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The Impact of Industry 4.0 on the Business Models of Small and Medium Enterprises: A Systematic Literature Review

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Abstract

New digital technologies, referred to as Industry 4.0, can create many opportunities, not only for larger organisations, but for small and medium enterprises (SMEs) as well. However, for SMEs to create value from Industry 4.0, the digital technologies must be applied in alignment with the SMEs' business model as the SME business model is the means through which the SME creates value. This study aimed to identify the key impacts of Industry 4.0 on business models SMEs through conducting a systematic literature review and a detailed analysis of 27 papers. We identified 5 primary impact areas namely customer, financial, organisational, employee and cost structure collated from of 23 sub impact areas. In order to report our findings, we mapped it to business model components consisting of value creation, value proposition and value capture. Through considering business model impact, SMEs may be able to leverage the technology platforms in Industry 4.0 towards business value creation and economic sustainability.

Keywords: Industry 4.0, small and medium enterprises, business models

1. Introduction

SMEs may be considered as the backbone of an economy and have direct influence on a nation's Gross Domestic Product [1, 2]. Like with the previous industrial revolutions, the Fourth Industrial Revolution (Industry 4.0), brings many changes in the way organisations function [3]. The implementation of Industry 4.0 technologies requires a business model to be redesigned to be sustainable and facilitate a magnitude of factors that arise from such a transformation [3, 4]. A business model, in this context, provides an approach towards a better understanding as to how Industry 4.0 technologies can be used to create and capture value, as well as generate revenue [3, 5, 6]. A business model is an *“organisation's approach to generating revenue at a reasonable cost, and incorporates assumptions about how it will both create and capture value”* [4, 5: 263].

There have been several studies conducted on the impact of Industry 4.0 on organisations, economies, and education in general. However, according to Müller [7], research on how business models of SMEs are affected by Industry 4.0, is very scarce. Therefore, this study aims to answer the research question: *“What are the key impacts of Industry 4.0 on the business models of SMEs?”*. By considering these impacts on

business models, SMEs may be able to consider opportunities more holistically in their effort to apply the advantages that Industry 4.0 technologies bring.

This paper is structured as follows: in Section 2 highlights the background to the study and in section 3, the research approach is presented. Section 4 contains the data analysis and the findings and contribution are discussed in Section 5. We conclude the paper in Section 6.

2. Background

SMEs make up, and contribute to, a significant part of the global economy [1, 2]. Yet, SMEs deal with several challenges pertaining to strategic planning and implementation when considering technologies that evolved in the realm of Industry 4.0 [8]. These challenges include a lack of focus on a strategy for their products and investments, lack of capital investment based on a targeted technology roadmap and lack of skills to address the impact, and opportunity, of Industry 4.0 technologies [8-10]. This is where business models play an important role as business models provide a framework to create value, capture value and generate revenue. Business models provide an approach and an understanding into utilising resources and infrastructure to provide value [11-15]. Joan [15] argues that a new technology will not succeed without a good business model.

In this section we provide background to the study by discussing business models in the context of SMEs, the scope of Industry 4.0 and the impact of the evolution of digital technologies on SMEs.

2.1 Business Models

Several definitions for business model exist in the literature. Hummel, Slowinski [11] defines a business model as the logic and principles by which a firm generates revenue. However, they go further into explaining that business models are the organisational structures, its resources and infrastructure around its business model to provide guidance on how things should be done. According to Baden-Fuller and Mangematin [12], a business model is defined as a framework used to create and provide value to the organisation and consumers, as well as generate revenue and profits.

A business model contains different elements, each element carrying a different responsibility to ensure the organisations success. Clauss [16] argues that there are three elements of a business model, namely value creation, value offer or value proposition and finally, value capture. The *value creation* element of the business model describes how and by what means the organisation creates its value [16]. Mueller and Daeschle [17] describes the value creation element as the tasks and work performed for the organisation to provide value to its customers. The value proposition, also termed value offer, addresses the aspect of the actual dealing with the customer. The actual dealing with the customer covers the aspect of different product and service offerings to capture the customer's attention and ultimately, their support and business. The value offer can be described as the bridge between value creation and the final stage of value capture [1, 13, 16].

Baden-Fuller and Haefliger [13] describes the value capture element as an organisation's method of capturing and delivering value. It can be further understood as the way in which value proposition is converted into revenue for the organisation which is used to cover costs and ultimately make a profit [7, 13, 16].

2.3 SMES and New Technologies

When it comes to SMEs, the adoption of new technologies is lagged as opposed to larger organisations [18]. In studies previously conducted relating to the third industrial revolution and the adoption of the internet by SMEs, a few challenges were identified such as: lack of understanding of the technology and how it can be incorporated into the organisation; lack of research and development; lack of skills to use the new technology and the price of technology [18, 19].

From more recent studies conducted with regards to Industry 4.0 and the adoption by SMEs, the same issues are still prevalent compared to findings from previous industrial revolutions. A significant challenge to the adoption is identified from the cost vs benefit analysis of Industry 4.0. Unlike major corporations and larger enterprises, SMEs have a limited workforce and limited funding. The limitation in funding plays a vital role in the adoption of Industry 4.0. Another major challenge is that Industry 4.0 brings a significant change to how the organisation would function. In the initial stages of implementation, the SME would be required to use a substantial amount of capital to set up for Industry 4.0, and the return on this is not delivered immediately. It takes time for the return to grow to before having a vital effect [6, 8, 10, 20, 21].

2.3 The impact of Industry 4.0 on SME's

Industry 4.0 applies different components and machines to create a more extensive system. Each component and machine plays a role to support the broader objective of the organisation [3, 9, 17, 22, 23]. The initial literature and reports on Industry 4.0 suggested that it will have a substantial benefit on SMEs; however other research argues that Industry 4.0 will have a negative impact on SMEs [8]. There are visible and noticeable changes in the structure and in the way SMEs operate, that result from Industry 4.0. SMEs are no longer seen as a standalone organisation, but as a component in a more extensive network [24]. SMEs that have adopted Industry 4.0 now form part of a new digitalised landscape and environment, changing the SME business model from a "seller" to a "networker". To continue operating, SMEs need to adapt to the ever-changing digitalised environment, while managing the drastic changes in the traditional business models of SMEs as Industry 4.0 aims to make organisations more productive. This effort results in drastic changes in the operations, structure and manner in which business is conducted [1, 3, 24, 25].

3. Research Approach

The aim of this study was to understand the key impacts of Industry 4.0 on the business models of SMEs. In order to achieve this outcome, a systematic literature review

(SLR) was conducted [26]. In order to conduct the literature search, academic databases such as ScienceDirect, ResearchGate, Google Scholar, Academia, Emerald Insight, SpringerLink, IEEE Xplore Digital Library and Web of Science containing peer reviewed literature were searched. Initially, there were 242 articles identified and screened. Inclusion criteria such as publications between the years 2011 to 2019, English papers and articles relevant to the research question were applied resulting in 27 articles remaining which were used for the purpose of the SLR.

The selected papers were analysed and 23 sub-themes related to Industry 4.0 impact on SME business model were extracted. Through a process of axial coding, linkages between the identified sub-themes were constructed [27] and 5 themes were identified as depicted in Table 1. The identified themes were customer; financial; organisational; employee and cost structure.

Table 1: Themes and sub-themes extracted of the impact of Industry 4.0 on the business models of SMEs

Theme	Sub-Theme	Literature
Customer	Customer Relationships	[1, 3, 7, 9, 12, 22, 28-34]
	Customer Satisfaction	[7, 31, 32]
	Customer Service and Support	[10, 22, 23, 32]
	Customer Retention	[22, 35]
	Customer Identification	[13, 31, 34]
	Customer Understanding	[9, 23, 25, 33, 34, 36]
	Customer Interaction	[3, 33]
	Customer Segments	[3, 7, 24, 30]
Financial	Revenue Model	[1, 7, 22, 24, 33, 34]
	Revenue Streams	[1, 7, 13, 22-24, 29, 30, 34, 35]
	Product and Service Offerings	[1, 7, 22, 24, 25, 28-34, 37]
	Product Innovation	[3, 23, 24, 29, 30, 34, 38]
	Increased Competition	[1, 9, 23, 31, 32, 35, 37, 38]
Organisation	Organisational Structure	[3, 23, 39]
	Organisational Culture	[23, 24, 28, 34, 40]
	Business Processes and Key Activities	[22-24, 31, 33, 35, 41]
	Industry partners and business relationships	[1, 3, 7, 22, 24, 25, 28, 30, 34, 36]
Employee	Employee Relationships	[3, 9, 33]
	Employee selection and adoption	[3, 7, 9, 23, 28, 32-34, 41]
	Employee Skills and Training	[3, 22, 23, 28, 32-35]
Cost Structure	Capital Investments	[7, 10, 42]
	Equipment, machinery and technology	[1, 3, 7, 10, 24, 32, 34]
	Reduced costs and increased productivity	[1, 31]

For each theme identified, all the relevant sub-themes and references are shown in Table 1. Each theme and its sub-themes are discussed in detail in the next section.

4. Analysis and findings

The purpose of this paper was to define the key impacts of Industry 4.0 on the business models of SMEs. Through the SLR, 23 sub-themes coded to 5 primary themes were identified.

4.1 Theme 1: Customer

The customer theme is comprised of 8 sub-themes and addresses the customer aspect of the SME business model. Customer relationships are the different links and relationships that an SME establishes between itself and its consumer base. Customer segments describe the different groups and types of customers that the business wants to deal with. Another important aspect of the customer theme is the customer identification and customer understanding sub-themes addressing the way in which target customers are identified and understood. Customer understanding also contributes towards customer retention and customer satisfaction.

Table 2: Customer Theme Frequency

Theme	Sub-Theme	Frequency
Customer	Customer Relationships	13
	Customer Satisfaction	3
	Customer Service and Support	4
	Customer Retention	2
	Customer Identification	3
	Customer Understanding	6
	Customer Interaction	2
	Customer Groups	4
	Total	37

The frequency count for the customer theme is 37. Table 2 summarises the number of times each sub-theme in the customer theme is mentioned. The sub-theme which occurred the most throughout the literature was the Customer Relationships theme (13).

4.2 Theme 2: Financial

The financial theme comprises of the revenue model, revenue streams, product and service offering, product innovation and increased competition. Revenue streams refer to the different means for the organisation to capture value and create an income. Industry 4.0 has a major impact on the streams of revenue and therefore has an impact on the revenue model. With industry 4.0, there are more possible models of pricing for example, pay per use or pay per feature. The revenue streams in certain cases can have a direct relationship with the product and service offerings as such that, as a product or service is developed, changed or removed, the revenue stream is affected. However, the relationship is not one-sided; when a revenue stream is changed, removed or developed, the product and service offerings have to adapt to the revenue streams. Product innovation is closely tied to product and service offerings as well as revenue streams. The literature describes product innovation as an important factor in the adoption of industry

4.0 and the organisations success henceforth. Increased competition is centred on competitive advantage and market competition. The way in which market competition is approached and the means to get a competitive advantage is the focus of this sub-theme.

Table 3: Financial Theme Frequency

Theme	Sub-Theme	Frequency
Financial	Revenue Model	6
	Revenue Streams	10
	Product and Service Offerings	13
	Product Innovation	7
	Increased Competition	8
Total		44

The entire financial theme collated reflected a frequency of 44. Table 3 contains an overview of the financial theme as well as the number of times the sub-themes were mentioned in the literature analysed.

4.3 Theme 3: Organisation

The organisational theme consists of 4 sub-themes addressing the day to day running of the organisation, as well as the structure and layout of the organisation. The industry partners and business relationships sub-theme addresses the links and relationships the organisation with possible key partners, suppliers and any other personnel in the business model. Industry 4.0 brings a change to the way in which the business will maintain relationships with key partners, competition and other relationships surrounding the organisation. The relationships upheld with partners and business personnel is an important part of the business model and plays a role in the intended success and functionality of the organisation. Business processes and key activities address how tasks are set out and completed. It also entails the everyday operations and tasks of the organisation and the ways in which they are completed. The business processes and key activities also affect the structure and culture of the organisation. The organisational structure and culture can affect the selection and adoption of employees as well as employee training and skills.

Table 4: Organisation Theme Frequency

Theme	Sub-Theme	Frequency
Organisation	Organisational Structure	3
	Organisational Culture	5
	Business Processes and Key Activities	7
	Industry partners and business relationships	10
Total		26

The organisational aspect including all sub-themes was mentioned a total of 26 times through the literature reviewed. Table 4 contains a summary of the frequency of the organisational theme.

4.4 Theme 4: Employee

The SME may proceed with the adoption of Industry 4.0 opportunities, but in order to do so, the employees need to be prepared and trained for this. There are 3 sub-themes that were identified within the employee theme. Employee skills and training, employee relationships; employee selection and adoption. Employee skills and training discusses the aspects of the core competencies and minimum requirements required by the employees of the organisation. With Industry 4.0, the entire dynamic and role of the workforce are altered. The organisation requires more skilled workers to form part of the workforce. The literature suggests that there would be a predicted staff reduction in the lower and middle qualified workers. It is also apparent that the organisations need for more skilled workers would either require a new selection of staff or extensive training.

The dynamics of the relationship between employee and employer will also be impacted due to the implementation of Industry 4.0 technologies - the employee relationship aspect evaluates and discusses the change in links and relationships within the SMEs staff. The literature further suggests that there will be a major impact on the relationships surrounding the organisation e.g. with suppliers or vendors.

Table 5: Employee Theme Frequency

Theme	Sub-Theme	Frequency
Employee	Employee Relationships	3
	Employee selection and adoption	9
	Employee Skills and Training	8
Total		20

The employee theme is mentioned a total of 20 times in the analysed literature. Table 5 contains a summarized version showing the number of times the employee theme and sub-themes we addressed in the literature found.

4.5 Cost Structure

The cost structure entails the financial and monetary impacts of the adoption of Industry 4.0 on the organisation. During the initial phases of the implementation of Industry 4.0, there is a requirement for larger capital expenditure as well as newer equipment and machinery. Industry 4.0 requires newer technologies and equipment, machinery and different types of technologies to perform the required functions. They are usually costly and was an aspect clearly identified from the SLR dataset. Capital investments, while they are mainly comprised of equipment, machinery and different technologies, they also include employee training and potentially new warehousing.

The third sub-theme within the cost structure theme dealt with reduced costs and increased productivity. In the literature, there is a consensus view that Industry 4.0 will bring about reduced costs in the long term and a more efficient and effective method of production, thereby increasing the overall productivity of the organisation. This will have a relationship with the customer offerings, such that products can be produced faster and with better quality than the conventional means. This does pave the way for a larger customer base as well as a new customer base. There is also agreement that industry 4.0 will allow for future growth.

Table 6: Cost Structure Theme Frequency

Theme	Sub-Theme	Frequency
Cost Structure	Capital Investments	3
	Equipment, machinery and technology	7
	Reduced costs and increased productivity	2
Total		12

The cost structure theme is a key aspect of implementing and utilising Industry 4.0 and is mentioned in the literature 12 times. Table 6 contains a summary of the frequency of the relevant sub-themes.

5. Discussion

Figure 1 summarises the top 5 themes which were identified in the dataset. From the analysis of themes and sub-themes based on frequency count (section 4), the top 5 sub-themes may be identified. The sub-themes which presented itself the most was the Product and Service offerings theme and the Customer Relationships theme (13 times each, 48.14% each). Capital investments in equipment, machinery and technology, as well as Revenue Streams and Industry Partners and Business relationships presented 10 time each and related to 37.03% each of the total sub-themes identified. These themes will be considered the key elements and themes to be affected by Industry 4.0 for the purpose of this study.

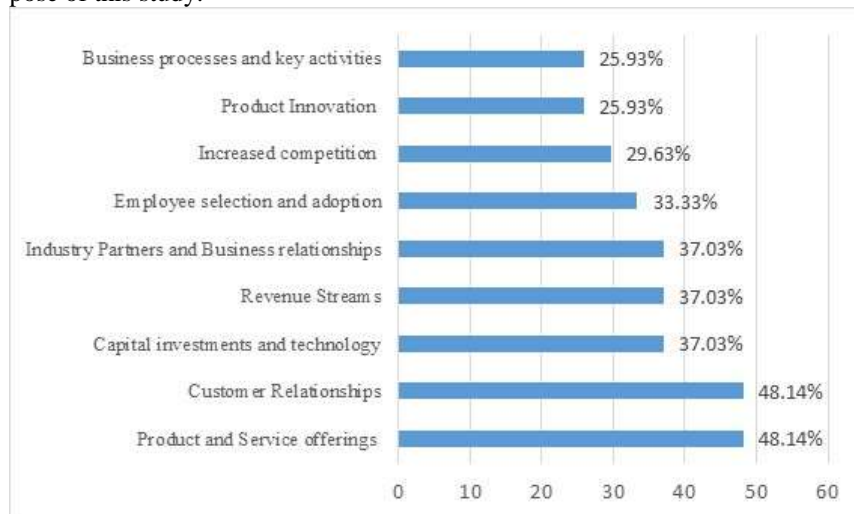


Figure 1 Top 5 business model impact sub-theme frequency

In order to report the SLR findings, the business model definition of Clauss [16] consisting of 3 aspects namely value creation, value proposition and value capture were used to map the themes and sub-themes to. Figure 2 diagrammatically represents the business model elements to which each theme and sub-theme belong to.

VALUE CREATION	VALUE OFFER / PROPOSITION	VALUE CAPTURE
<p>EMPLOYEE</p> <ul style="list-style-type: none"> • Employee Relationships • Employee selection and adoption • Employee Skills and Training 	<p>FINANCIAL</p> <ul style="list-style-type: none"> • Product and Service Offerings • Product Innovation 	<p>FINANCIAL</p> <ul style="list-style-type: none"> • Revenue Model • Revenue Streams • Increased Competition
<p>ORGANISATION</p> <ul style="list-style-type: none"> • Organisational Structure • Organisational Culture • Business Processes and Key Activities • Industry partners and business relationships 	<p>CUSTOMER</p> <ul style="list-style-type: none"> • Customer Relationships • Customer Identification • Customer Understanding • Customer Interaction • Customer Segments 	<p>CUSTOMER</p> <ul style="list-style-type: none"> • Customer Satisfaction • Customer Service and Support • Customer Retention
<p>COST STRUCTURE</p> <ul style="list-style-type: none"> • Capital Investments • Equipment, machinery and technology 		<p>COST STRUCTURE</p> <ul style="list-style-type: none"> • Reduced costs and Increased productivity

Figure 2 Industry 4.0 business model impacts on SMEs

The value creation element consists of three themes; employee, organisation and cost structure. The aspects of the organisation can have a major impact on employees and the sub-themes within the employee aspect. Within the value proposition element, two themes were mapped: Financial and Customer. The most mentioned themes (Figure 1) are the Customer Relationships theme and the Product and Service offering, both of which fall within the value offer element. Finally, the value capture element contains 3 themes: Financial, Customer and Cost Structure. It must be noted that Cost Structure, Financial and Customer had to be mapped at a sub-theme level as some sub-themes related to different business model elements.

6. Conclusion

Industry 4.0 can create many opportunities for not only larger organisations, but for SMEs as well. However, for the technology of industry 4.0 to create value for the SME, the technology needs to be used in alignment with the business model. In order to consider the impact of Industry 4.0 on the business models of SMEs, we conducted an SLR to identify business model impacts and identified 5 themes and 23 sub-themes. In order to report the business model impacts, the themes and sub-themes were related the components of a business model as defined by Clauss [16]: value creation, value proposition and value capture. By enabling SMEs to consider business model impact and opportunity holistically, they may be able to leverage the technology platforms in Industry 4.0 towards business value creation and economic sustainability.

The next step in terms of this research study is to test the Industry 4.0 business model impacts on SMEs in practice and collect data regarding the actual experiences from SMEs compared to our research findings.

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