital technologies used to support supply chain activities, current employee skills and challenges, plans to prepare for digital transformation, and attitudes toward potential employee training opportunities offered by a local business school. As detailed below, in Table I, the research questions map to the dimensions of the Supply Chain Digital Transformation Model as adapted and applied in this study (Strategy, People, Processes and Technology). The survey was emailed via Qualtrix to approximately 900 businesses in the area of interest, with business contacts obtained from the Southwest Indiana Chamber of Commerce and the Henderson, Kentucky Chamber of Commerce. Table I maps the four dimensions in the Digital Transformation Model used in this study to the research questions (RQs) that measured them.

Table 1: Coverage of the four digital transformation dimensions by RQs

	Strategy	People	Process	Tech
RQ #1-Fig. 5 Operational Challenges?			X	
RQ #2-Fig. 6 Tech used to support supply chain?				X
RQ #3-Fig. 7 Preparation for a digital future?	X			X
RQ #4-Fig. 8 Investment in digital technologies?	X			X
RQ #4-Fig. 9 Current employee skills?		X		
RQ #4-Fig. 10 Challenges related to employees?		X		
RQ #5-Fig. 11 Helpfulness of potential training?		X		
RQ #5-Fig. 12 Importance of training topics?		X		X

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Findings

Survey Response:

Company Demographics:

Fig. 2 Role of Respondent in the Company

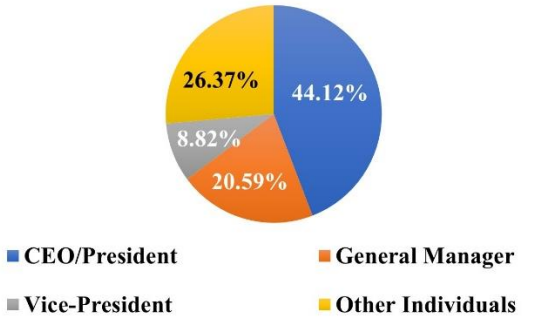


Fig. 3 Type of Company

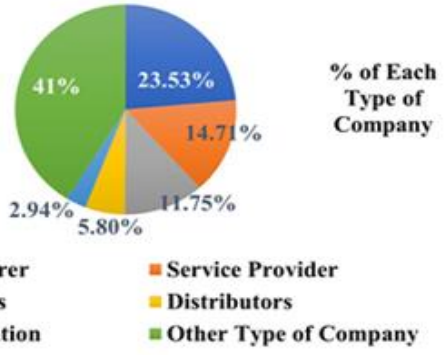
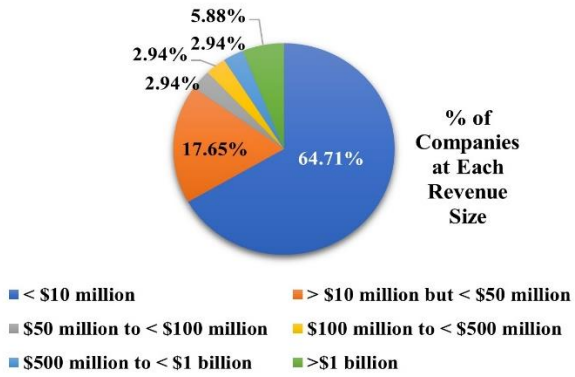
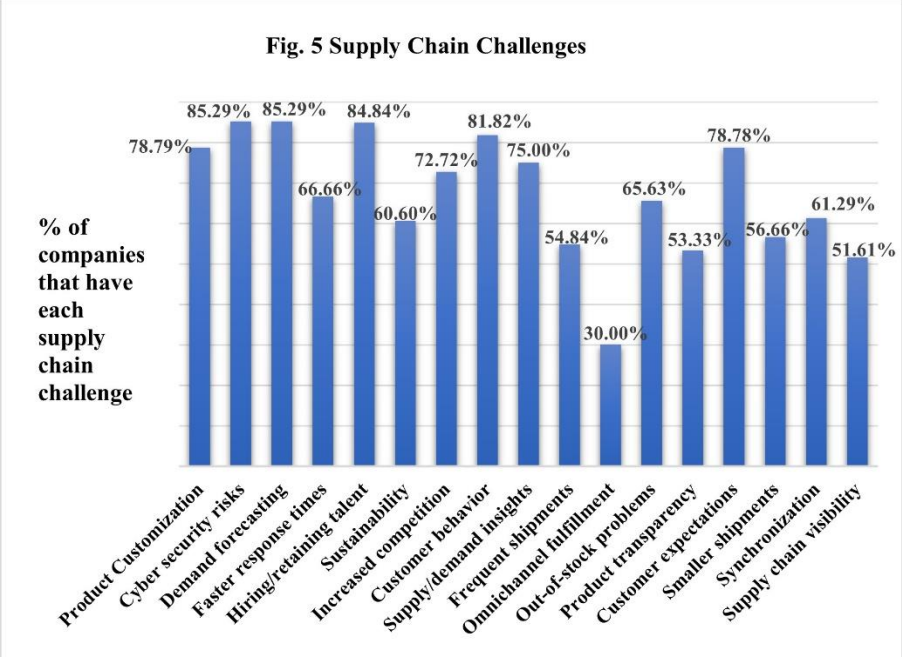


Fig. 4 Company Size in Revenue

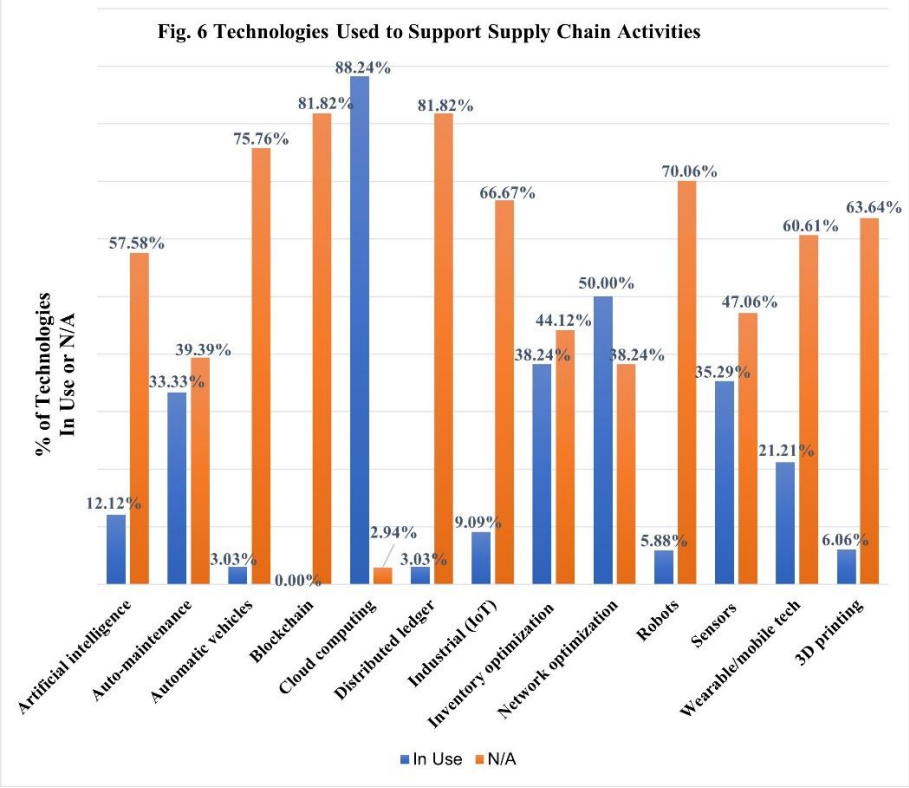


- ***Research Question 1: What operational challenges do companies face related to the supply chain?***(See Fig. 5)

The survey revealed cybersecurity risk and demand forecasting (85.29% each), hiring/retaining talent (84.84%), and customer behavior (81.82%) and expectations (78.78%) as the greatest supply chain challenges.



- ***Research Question: 2: What types of digital technologies are companies using to support supply chain activities?*** (See Fig. 6.)



Results for technologies used showed low to modest use of the technologies included in the survey, with the exception of cloud computing, which is used by 88.24% of companies and

supply chain network optimization tools, used by 50% of companies. Only three other technologies were used by more than 30% of companies—automated predictive or preventive maintenance, inventory optimization tools, and sensors or automatics ID. The remaining technologies were rated as Not Applicable--Automatic vehicles, Blockchain, distributed ledge, Industrial IoT, robots, wearable/mobile technology, and 3D printing

- ***Research Question #3: What preparations are companies making to prepare for a digital future?*** (See Figs. 7 and 8).

As shown in Fig 7, although percentages are low, some companies surveyed are taking steps to prepare for a digital future, including learning more about digital technology from vendors (28%), reskilling workers (17%), increasing investment in innovation (16%), piloting new technologies (14%), recruiting based on future needs (14%) and creating an atmosphere of innovation (11%).

Fig. 7 Preparation for the Next Ten Years

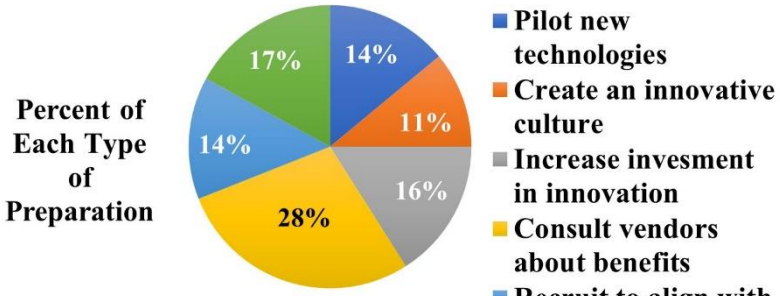
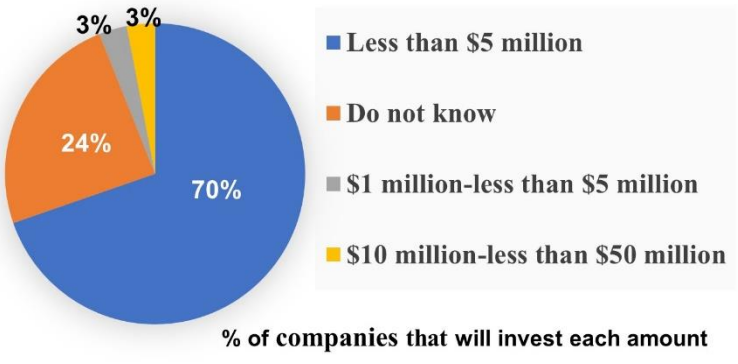


Fig. 8 shows that 73% of companies plan to spend less than $5 million on investment in digital over the next 3 years, and 24% of them do not know what this expenditure will be.

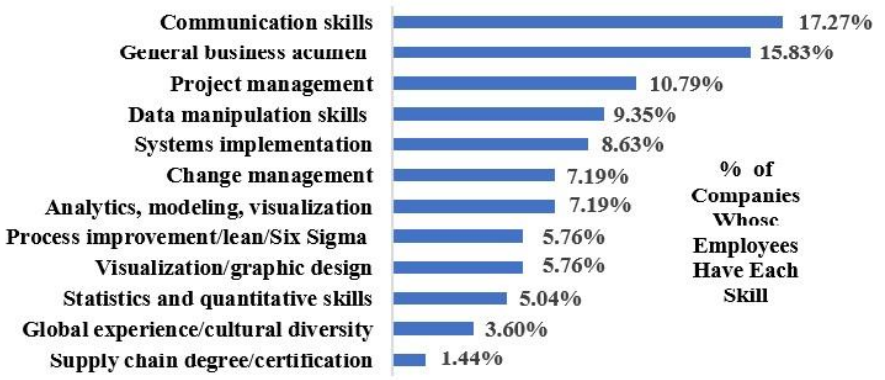
Fig. 8 Investment in Digital over Next Three Years



- ***Research Question 4: Do employees currently have the skills they need for supply chain digital transformation?*** (See Figs. 9 and 10.)

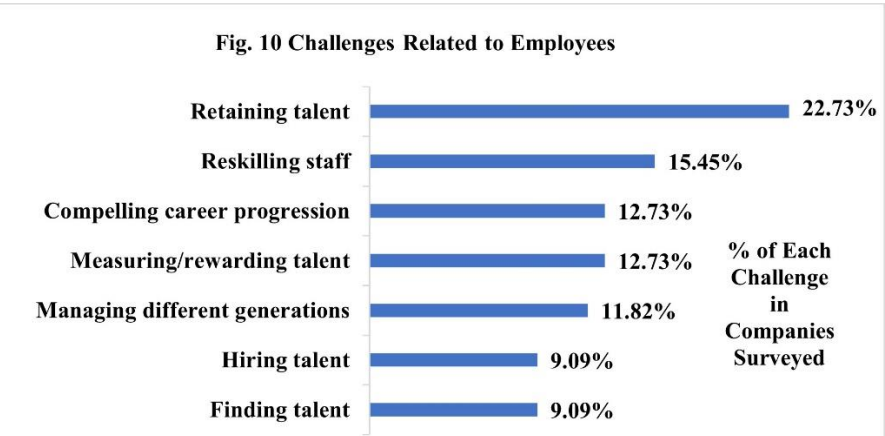
As shown in Fig. 9, companies rated employee skill levels as generally low on the skills included in the survey. Communication and interpersonal skills (17.27%), general business acumen and cross-functional knowledge (16.00%), and project management (10.79%) were rated highest. Data manipulations skills, systems implementation, analytics, modeling, visualization, and change management were rated between 7-9%. The lowest ratings (1%-5.7%) were given to process improvement/lean Six Sigma, visualization, graphic design, statistics and quantitative skills, and supply chain management degree/certification.

Fig. 9 Current Employee Skills



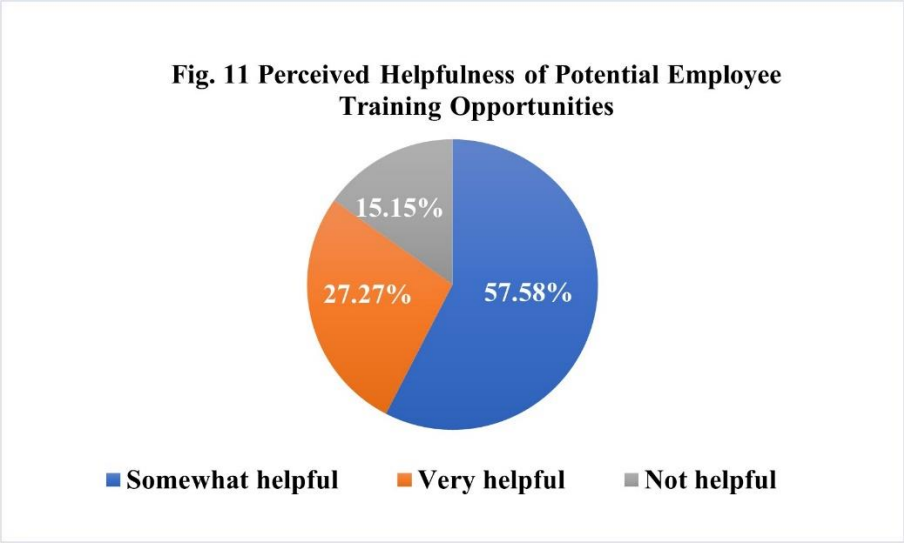
As shown in Fig. 10, the top five challenges related to employees were finding, hiring, and retaining talent and reskilling and training existing staff, along with managing different generational work habits and expectations.

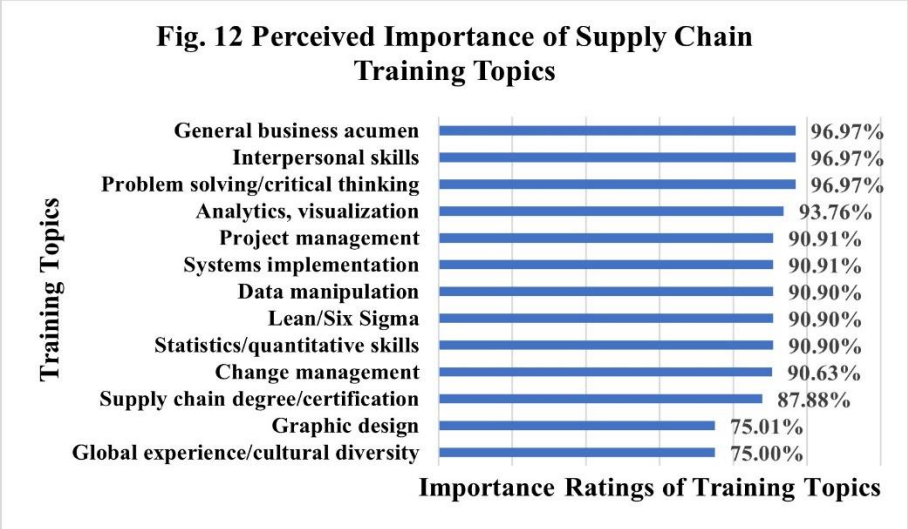
Fig. 10 Challenges Related to Employees



- ***Research Question #5: What are the attitudes of companies toward potential employee training opportunities offered by a local business school?*** (See Figs. 11 and 12.)

More than 84% of companies surveyed perceived the helpfulness of potential employee training opportunities to be either Somewhat or Very Helpful (See Fig. 11.). All supply training topics were rated from 75% to Somewhat Important to Very Important (See Fig. 12.).





DISCUSSION OF RESULTS

The following discussion covers the results for each of the four dimensions in the Supply Chain Digital Transformation Model as well as insights from the results in terms of stages of supply chain digital technology transformation maturity.

Insights about Strategy

As shown in Fig. 7, ratings for preparations for a digital future are generally low for the surveyed companies, but they do indicate that some of companies are aware of the need to learn more about technology, reskill employees, increase investment in innovation, pilot new technologies, recruit based on future needs, and create an atmosphere of innovation. Given the large number of SMEs in the surveyed area, who may lack interest or have financial constraints,

this result is not surprising. Fig. 8 shows that 73% of companies plan to spend less than $5 million on investment in digital over the next 3 years, and 24% of them do not know what this expenditure will be. The 24% of respondents who are not aware of investment in digital planned by the company are most likely non-C-suite personnel or managers who are not included in such discussions. The relatively low amounts to be invested in digital technology are also not surprising, given the modest company revenues reported by the respondents in Fig. 4, as well as the percentages for preparations for the next the years shown in Fig. 7.

Insights about People

Fig. 9 shows that employee skills are strongest in communication/interpersonal skills, general business, and project management, but much weaker in data manipulation skills, systems implementation, change management, analytics/modeling/visualization, Six Sigma, statistics and quantitative skills, and supply chain degree/certification. In other words, employees appear to have skills that can maintain the status quo of operations, but they lack the technical and analytical skills that are necessary for implementing digital transformation. The issue of skill levels is also reflected in the results for Challenges Related to Employees, which indicate that retaining and reskilling talent are the challenges experienced by most of the companies. The skills result is consistent with argument noted earlier that employee skill gaps are the most serious impediment to successful digital transformation [13] [24].

The results in Figs. 11 and 12 indicate strong support for the idea of employee training, as well as the importance of the training topics listed. Despite the fact that most companies surveyed are only using digital technology to a limited extent and for the most part are not planning to make technology upgrades or significant investment in technology, they appear to understand the importance of embracing the technologies they need for digital transformation and strongly support the idea of training. This result is consistent with the argument for support and training being needed by companies, particularly SMEs, for digital transformation efforts ([5] [41] [69].

Insights about Processes

As shown in Fig. 5, the companies surveyed are experiencing challenges related to the supply chain, the greatest challenges being cybersecurity risk, demand forecasting, hiring/retaining talent, and customer behavior/expectations. A breakdown of these results indicates the following: All four of these challenges are issues that are being felt at the global level. Cybersecurity risk is faced by enterprises everywhere. Demand forecasting has been exacerbated by increased customer expectations for quick service and customization; and hiring and/or skilling is a challenge being experienced by companies globally due to the demands of digital transformation [13] [24].

Insights about Technology

As indicated in Fig. 6, with the exception of cloud computing, which is used by 88.24% of companies and supply chain network optimization tools, used by 50% of companies, only three other technologies are used by more than 30% of companies—automated predictive or preventive maintenance, inventory optimization tools, and sensors or automatics ID. The cloud computing result is significant, because this means that close to 90% of companies surveyed have adopted a digital technology that, as pointed out earlier in Table I, makes their data more secure and available in any location, facilitates cross-functional workflow, and makes the

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organization more agile, resilient, and connected. The result for supply chain network optimization, used by 50% of companies surveyed, is also notable, as this technology enables faster, more accurate order fulfillment and visibility all along the supply chain, and maximizes profits while minimizing costs. Hopefully, this is just the beginning of digital transformation efforts in the surveyed companies. The remaining technologies were rated as Not Applicable--automatic vehicles, Blockchain, distributed ledge, industrial IoT, robots, wearable/mobile technology, and 3D printing. The NOT Applicable ratings may have been given because these technologies are truly not applicable in the particular business environment of some companies. For instance, the service providers, personal transportation companies, and consultants who responded to the survey may very well not have a need for the N/A-rated technologies. On the other hand, these ratings and the generally low ratings for all of the technologies except for cloud computing could indicate a lack of awareness or interest in these technologies or company leadership that does not seek innovation.

Stages of Digital Transformation Maturity

The information gathered about supply chains in companies in the area of interest enabled an approximation of the stage of digital transformation maturity in which they currently reside. Gartner's digital transformation maturity model [44] was used to evaluate the digital transformation maturity of the companies surveyed. As shown below, the lowest stage of maturity in each model describes companies that are predigital—with many traditional supply chain model technologies in use and with some idea of/interest in digital technologies, but no implementations yet. At the second level, a limited amount of stand-alone digital technologies are explored, piloted, and implemented, but only for specific supply chain tasks, with no integration across the supply chain. At the third level, digital technologies are more widely embraced and used, both internally, as well as with supply chain partners. In the fourth stage of digital transformation maturity, transformation of the supply chain is complete, with seamless operations and supplier collaboration, real-time data collection, and growing financial gains and competitiveness for the firm.

The majority of companies would be in Stage 1. However, at least some of the companies, but possibly not all, would fit into Stage 2 of Supply Chain Digital Transformation Maturity--a limited amount of stand-alone digital technologies are explored, piloted, and implemented:

*Adoption of Digital Technologies***:** 88.24% of companies use cloud computing (88.24%), supply chain network optimization tools (50%), automated predictive maintenance, inventory optimization tolls, and sensors/Automatic ID (30%+).

Preparations for a Digital Future: 28% plan to learn more about digital technology from vendors, 17% plan to reskill workers (17%), 16% will increase investment in innovation, 14% will pilot new technologies, 14% will recruit based on future needs and 11% will create an atmosphere of innovation and will invest in digital technology.

CONCLUSIONS, WEAKNESS/STRENGTHS OF STUDY, FUTURE RESEARCH DIRECTIONS

The response to the survey implemented in this study was, admittedly, low (n=37), thus limiting the validity and applicability to companies in other geographic locations. The low response rate could possibly be explained by the large number of SMEs in the area, who have

been characterized as potentially lacking interest in innovation, due to financial, company culture, or other reasons [69].

However, the results indicate that although some companies surveyed may not have moved much or at all toward digital transformation, they still welcome and embrace opportunities for training. Their hesitation to plan for digital transformation or invest in technology may be due to the recognition that their employees lack the necessary digital skills, in addition to other issues such as financial constraints, or a cultural resistance to change. The strong support for potential training stands out as a major result of this study, pointing to training as a "jump starter" for companies seeking to move forward with digital transformation, and implying the importance of a proactive role for outside entities like local universities, government agencies, or consultants who can provide this support. Another positive finding was that at least some of the companies in the study appear to be currently in Stage 2 of Supply Chain Digital Transformation Maturity, based on their level of adoption of digital technologies, preparations for a digital future, and plans to work on upskilling/reskilling their employees.

A strength of this study is the fact that regional areas, as well as SMEs, are not often the subject of survey studies; and, as reported earlier, the particular issues faced by SMEs are often overlooked by researchers [5] [69]. Given the vast number of SMEs around the world, further in-depth research into the experience and support needs of SMEs as they pursue digital transformation is an important area for future research. Interviews with company leaders and employees would be very helpful, as would workshops or other venues in which these individuals could share their challenges and vision for a digital future. In particular, a more granular look into exactly why some companies are not embracing digital transformation would be valuable. This information would encourage companies to seek the support they need and would also be helpful to external entities who could help them. Hopefully, such research will contribute to the ability of SMEs to join larger companies in reaping benefits from the connectivity to stakeholders, visibility, streamlined operations, cost savings, and efficiency that are possible with digital transformation.

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