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The Impact on Adopting the Fourth Industrial Revolution on Small and Medium Enterprises

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1. Introduction

The fourth industrial revolution, according to many, has already started (Ross and Maynard, 2021). It is obvious that such significant changes need time to develop and do not happen overnight. The fourth revolution, also referred to as i4.0, is not about the mass production model that dominated the second revolution, the steam that powered our factories in the first revolution, or even the emergence of computer driven systems from the third revolution that we are currently living in and transitioning from (Franks, 2021). It's about networking in Industry 4.0. It is a chance to fundamentally alter how business reacts to societal requirements. Similar to how preceding revolutions were powered by innovations in production processes and systems, the advancement of i4.0 will be supported by a smart, interconnected, pervasive environment (Oztemel and Gursev, 2020). The potential for disruption will be felt very strongly by those who are left behind.

Nine technological pillars form the foundation of industry 4.0 (Erboz, 2017). These developments allow for the creation of intelligent and autonomous systems by bridging the physical and digital realms. Some of these cutting-edge technologies are currently used by businesses and supply chains, but when they're combined, industry 4.0's full potential is realised.

The nine technology pillars include the following.

1. Big data and artificial intelligence analytics.
2. Horizontal and vertical integration.
3. Cloud computing.
4. Augmented reality.
5. Industrial internet of things.
6. Additive manufacturing and three-dimensional printing.
7. Autonomous robots.
8. Simulation/digital twins.
9. Cybersecurity.

According to the composition of the 2021 UK business population, SMEs (small and medium-size enterprises) report 99.9% of UK businesses (Gov UK, 2021), and the World bank reports around 90% of worldwide businesses fall into the SME category and employ more than 50% of the worlds working population (World Bank, n.d). Clearly, SMEs play a substantial role in most economies, particularly those of developing countries. While there may be good reasons to delay investing in digital technologies, it is crucial that SMEs do not fall behind. While making speculative investments in uncharted territories can be frightening, it is likely that the creative and inventive enterprises who are prepared to take risks will prosper and benefit from the fourth industrial revolution.

SMEs face unique challenges as a result of industry 4.0's drastic shift in business practices due to the significant need for capital and expertise. I4.0 and the technologies it encompasses aim to boost SMEs productivity, adaptability, and competitiveness. Industry 4.0 deployment should ideally be accompanied by a change to the company's business model, which is the logic used by the company to create and capture value, in order to realise such a significant change in a financially sustainable manner. Additionally, as the i4.0 idea and its underlying technologies are continuously improved, business models that support its deployment and long-term viability must also be continuously evaluated.

(OECD,2021) Small and medium enterprises have been lagging in the digital race for several years. Figure 1.1 illustrates the average diffusion rate of different types of technology, social media, big data, cloud computing, etc, it is obvious that the diffusion rate amongst large firms, medium-sized firms, and small firms are very different. The digital gap between them is striking and persistent across all the technology eras. The figure also demonstrates to some extent that this gap is not so large in some specific domains with some specific technology error, the use of social media, the use of e-commerce, and the interaction through digital channels. This highlights that SMEs tend to digitalise some functions, like marketing and administration first, but is also reveals that this gap enlarging as technology becomes more sophisticated, like for big data analytics or implementing enterprise resource planning.

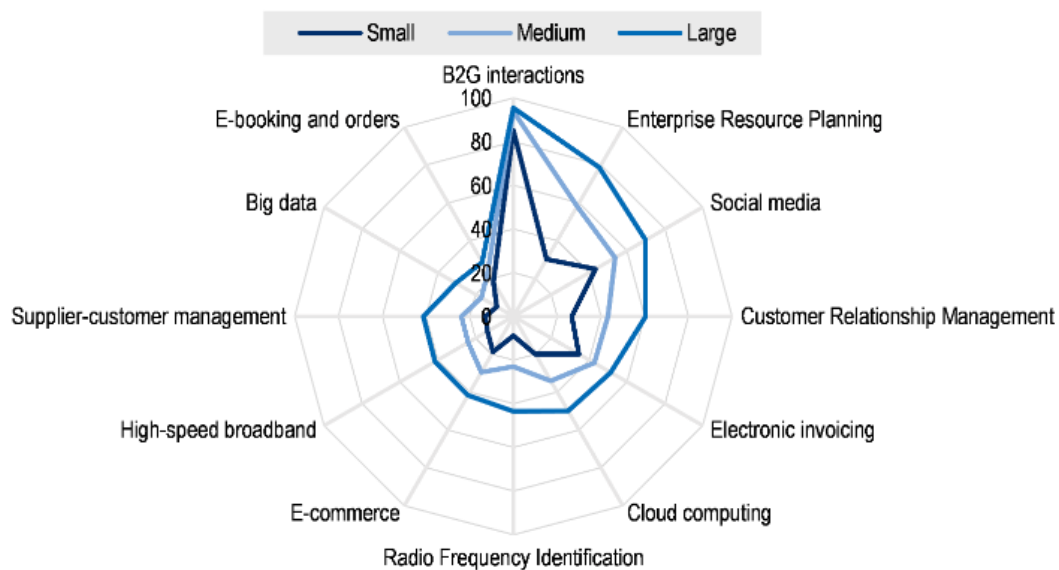


Figure 1.1. The average technology diffusion rates by firm size for 2015-2018 (OECD, 2021).

This assessment aims to examine the impact of adopting industry 4.0 on small and medium enterprises by exploring the elements of the business requirements and the humanistic elements that would be useful to determine such impact.

2. Adopting Industry 4.0 Overview

(Aithal, 2017) Before a business can take the first steps toward industry 4.0 readiness, they need to know their beginning position to facilitate a planning route. Auditing and analysing current corporate systems, assets, and procedures is a smart initial step. This will enable the knowledge of current standing, assist with setting priorities, and help find fast wins. Every aspect of an SMEs business will benefit greatly from and be impacted by industry 4.0 technologies. Enterprises require executive buy-in and participation because this is much more than just an IT upgrade.

(Zachariah et. al., 2015) Internet of thing gateway devices can frequently be retrofitted to older machinery. These devices have made it possible for IoT sensors to transmit performance data. It is also conceivable, however seldom, to add and connect optical and thermal sensors to provide a more accurate view. Depending on the machinery's age and function, the best course of action will vary, and an audit and research can help determine whether retrofitting historical assets will be more valuable in the long run than replacing the machinery.

(Akyurt et. al., 2020) The intelligence of an industry 4.0 technology stack is a reliable back-end system, like enterprise resource planning (ERP). Unlike today, when a sophisticated ERP system serves as the hub for interconnected operations spanning manufacturing, logistics, engineering, and many other business domains, the ERP of the past primarily controlled office-based procedures. SMEs will need to evaluate their current ERP systems to see if it could handle the workload as part of the digital transition. The capabilities of legacy ERP systems running on antiquated, disk-based databases are being strained to the breaking point. Enterprise resource planning systems within SMEs will need verification that capabilities will be met and determine how well the data they come from connected factories, assets, goods, and people. For example, does it provide embedded AI, machine learning, and analytics technologies? To benefit from i4.0, SMEs may need to modernise their systems if it is already outdated.

(He and Turner, 2021) A question that many SMEs leaders might imagine would be in identifying which i4.0 technologies are best for their business. The procedures that are most essential to the core business model and the parts of the firm that stand to gain the most from the transformation will determine which technology an SME should look to introduce in first instance. Enterprises frequently concentrate on one key technology at a time when first starting out. Industry 4.0 solutions by nature provide a wealth of robust Big Data and insights that can help precisely calculate the best return on investment and the advantages.

(Ustundag and Cevikcan, 2018) Digital transformation may be implemented slowly without significantly disrupting the organisation, unlike many other large core changes. Many i4.0 technologies can be implemented relatively immediately if a solid ERP system and digital transformation strategy has been established.

(Li, 2022) Like many situations, change can be difficult. Staff that felt overwhelmed and intimidated by computers' complexity opposed the transition of businesses from typewriters to computers. However, unlike those initial technologies advancements, industry 4.0 solutions actually make things simpler for the user rather than making them more complex. The interfaces are more user-friendly, the workflows are streamlined, and manual and repetitive processes are automated. Many 4.0 technologies, including augmented reality wearable and mobile-optimised experiences, not only require an operator but can also make training much easier. Therefore, the worry of staff retention simply requires up-skilling appose to direct replacement.

(Moosavi et. al., 2021) The pandemic had a significant impact on industry, and future events are not always predictable. Although the future cannot be foretold, I4.0 may help in taking measures to make sure that businesses are more robust and ready for it. I4.0 technologies were built with the express purpose of accelerating growth and responding to unforeseen events. SMEs will be prepared for new circumstances as a result.

(Ammar et. al., 2021) Software solutions for i4.0 have features like built-in scalability, agility, and resilience. I4.0 systems will provide SMEs with the knowledge and assurance to adapt and implement change swiftly across the business or manufacturing model needs to be drastically changed to meet market demands.

(Kurt, 2019) There is little doubt that the labour force will alter as a result of the fourth industrial revolution. ideas and innovative thinking are what inspires innovation, not repetitive labour. A workforce that has been technologically enhances is liberated to use their brains rather than merely

their bodies. Only a small number of numbers of computer programmers existed worldwide in the 80s, there are now more than 20,000,000 today. Robots will replace many physical duties, but many more will also be added to manage an enterprise firm that has been enhanced by the fourth industrial revolution.

2.1 Social Impact

Enterprise officials and directors are hopeful about industry 4.0's effects, with 87% of respondents to a Deloitte survey agreeing that i4.0 will increase social and economic equality and stability (Deloitte, 2018). They appear to view technology as an equaliser with the chance of increasing access to funding, employment, and education for people from all backgrounds and social classes. However, new technologies will also necessitate changing skills and will probably have an influence on employment that could result in economic inequality and uncertainty. Additionally, according to (Deloitte, n.d), the combined effects of technological advancements and demographic shifts are beginning to climb the steep portion of an exponential curve, that suggests change may be accelerating at rates far greater than those of previous industrial revolutions (Hagel et. al., 2016).

There is no doubt that in years to come, i4.0 will significantly alter practically all facets of society. The majority of industry leaders believe that businesses, both public and private, will have the largest impact on how industry 4.0 will change society. This provides an opportunity for SMEs to lead the revolution and take charge of their destination before large corporations making it very difficult for them to do so. Since business leaders believe that business has the greatest impact, it stands to reason that they would want their firms involved in significant roles in bringing about this more stable and equal society. However, Deloitte's findings show that leaders do not think businesses have much influence on societal issues like education, environmental sustainability, or social and geographic mobility, particularly for SME leaders (Deloitte, 2018). These are simply viewed as external factors and organisations lacking a sense of responsibility for creating a "better world" may find it more difficult to succeed in the i4.0 environment.

Although corporate social responsibilities are commonplace, it does not appear that businesses are sufficiently encouraged or supported to direct their strategies toward serving a wider range of stakeholders and tackling social issues (Sanchez, 2019). SMEs as significant economic players must consider the inter-relationships amongst a larger group of stakeholders within their strategy planning if business is to provide a prominent position in the wide-ranging societal ramifications of industry 4.0. SMEs and larger businesses are starting to use i4.0 technologies in conjunction with a social and environmental impact mentality to create differentiated products, explore new markets, establish sustainable supply chains, recruit millennial talent, and change regulatory relationships. SMEs have to stay on top of this or risk being pushed out of the social impact debate by larger organisations (Morrar et. el., 2017).

The challenge for SMEs will be to develop and implement strategies for fostering revolutionary change that also has good and meaningful social impact. Utilising i4.0 technology for positive social effects can create new markets, spur adoption, and serve as an example for luring and keeping top personnel. In addition to the more conventional risk considerations of security, regulatory compliance, quality, privacy, and safety, enterprises need to think about the ethics and morality of adopting modern technology (Shingles et. al., 2016)

2.2 Strategic Implementation

Even though we frequently read about "great disruptors" reshaping multiple economies or even about well-established companies efficiently reinventing business or launching new goods or services, not all businesses are achieving such advances (Sony and Naik, 2019). Although many CEOs are aware of the changes Industry 4.0 heralds, they are unsure of how to take advantage of the prospects. In reality, only 14% of questioned CEOs are extremely convinced that their companies are prepared to take full advantage of the potential presented by Industry 4.0 (Deloitte, 2016). Many leaders may continue to focus on conventional corporate strategy rather than possibilities to find innovative ways for their stakeholders, which may be one factor contributing to this lack of trust (Sniderman et. al., 2016a).

Increasing productivity and creating new company goods are often discussed topics across many organisations. These are significant concerns for Industry 4.0, whose signature characteristics is the creation of novel products and services and an increase in productivity through the use of cutting-edge technology and/or the data produced by connected devices (Mussomeli, 2016).

Industry 4.0 offers a major opportunity for innovation beyond the goods and services that would require a fresh approach in areas like people, cyber risk, and market disruption. I4.0 applications can help with the delivery of continuous learning, tap into new talent pools, open doors to underserved markets, offer predictive tools to help with process improvement and risk reduction, connect supply chains, build new ecologies, and enable more agile systems that can adjust and react to changes in real time. However, according to Deloitte survey, business leaders perceive the future purely through today's business ideologies (Deloitte, 2018). Successful SMEs in particular may be affected by the concept known as "organisational inertia," which occurs when a company becomes concentrated on its prior successes to safeguard its current status while being unaware of changes occurring in the marketplace (Sniderman et. al., 2016b). Faster and more agile competitors may be less prone to keeping the status quo in place, making them more open to disruption. It might be challenging to identify and prevent the root causes that lead organisations to become inert. This is a serious problem since people who are stuck in inertia frequently don't notice it until their financial performance starts to decline or they are so behind the competitors that it is arduous, if not unattainable, for them to close the gap (Moeuf et. al., 2017). Organizations must, ultimately, broaden their strategic perspectives in order to take advantage of the opportunities Industry 4.0 will present.

SME leaders cannot be narrow-minded and focus just on short-term increased profitability when strategic debates increasingly centre on how business may change and benefit from innovation (Muller, 2019). Instead, it's critical to adopt a broader, longer-term vision that acknowledges the expanded role that organisations may serve in the proper application of disruptive technology (Briggs, 2017). Successful entrepreneurs will adopt a global perspective. They will notice links between company and societal requirements, financial results and creative initiatives, worker productivity and a changing population, and streamlining processes and adding new value. Determining the bigger picture can be beneficial in the long run.

2.3 Workforce Evolution

Notwithstanding the effects that Industry 4.0 would have on working population across all sectors and regions, many of the entrepreneurs do not show a sense of urgency in regard to addressing the issue of the future of the employment population. Most Organizations feel they are doing everything possible to get their employees ready for Industry 4.0, and that they can trust the

current educational institutions to adequately train and equip people, and that they can retrain current personnel as necessary (Lorenz et. al., 2015)(Nardo et. al., 2020).

Although it may be too soon to predict how or to what extent, it is a reality that many professions and the skills needed for them will change significantly. When attempting to predict the changes, administrators can take into account two primary forces: technology (such as robotics and cognitive/AI) and the evolving working population (i.e., gig economy, crowdsourcing, etc.) (Schwartz et. al., 2017).

Only a small fraction of businesses believes their frameworks are highly capable of foreseeing and managing the impacts that technological advancements will have on their workforce and organisational structures. Robotic systems and artificial intelligence are one area where the implications of technology are particularly troubling. Academics and business executives predict more employment where humans and machines work together (Hagel et. al., 2017a). Even though it is frequently discussed that the threat that technology poses to low-skilled occupations, almost every skill level will be impacted (Fareri et. al., 2020). However, for historical reference, technology has created far more jobs than it has wiped out (Steward et. al., n.d).

A framework that is more comprehensive than what SMEs are presently doing will be needed to create such a cooperative, ethical work/life culture. Businesses are typically the best at utilising cutting-edge technology to help workers work more effectively. However, this strategy, which restricts how people engage with technology to efficiency, could harm a company's ability to succeed. The staff needs to be adept at using technology as a potent agent of change if they are to meaningfully contribute to the creation of the i4.0 society (Stephan et. al., 2017).

A wide, social perspective must be taken into consideration as firms attempt to make the leap from using technology to alter their workforce. Many businesses believe that the labourers of their companies will increasingly consist of contract, temporary, and/or ad hoc workers. This is corroborated by a broader economic trajectory that indicates that one of the workforce sectors that is expanding the fastest is that of alternative workforce arrangements, where more employees are working off-campus and off-balance-sheet.

Industry 4.0 has the potential to open up opportunities for new roles that let people play to their strengths while working in conjunction with technology for continual improvement, unconventional work environments, and realigned roles and institutions for organisations that look beyond employee efficiency to consider how humans will interact with technology, how their organisations will end up serving unorthodox workers, and how they will empower all of their workers (Hagel et. al., 2017b).

2.4 Embracing Technology

To transition to i4.0, SMEs must be able to adapt and integrate physical and digital technologies in order to enhance processes, increase productivity, expand, and innovate. Any organisation could experience a significant transformation as a result. However, to fully realise Industry 4.0's transformative potential, it is also necessary to see the usage of linked, smart technologies from a wider angle. Companies are quite skilled at leveraging digital technology to accomplish the same tasks they've previously done, but faster and better, in these early stages of the revolution. True i4.0 firms go a level farther and gain competitive advantages through new business

models, figuring out new approaches to value creation, delivery, and capture. It can be difficult to make the transition from well-worn ground to truly innovative territory (Rajnai and Kocsis, 2018).

Industry 4.0 is revolutionary because technology gives businesses the ability to collect information about the world, analyse it digitally, and use the results to make better decisions in the real world. The physical-to-digital-to-physical loop, which is a perpetual and circular exchange of information, enabling enterprises to respond instantly to ecosystem shifts (Rocha et. al., 2018). Furthermore, it enables SMEs to use the enormous amount of data collected to begin spotting trends, simulate and model likely future scenarios, and even react and foresee prospective adjustments. As a result, they might be more open to unexpected market shifts, more ready to adjust to unexpected environmental changes, and better prepared to handle issues on both an internal and external level. Companies that leverage Industry 4.0 technology more broadly, incorporating partners, suppliers, consumers, employees, and other members of their ecosystems, can reap more profound advantages. Networks that can span various core processes, external organisations, and sectors are needed for new value-creation models (Qi and Tao, 2018).

How can SME leaders choose which technologies or business models to pursue when many organisations are not quite comfortable with the most transformational uses of technology and none can predict which scenarios will eventually become prevalent (CIPD, 2020)? There are various methods to undertake digital transformation, and enterprises can do so across their ecosystems in multiple directions at once. It is normal for SMEs to build on their current assets as they incorporate sophisticated technology, but it's crucial that new technologies pave the way for new business models.

The speed at which technologies are changing business is highlighted by this quick transition from opportunity to maturity. It also emphasises the necessity to achieve the right combination when approaching technology innovation by providing opportunities for long-term business cases and new value generation.

3. Case Study

(Plastic technology magazine, 2022) Peak nanosystems is a manufacturing SME with 62 employees, that specialises in nanolayered polymer optical lenses and thin films. The company was founded to commercialise nanotechnology. To scale up the business, the company's leaders looked to industry 4.0 technology for help. Peak nano had to make a significant financial investment, costing \$40 million in robotics alone. These robots, with big data, were tasked to produce nanolayer lenses on a commercial scale. Their lenses are coextruded on a dedicated machine to provide constant, highly configurable optics combinations. The polymer film is then robotically inventoried and trimmed. A robot will gather every one of the individual films—there may be as many as 300, each with hundreds or even thousands of nanolayers—and stack them in a precise order when it's time to make a lens. The film stack is then flattened out by the automated system to make a sheet that is between 3-5mm thick and, again, through automation these sheets shaped into a lens preform. The lens is then finished by machine work.

This SME is the key to differentiation within a very mature optical market. Everyone with the optics community is looking for the next big thing. Peak nano's ability to utilise industry 4.0 technologies to automate its workforce is a significant game changer. For comparison, a globally known optical manufacture based in North Wales, that has been around for over a century, relies on a nearly 700 workforces to manufacture convention precision optics. This shows that SMEs who adopt

i4.0 can provide considerable disruption to a market sector that has been stable for a generation. The replacement of repetitive manual labour with automated smart robotics has obviously has an impact on the potential working population. However, it has opened the possibility for highly skilled engineers to explore completely new problems and innovate beyond the third industrial revolution.

The embrace of i4.0 at peak nano also extends beyond the smart automation, and the revolution allowed them to breakthrough into two core markets, the optics market and the film capacitor market, providing significant technology disruption to the marketplace through new business models.

Peak nano, although the SME was born 2016, is still only scratching the surface of what they can achieve. They are currently exploring multiple things at one time. From building a large smart automated manufacturing plant whilst designing completely new systems that could trickle into a multitude of markets. They have incorporated their small team of employees into a connected environment where they are only just making the inroads into what their people can do and what their business can achieve as the power of industry 4.0 grows.

4. Methodology

A systematic assessment of the literature based on content analysis has been carried out in accordance with the current best practises. This includes the three phases of material gathering, category selection, and material evaluation. Reviews based on content analysis are applicable to any written communication, including websites and industrial standards, as well as academic publications.

5. Conclusion

Industry 4.0 serves as an illustration of how businesses and people's daily lives are being transformed by intelligent, connected technology. Although the fusion of physical and digital technologies creates a wealth of new possibilities, it also carries the risk of upsetting the status quo and increasing uncertainty. An innovative suggestion from a newcomer has the power to overthrow an established position, just as a sizable digital data set improved by artificial intelligence and sophisticated models can compete with the wisdom earned through years of real-world experience.

Secondly, Industry 4.0 aids SMEs to benefit from network-based, data-driven, autonomous, and cognitive digital systems instead of only leveraging technology to pursue the very same old business strategies, allowing physical technologies to build truly creative business solutions. However, along the way, its influences may expand rapidly and affect everything that organisation encounters. Consequently, it is critical to comprehend the key connections between business and social needs, financial results and creative strategies, productivity levels and people's perceptions of stabilisation and well-being, and the integration of current technologies with the development of entirely new solutions.

One thing is certain: The Fourth Industrial Revolution is here, and SMEs need to be prepared. Although it has the potential to disrupt many aspects across a wide spectrum—work, operations, and society—it is now here. It is obvious that the old method of operating is no longer sufficient, and those who fully embrace Industry 4.0 and all the opportunities it presents will have the greatest influence.

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