Abstract: Technology adoption is always a difficult task for Small and Medium-sized Enterprises (SMEs) due to lack of resources and other market issues. Many technology challenges adversely affect the sustainable business performance of SMEs. However, the incorporation of Industry 4.0 can overcome various technology issues. The goal of Industry 4.0 is to attain an advanced level of operational effectiveness and productivity, as well as a higher level of automatization. Thus, the objective of this study is to identify the role of Industry 4.0 to promote sustainable business performance in SMEs in Thailand. A survey has been prepared to collect the data from managers of SMEs and analyzed with the help of Partial Least Square. The questionnaire was used to collect the data and questionnaires were distributed by using simple random sampling. A total of 500 questionnaires were distributed amongst the managerial staff of SMEs located in Thailand. From these distributed questionnaires, 280 were returned and 270 valid responses were found. Data were analyzed by using Partial Least Square (PLS)-Structural Equation Modeling (SEM). Findings reveal that Industry 4.0 is a key to the growth of sustainable business performance among SMEs. Elements of Industry 4.0 such as big data, Internet of Things and smart factory have a positive role in promoting information technology (IT) implementation, which contributes to sustainable business performance. Moreover, organization structure and process strengthen the positive relationship between Industry 4.0 and IT implementation.

Keywords: Industry 4.0; big data; business performance; IoT; smart factory; SMEs

1. Introduction

The objective of Industry 4.0 is to attain an advanced level of operational effectiveness and productivity, as well as a higher level of automatization (Ślusarczyk 2018; Thames and Schaefer 2016). As Industry 4.0 has a significant role in the production and service sectors, it has a direct relationship with performance (Imran et al. 2018; Rüßmann et al. 2015; Shrouf et al. 2014; Waschneck et al. 2016). Roblek et al. (2016) and Posada et al. (2015) have mentioned that various features of Industry 4.0 are highly connected with internet technologies as well as progressive algorithms. However, they also specify that Industry 4.0 is one of the technical procedures of value addition and effective knowledge management practices.

Despite the extensive literature on Industry 4.0, a systematic, as well as a comprehensive review of studies on Industry 4.0, is missing (Lu 2017). Consequently, this study proposes a framework with the help of Industry 4.0 and presents the significance of this fourth revolution in Small and Medium-sized Enterprises (SMEs). It presents how Industry 4.0 is useful to overcome various technological challenges in SMEs and improves sustainable business performance. This study especially emphasizes on SMEs situated in Thailand. SMEs performance in Thailand increased in 2017 as is shown in Figure 1. In 2017, the increase in annual revenue was 44%, the increase in efficiency was 42%, the increase in business savings was 31%, the reduction debt was 26%, and the increase in investment was 25%.

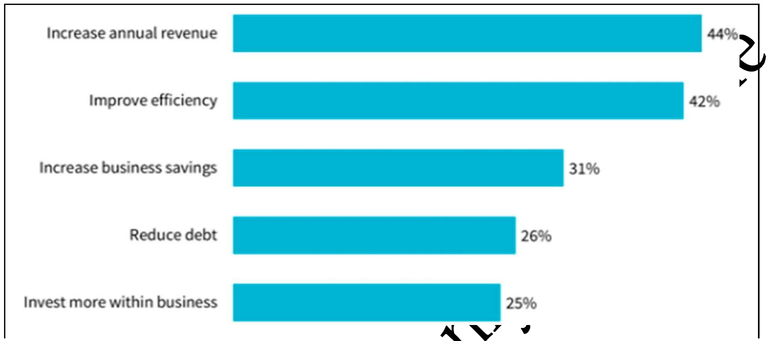

Figure 1. Thailand SMEs Performance. Source: RFI Group—Thailand SME Banking Council (2017).

SMEs are the pillar of the economy in many countries because this sector has a generous contribution to the economy through GDP (Gross Domestic Product) creation (Etuk et al. 2014; Ilegbinosa and Jumbo 2015; Lloyd 2002). Due to the nature of small-scale businesses, SMEs have various issues. One among them is a technological issue (Acs and Preston 1997; Dobrović et al. 2018). Due to technological challenges, the performance of SMEs is not smooth. SMEs experience limitations when adopting the latest technology as it is adopted by the big organizations. This is the reason that the performance is low in the SMEs sector of Thailand due to various challenges (Chittithaworn et al. 2011). These SMEs are unable to maintain constant growth in performance. Therefore, there is a performance sustainability issue in SMEs of Thailand.

Technology adoptions are always a difficult task for small scale businesses (Burgess 2001) due to a lack of resources and other market issues. SMEs are facing issues in technology implementations (Jones and Kato 2003). These technical issues are related to the data management, data extraction and functional structure of the organization that support the new technology implementation. Technology also requires well-skilled people for proper implementation. Therefore, while adopting the latest technology, SMEs requires good human capital for better implementation.

It is possible to overcome all these issues with the help of Industry 4.0. Industry 4.0 has a positive role in resolving various issues related to data management and other technological issues. Due to these features, Industry 4.0 has a significantly positive effect on boosting products and services (Imran et al. 2018). Various Industry 4.0 factors such as big data, Internet of Things (IoT) and smart factory have a positive role in boosting sustainable performance. Therefore, incorporation of Industry 4.0 can increase sustainable business performance by resolving various technology issues. Thus, the objective of this study is to identify the role of Industry 4.0 to promote sustainable business performance in Thailand SMEs.

The current study is one of the pioneer studies which discussed the role of Industry 4.0 in technology management. Literature is available which shows the connection between Industry 4.0 and technology management; however, it was very rare that any study formally documented the role of Industry 4.0 to resolve the technological issues, particularly in SMEs. Therefore, this study contributed to the literature by providing valuable insights in technology management through Industry 4.0.

2. Theoretical Outlook and Hypotheses Development

The present industrial expansion has continued for many decades, and currently, it is in the age of Industry 4.0 (Lu 2017). The concept of Industry 4.0 was originally planned for an emerging German economic system in the year of 2011 (Vogel-Heuser and Hess 2016). Lukacˇ (2015) mentioned that the first industrial revolution started in the last period of 18th century. This revolution was characterized by automatic production plants grounded on the water as well as steam power. The second industrial revolution began in the early 20th century, characterized by mass labor production grounded in electrical energy. The third industrial revolution started in the 1970s with the distinctive features of programmed production grounded in new technology related to the internet. Finally, the fourth industrial revolution, namely; Industry 4.0, is continuing including the features of Cyber-Physical System (CPS) production, grounded in diverse data as well as knowledge combination (Lu 2017). The principal characters of CPS are based on the notion to achieve dynamic necessities of production and to advance the efficiency and competence of the whole industrial sector. Industry 4.0 includes many technologies and related patterns, cloud-based manufacturing, various resource planning activities, IoT, and social product progress (Georgakopoulos et al. 2016; Kube and Rinn 2014; Lin et al. 2016; Nagy et al. 2018; Pfeiffer 2016; Thamsen and Wulff 2016; Wan et al. 2016) and has a significant role in digital English and education (Hariharasudan and Kot 2018). Most of the features are shown in Figure 2. These features include: cloud computing, augmented reality, multilevel customer interaction, advanced algorithms with big data, smart sensors, mobile devices, IoT platforms, location detection, advanced human machine and 3D printing.

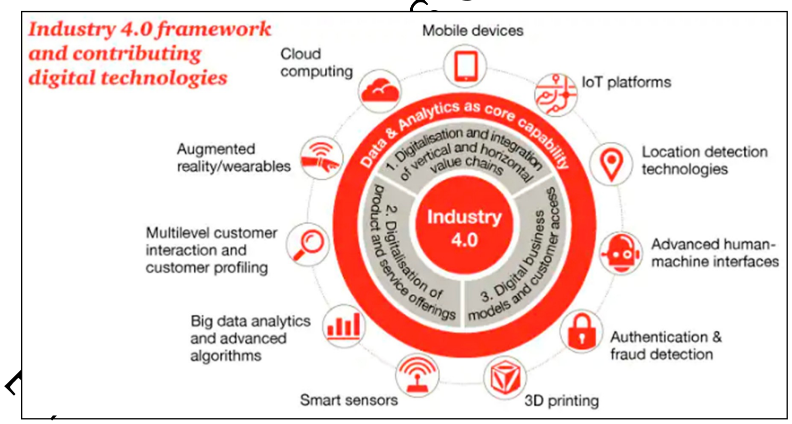

Figure 2. Industry 4.0 technology features and contributions towards digitalization. Source: Industry 4.0: Building the digital enterprise, 2016 global industry 4.0 survey, PwC engineering, & construction 2016.

Academics have described Industry 4.0 from various viewpoints in this group. For instance, Industry 4.0 is "the integration of complex physical machinery and devices with networked sensors and software, used to predict, control and plan for better business and societal outcomes" "(Industrial Internet Consortium 2017). Henning (2013) defines Industry 4.0 as "a new level of value

chain organization and management across the lifecycle of products". Hermann et al. (2016) describe Industry 4.0 as "a collective term for technologies and concepts of value chain organization".

This study is concerned with the three major elements of Industry 4.0 which comprise big data (BD), IoT and smart factory (SF). All these factors have a significant connection with the production and services of SMEs, and increase the performance (Imran et al. 2018). Branches of Industry 4.0 including big data (BD), IoT and smart factory (SF) can resolve technological challenges of SMEs, and these ultimately increase the sustainable business performance. Figure 3 shows how Industry 4.0 promotes the performance. It shows that five Industry 4.0 factors have significant effects on production and services. Production and services have significant effects on production and service industry performance. Therefore, it shows that Industry 4.0 increases the production and service industry performance. It is proven by the literature that Industry 4.0 has a positive influence on production and services, and it increases the performance (Imran et al. 2018).

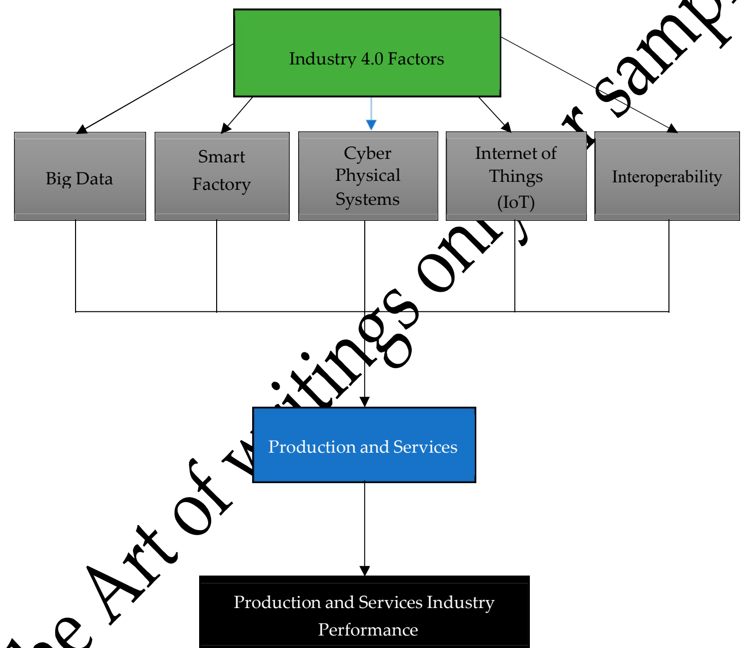

Figure 3. Industry 4.0 effect on performance. Source: Imran et al. (2018).

Big data is one of the umbrella terms for any method utilized to process a vast quantity of data, knowledge or information, including capture, safety, transmission, storing, analysis, search, confidentiality, and with data which is both structured and unstructured (Xu and Duan 2019). Big data is generally used to handle massive amounts of data (Hashem et al. 2015). The nature of big data encompasses extensive measures to identify and interpret the data into new ideas. Several scholars have used big data in previous studies. For example, Manyika et al. (2011) have mentioned that big data is a systematic visualization where "the amount of data just beyond technology's capability to store, manage, and process efficiently". Zikopoulos et al. (2013) have categorized big data by three Vs:

volume, variety, and velocity. "Big Data is a collection of data from traditional and digital sources inside and outside your company that represents a source for ongoing discovery and analysis".

Big data generally has a better advantage to implement new technology. It has a significant relationship with technology adoption (Dhar and Mazumdar 2014; Raguseo 2018). Therefore, the implementation of big data can overcome various technology-related challenges. It provides better technology, which helps to find better ways to store data efficiently (Gu et al. 2014; Lynch 2008). Initially, there were many challenges faced by various companies regarding data storage (Langer 2011; Rashmi et al. 2013; Yang and Jia 2012) but now Industry 4.0 resolves these issues by introducing big data technology in various firms. Therefore, SMEs could resolve technology challenges with the help of an efficient big data system.

Hypothesis 1 (H1). *There is a relationship between big data and IT implementation.*

Many researchers have examined business information technology (IT)-related matters to find their assistance. For instance, Dos Santos et al. (1993) emphasized on the declarations of IT investments as well as advanced IT investments. Brynjolfsson and Hitt (1996) and Hitt and Brynjolfsson (1996) utilized three procedures to examine the connection between IT as well as profitability. Bharadwaj (2000) employed resource-based insight to study technology ability and company performance. Hitt and Brynjolfsson (1996) considered the business influence of enterprise source planning. The ultimate purpose of these researchers has been to comprehend whether IT could assist firms in upsurging efficiency.

In current years, IoT has developed the most significant subject in numerous industries. IoT is not only the major buzz word in businesses but is an emerging drift, an established plan, and a ground-breaking technology. Initially, Ashton (2009) projected the idea of IoT and defined IoT as exclusively recognizable consistent objects with radio-frequency identification (RFID) expertise, which has the ability to alter the world. Tang et al. (2018) have specified IoT tools which connect through the network. Few initial IoT applications been previously industrialized in health sectors, transport, home utilization, and various self-propelled industries (He et al. 2014; Joshi and Kim 2008). Industry 4.0 is based on five vital skills of IoT: RFID, cloud computing, middleware, and different IoT software applications. IoT technologies have also been extensively used in numerous industries; for instance, IoT can advance logistics as well as supply chain effectiveness by providing more comprehensive knowledge (Flügel and Gehrmann 2008). Literature predicted that IoT would reach 26 billion parts in 2020, up from 0.9 billion in 2009. Therefore, we can understand the strength of the persuading power that IoT skills can bring. Presently, different research focusing on IoT emphasizes on the expansion of IoT technologies as well as applications, whereas no such research analyzes the influence of IoT execution on sustainable business performance; therefore, this study aims to fill this gap. After examining the prior studies, it is revealed that the study carried out by Huang (2015) detected the efficiency from an external view; on the contrary, the study carried out by Huang (2016), examined the performance from an inside view. By addressing the above mentioned studies, the present study proposes to examine sustainable business performance in SMEs through IoT and other fundamentals of Industry 4.0. This research is significant for managers to implement IoT as a significant technology for sustainable business performance.

IoT has a significant relationship with the latest technologies (Fortino and Trunfio 2014; Pang 2013; Patel and Patel 2016; Suresh et al. 2014; Yun and Bu 2010), which positively affects business performance. With the latest technologies of Industry 4.0, through IoT, the technological issues among SMEs are reduced as the IoT has a significant relationship with the business process (Dachyar and Risky 2014; Del Giudice 2016; Dweekat et al. 2017). Therefore, IoT can foster business performance through different technological issues, which decrease the technological challenges in business. IoT has a splendid concept with simple terms. IoT is connected or interlinked with multiple devices via the internet. Generally, three IoT components are used in business, including (a) hardware, (b) middleware, and (c) presentation (Gubbi et al. 2013), and these lead towards business performance. All these

components contribute to sustainable performance in SMEs. Sustainable performance always leads to better business survivability (de Sousa et al. 2018; Duygulu et al. 2016; Eisingerich and Bell 2008).

Hypothesis 2 (H2). *There is a relationship between IoT and IT implementation.*

Moreover, the notion of the smart factory (SF) is the combined relationship of numerous stages of original production from the preliminary planning stages to actuators in the field. The flexibility, the resource success, and the incorporation of supply, as well as demand procedures, are better in Industry 4.0; hence, factories, cities, production, equipment and things become smart (Varghese and Deepaknath 2014; Ali and Haseeb 2019). Stock and Günther (2016) explained that the key applications related to Industry 4.0 are Smart Factory (SF) and engineering the various smart products. In this field, Table 1 shows 27 studies in this group, 13 are related to smart factory and manufacturing, almost 10 debated on Smart Production, and the other four discussed smart City. Generally, smart factory has a significant role in manufacturing, and increases sustainable business performance.

Table 1. Studies on Smart Factory and Manufacturing.

Research Category	Publication
Smart Factory and Manufacturing	Chen and Xing (2015) Kolberg and Zühlke (2015) Oses et al. (2016) Paelke (2014) Pisching et al. (2015) Rüßmann et al. (2015) Wang et al. (2016) Sanders et al. (2016) Scheuermann et al. (2015) Shafiq et al. (2016) Thames and Schaefer (2016)

Industry 4.0 develops factories that are extra intelligent, dynamic and flexible by preparing to manufacture with different devices, and independent arrangements (Roblek et al. 2016). Consequently, machines, as well as tools, will attain great levels of automation. Additionally, the manufacturing procedure has the volume of satisfying more multifaceted and capable standards of products (Roblek et al. 2016). Therefore, factories with smart manufacturing are the primary purpose of Industry 4.0 (Sanders et al. 2016). Agent paradigm is documented as one of the real instruments for manufacturing in a smart way, which can increase the efficiency.

Industry 4.0 could make value-added addition, which arises horizontally as well as vertically in the procedure of manufacturing (Shafiq et al. 2016; Stock and Günther 2016). Precisely, the horizontal process is combined by various value making components, from the flow of material to the supply chain of the product life cycle, while the vertical process joins in the product, human needs and equipment with a diverse combination of value formation and manufacturing schemes. According to Lasi et al. (2014), Industry 4.0 initiates manufacturing in two different directions: the application-pull process and the technology-push process. Initially, it encourages dynamic changes produced by a new group of industrial structure.

Therefore, all these features of Industry 4.0 related to smart factory have a direct effect on technology implementation, which positively affects business sustainability, as a smart factory helps to develop a small production system, which ultimately supports sustainability in production (Shrouf et al. 2014) that facilitates business performance among SMEs. As various studies prove, Industry 4.0 has a positive effect on production (Brettel et al. 2014; Weyer et al. 2015; Zawadzki and Żywicki 2016).

Hypothesis 3 (H3). *There is a relationship between smart factory and IT implementation.*

From the above discussion, it is evident that Industry 4.0 factors such as big data, IoT and smart factory have a positive relationship with information technology implementation. Moreover, information technology implementation has a positive association with sustainable business performance. IT is an essential and significant resource to accomplish the business vision (Feeny and Willcocks 1998). Moshiri and Simpson (2011) point out that advances in IT can dramatically change individual and organizational performance such as transforming business organization, increasing competition, and fostering innovation. Technological advancement plays an important role in most sectors of the economy (Ali and Younes 2013; Szczepańska-Woszczyna 2014) and it significantly affects the way of doing business. In the automotive industry, IT is found crucial to making their operations responsive to customer requirements. The study by Moshiri and Simpson (2011) revealed that the use of computers by employees has a positive influence on the firm's productivity.

However, in most of the organizations, IT implementation is an issue. Nowadays, IT is extensively employed to strengthen and overcome the weaknesses of the supply chain, enhance operating efficiency, reduce operating costs, increase responsiveness, increase agility (Javanmardi et al. 2012; Chaudhry et al. 2017) reduce cycle times, develop collaborative work, expand market borders, develop seamless partnerships, improve teamwork, enhance customer relationships, proactivity on response (Fasanghari et al. 2007), increase information and product flow (Craighead and Laforge 2003), improve timeliness and accurate information flow (Kim et al. 2011). Therefore, the firm supports the utilization of IT to maintain and sustain the ability to satisfy the customer (Omar et al. 2006). The appropriate use of IT offers opportunities for the organization to improve the performance of supply chain, productivity and profitability. However, numerous companies' personnel are lacking of IT knowledge and IT skills (Fasanghari et al. 2007). Hence, it requires investments in human and social capital to build up a strong capability of IT and better implementation.

The resource-based view (RBV) of IT recommends that the IT resources in the firm can be the competitive capability of the firm. Bharadwaj (2000) points out that the firm's human IT skills, IT infrastructure, and IT reconfigurability are the firm's unique resources. Every single IT resource is unique and complex to acquire. The combination of the single IT resource created a firm's strong organizational capability (Bharadwaj 2000). The relationship between IT capability and organization performance is becoming more complex than ever before (Jeffers et al. 2008). Bharadwaj (2000) points out that various IT capabilities could be sources of competitive advantage. However, a limited number of studies have explored the RBV of IT capability, and most of the analyses to date are of a conceptual nature.

Therefore, technology implementation is the most essential step to building sustainable business performance among SMEs. Literature also shows that technology implementation and business performance have important connection with each other (Epelbaum and Martinez 2014; Malhotra 2005), increase sustainable business, and have a positive effect on overall business performance (Eisingerich and Bell 2008; Kristensen and Westlund 2004; Wang 2014). Therefore, it is needed for SMEs to develop good sustainable business practices, which will automatically lead to high performance, because it also reduces enterprise risk (Hameed et al. 2017). According to the previous literature, it is clear that IT is available in organizations; however, the implementation of IT is missing, and it shows negative results towards sustainable business performance. Therefore, implementation is most crucial factor in the IT system to get better results.

Hypothesis 4 (H4). *There is a relationship between IT implementation and sustainable business performance.*

Hypothesis 5 (H5). *IT implementation mediates the relationship between big data and sustainable business performance.*

Hypothesis 6 (H6). *IT implementation mediates the relationship between IoT and sustainable business performance.*

Hypothesis 7 (H7). *IT implementation mediates the relationship between smart factory and sustainable business performance.*

Consistent with Industry 4.0 and IT implementation, the organization structure and process (SP) should be supportive of adopting various technological changes. In the current study, structures and processes are grounded with how the organization categorizes for IT. It includes IT expansion, distribution of IT advantages, structures and the mechanisms for transporting business and IT organization together (Peppard and Ward 2004). Structures and processes are also measured as the process by which organizational movement takes place. Insufficient or unsuitable structures and processes can negatively affect the success of IT in firms (Delone and McLean 2003).

The IT organization advances the applications in reply to business requirements or grounded on what it thinks the business necessitates. Suitable structures and processes are essential to enable IT/business incorporation. Brown and Magill (1994) have worked on evolving a model of antecedents in the alignment of the function with the organization, yet that model has had exclusive emphasis on structural dimensions, which has overlooked the importance of total organizational involvement in IT. Therefore, the structure and process of the organization have an important role in technology implementation. Good organization structure and process lead to better strategic alignment, which leads to the better management processes, strategy, technology, individual/employee role and better technology implementation (Al-Majali 2011) as it is shown in Figure 4.

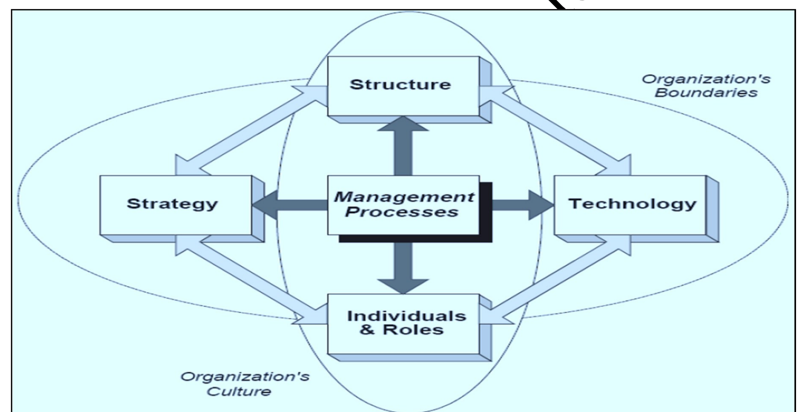

Figure 4. Massachusetts Institute of Technology Model. Source: Al-Majali (2011).

Henderson and Venkatraman (1999) explained that alignment includes compatibility addition among business strategy, IT strategy, and IT infrastructure and procedures. "Alignment has been defined as the degree to which the IT mission, objectives, and plans support and are maintained by their business counterparts (Reich and Benbasat 1990, 1996)". Marginson et al. (2000) designated alignment as the fit of IT strategies with different business plans as well as goals. However, Kanellis et al. (1999) specified that alignment is appropriate between its strategy and organization and, technology, structure, procedures as well as environment.

Various studies proved that technology implementation has a significant relationship with business performance (Brynjolfsson and Hitt 2000; Ghobakhloo and Hong 2014; Ho 1996; Hoque et al. 2011; Kihara et al. 2016) and structure and process of an organization shows a strong relationship with IT implementation (Heracleous and Barrett 2001) and it also a has relationship with strategy implementation (Skivington and Daft 1991). It also has an effect on strategy or technology implementation from Industry 4.0 that positively affects business performance among SMEs. If the organization structure and process is not supportive of adopting big data technology, it influences negatively. On the other hand, if the organizational structure is not supportive of adopting technology related to Internet of Things (IoT) and smart factory, and it also influences negatively on the adoption of new technology and sustainable business performance. Therefore, organization structure and process should be supportive of accepting and implementing new technology related to big data, Internet of Things (IoT) and smart factory which will lead to better sustainable business performance among SMEs. Therefore, organization structure and processes have an influence on the relationship between Industry 4.0 and IT implementation.

Hypothesis 8 (H8). *There is a relationship between structure and processes, and IT implementation.*

Hypothesis 9 (H9). *Structure and processes moderate the relationship between big data and IT implementation.*

Hypothesis 10 (H10). *Structure and processes moderate the relationship between IoT and IT implementation.*

Hypothesis 11 (H11). *Structure and processes moderate the relationship between smart factory and IT implementation.*

3. Methodology

The objective of this study is to identify the role of Industry 4.0 to promote sustainable business performance in Thai SMEs. Three major elements of Industry 4.0 were considered, namely; big data, IoT and smart factory. Moreover, organization structure, process and technology implementation were also considered. Figure 5 shows that how Industry 4.0 factors contribute towards sustainable business performance.

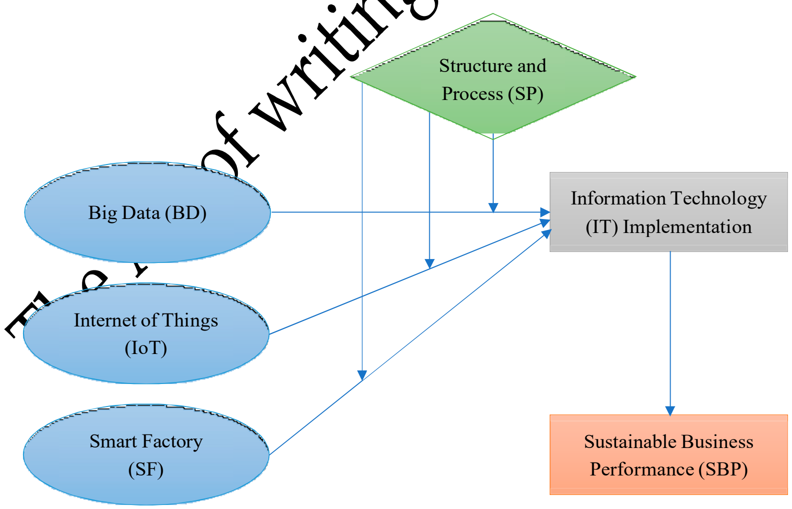

Figure 5. Theoretical framework of the study showing the contribution of Industry 4.0 towards sustainable business performance.

Figure 6 comprehensively shows the various concerns involved in the research design. This research design was initialized by a discussion of the details of this study, which comprised the population of this study, unit of analysis, and sampling design. The discussion of research design was followed by the instrument development which involved the design, structure, and measurement scale of the survey questionnaire. The pretesting and pilot study were carried out before the data collection, the methodology to test, the content validity and reliability. The data collection methodology was finalized about the method, procedure, and period of data collection of this study. Analytical methodology and interpretation were discussed as well as the hypotheses testing of this study.

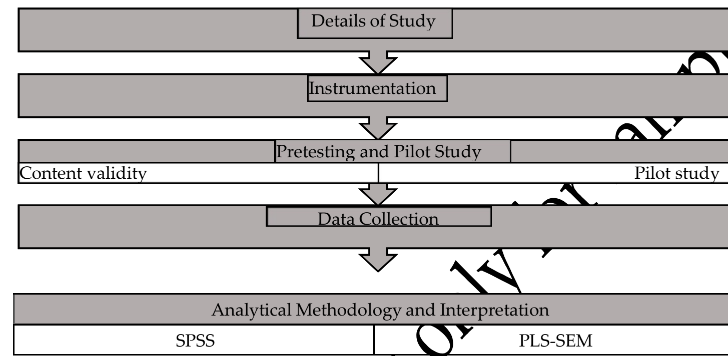

Figure 6. Flow Chart for Quantitative Research Design. Source: Sekaran and Bougie (2010, p. 68).

In this study, by following the cross-sectional research design, a survey was carried out. First of all, the pilot study was performed, and 70 responses were used. Results of the pilot study showed that the questionnaire had a satisfactory level of reliability and validity. After the pilot study, a total of 500 questionnaires was distributed among the managerial staff of SMEs located in Thailand.

The survey was carried out with the help of the 7-point Likert scale. The questionnaire was divided in to two major sections. The first major section was based on the respondent's profile including, age of respondents, income of respondents, gender of respondents, education of respondents and marital status of respondents. The second section was based on key scale items of each variables.

SMEs (small and medium-sized enterprises) in the textile and clothing was considered to collect the data. Managers which were related to the technology management of these SMEs were selected to receive a response. From these 500 distributed questionnaires, 280 were returned, and 10 questionnaires were incomplete and excluded from the analysis. The response rate was 56%. Thus, 270 valid responses were found. The valid response rate was 54%. Therefore, 270 responses were used to analyze the data. Data were collected from October 2018 to December 2018.

All the measures were adapted from previous studies. Measures for Industry 4.0 factors; big data, IoT and smart factory were adapted from Imran et al. (2018). IT implementation was measured with the help of five items, which were adapted from Sabherwal and Kirs (1994). Measures for sustainable business performance were adapted from Nawanir (2016). Finally, the measures for structure and process were measured by adapting the scale from Peppard and Ward (2004).

4. Data Analysis and Results

This study used Partial Least Square (PLS) to analyze the data. However, before analyzing the data, first of all, a preliminary analysis was conducted to investigate missing value, outlier, mean, median, standard deviation, and whether the data is normal or non-normal. This analysis is shown in Table 2. The data has no missing value and free from an outlier. Moreover, it is found that data is normally distributed.

Table 2. Preliminary Analysis.

	No.	Missing	Mean	Median	Min	Max	SD	Kurtosis	Skewness
BD1	1	0	3.231	3	1	7	1.51	−0.449	0.131
BD2	2	0	3.203	3	1	7	1.817	−0.617	0.479
BD3	3	0	3.476	3	1	7	1.857	−0.732	0.365
BD4	4	0	3.476	3	1	7	1.904	−0.747	0.445
BD5	5	0	3.491	3	1	7	1.692	−0.373	0.337
IoT1	6	0	3.443	3	1	7	1.83	−0.709	0.289
IoT2	7	0	3.429	3	1	7	1.809	−0.858	0.166
IoT3	8	0	3.608	4	1	7	1.856	−0.722	0.269
IoT4	9	0	3.675	3	1	7	1.861	−0.737	[illegible]
IoT5	10	0	3.59	3	1	7	1.932	[illegible]	0.432
SF1	11	0	3.514	3	1	7	1.887	[illegible]	0.425
SF2	12	0	3.528	3	1	7	1.808	−0.517	0.393
SF3	13	0	3.533	3	1	7	1.882	−0.729	0.348
SF4	14	0	3.425	3	1	7	1.759	−0.37	0.493
SF5	15	0	3.467	3	1	7	1.912	−0.903	0.249
ITI1	16	0	3.396	3	1	7	[illegible]	−0.557	0.379
ITI2	17	0	3.604	3	1	7	1.795	−0.619	0.318
ITI3	18	0	3.042	3	1	7	1.432	0.117	0.653
ITI4	19	0	3.118	3	1	7	1.467	0.727	0.96
ITI5	20	0	3.208	3	1	7	1.419	0.948	0.935
SBP1	21	0	3.151	3	1	7	1.423	0.58	0.79
SBP2	22	0	3.071	3	1	7	1.377	0.533	0.68
SBP3	23	0	3.137	3	1	7	1.452	0.519	0.718
SBP4	24	0	3.09	3	1	7	1.413	0.558	0.79
SBP5	25	0	3.042	3	1	7	1.409	−0.157	0.444
SP1	26	0	3.113	3	1	7	1.352	0.427	0.624
SP2	27	0	3.071	3	1	7	1.38	0.4	0.696
SP3	28	0	3.104	3	1	7	1.427	0.56	0.807
SP4	29	0	[illegible]	3	1	7	1.34	−0.043	0.498
SP5	30	0	3.104	3	1	7	1.306	0.022	0.459

After preliminary analysis, data reliability and validity were assessed with the help of PLS-SEM. In this case, Cronbach alpha and Composite Reliability (CR) were examined to check the reliability. In the case of validity, convergent validity and discriminant validity were examined. Figure 7 shows the measurement model assessment in which all items have loadings above 0.7. Table 3 shows the factor loadings. Table 4 shows that both CR and Cronbach alpha are also above 0.7.

According to Hair et al. (2017), all the items must have factor loadings above 0.7. The items having factor loadings less than 0.7 should be deleted. In this study, none of the items has factor loadings below 0.7. Thus, all the items have been retained. Discriminant validity is given in Table 5, and it is achieved with the help of AVE square root.

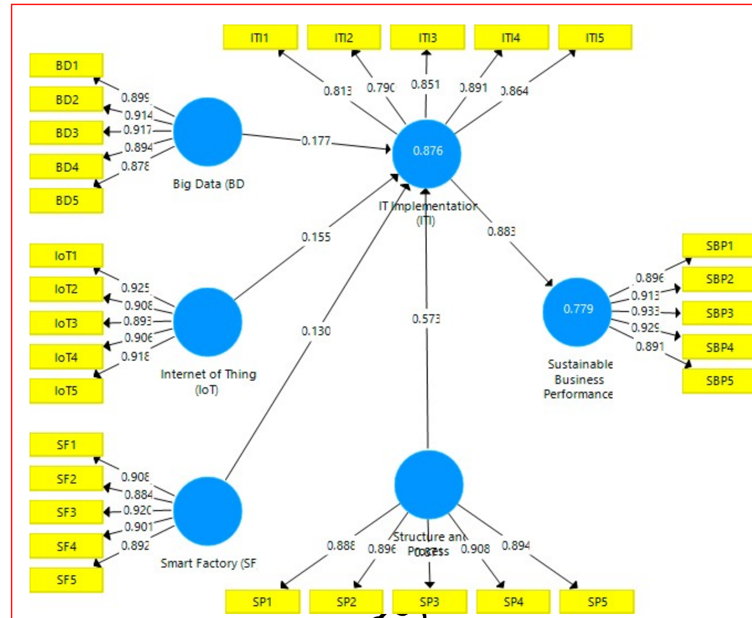

Figure 7. Measurement Model Assessment.

After the assessment of reliability and validity, the study carried out further analysis for hypotheses testing. Figure 8 indicates direct hypotheses testing and Table 6 shows the results. In this study, a minimum level of *t*-value is 1.96 to accept or reject the hypotheses. Results show that all the direct relationships have a *t*-value above 1.96, which indicates a significant relationship. Moreover, all the relationships have a positive beta value, which shows a direct relationship. Therefore, big data, IoT and smart factory have a positive relationship with IT implementation. In addition, structure and processes also have a positive relationship with IT implementation. The relationship between big data and IT implementation found β-value 0.177 and *t*-value 2.151 which is supported. The effect of IT implementation on sustainable business performance found β-value 0.883 and *t*-value 64.274 which is also supported. The effect of IoT and smart factory on IT implementation found β-value 0.115, 0.130 and *t*-value 1.979 and 2.546, thus, these hypotheses are also accepted. Finally, structure and process also found significant positive relationship with IT implementation with β-value 0.573 and *t*-value 18.655.

Consistent with the direct effect, indirect effects are also significant. The indirect effect is shown in Table 7. In line with direct effect, to examine the indirect effect, *t*-value 1.96 is considered. All the mediation hypotheses are accepted. Therefore, IT implementation is a mediating variable between Industry 4.0 and sustainable business performance.

Table 3. Factor Loadings.

	Big Data (BD)	IT Implementation (ITI)	Internet of Things (IoT)	Latent Variable 1	Smart Factory (SF)	Sustainable Business Performance
BD1	0.899					
BD2	0.914					
BD3	0.917					
BD4	0.894					
BD5	0.878					
ITI1		0.813				
ITI2		0.790				
ITI3		0.851				
ITI4		0.891				
ITI5		0.864				
IoT1			0.925			
IoT2			0.908			
IoT3			0.893			
IoT4			0.906			
IoT5			0.918			
SBP1				0.896		
SBP2				0.913		
SBP3				0.933		
SBP4				0.929		
SBP5				0.891		
SF1					0.908	
SF2					0.884	
SF3					0.920	
SF4					0.901	
SF5					0.892	
SP1						0.888
SP2						0.896
SP3						0.871
SP4						0.908
SP5						0.894

Table 4. Reliability and Convergent Validity.

	α	rho_A	CR	(AVE)
Big Data (BD)	0.942	0.942	0.955	0.811
IT Implementation (ITI)	0.898	0.903	0.924	0.710
Internet of Things (IoT)	0.948	0.949	0.960	0.828
Structure and Process (SP)	0.935	0.936	0.951	0.794
Smart Factory (SF)	0.942	0.943	0.956	0.812
Sustainable Business Performance	0.950	0.950	0.961	0.833

Table 5. Discriminant Validity.

	(BD)	(ITI)	(IoT)	(SF)	(SP)	(SBP)
Big Data (BD)	0.900					
IT Implementation (ITI)	0.826	0.843				
Internet of Things (IoT)	0.838	0.807	0.910			
Smart Factory (SF)	0.726	0.799	0.838	0.901		
Structure and Process (SP)	0.667	0.772	0.634	0.627	0.891	
Sustainable Business Performance (SBP)	0.721	0.783	0.683	0.662	0.709	0.913

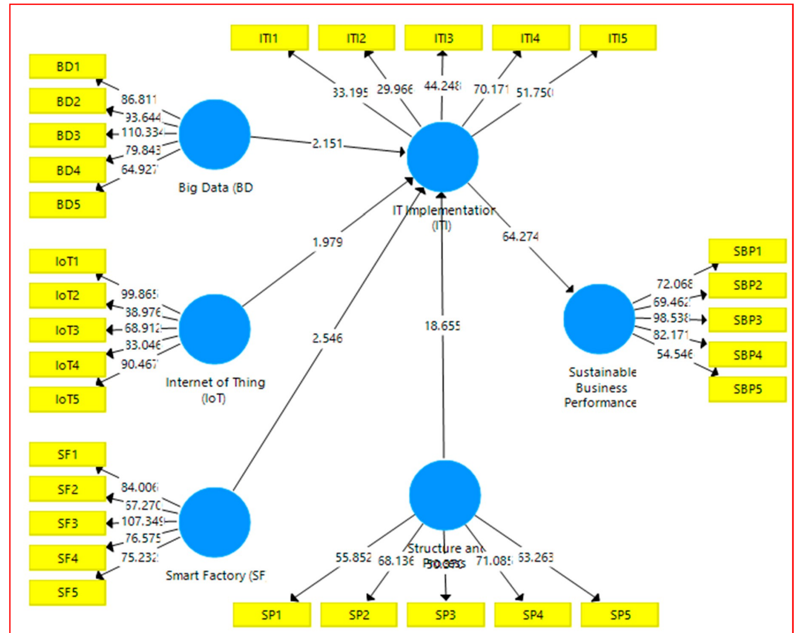

Figure 8. Structural Model Assessment.

Table 6. Direct Effect Results.

	(O)	(M)	(STDEV)	T Statistics	*p* Values
Big Data (BD) -> IT Implementation (ITI)	0.177	0.176	0.082	2.151	0.032
IT Implementation (ITI) -> Sustainable Business Performance (SBP)	0.883	0.883	0.014	64.274	0.000
Internet of Things (IoT) -> IT Implementation (ITI)	0.155	0.157	0.078	1.979	0.048
Smart Factory (SF) -> IT Implementation (ITI)	0.130	0.129	0.052	2.546	0.021
Structure and Process (SP) -> IT Implementation (ITI)	0.573	0.575	0.031	18.655	0.000

Table 7. Mediation Effect.

	(O)	(M)	SD	T Statistics	*p* Values
Big Data (BD) -> IT Implementation (ITI) -> Sustainable Business Performance	0.156	0.155	0.073	2.149	0.032
Internet of Things (IoT) -> IT Implementation (ITI) -> Sustainable Business Performance	0.137	0.139	0.069	1.972	0.049
Smart Factory (SF) -> IT Implementation (ITI) -> Sustainable Business Performance	0.115	0.114	0.026	4.391	0.000

Table 8 highlights the results of the moderation effect and Figure 9 shows the structural model for moderation effect through PLS. The same criteria were followed, and the minimum level of *t*-value (1.96) is considered. It is found that structure and processes are a moderating variable between big data and IT implementation with β-value 0.039 and *t*-value 2.492. It is also found that structure and processes are a moderating variable between smart factory and IT implementation with β-value 0.048 and *t*-value 2.519. However, the moderation effect is insignificant between IoT and IT implementation. Thus, hypothesis 9 is not supported as the β-value 0.036 and *t*-value 0.322.

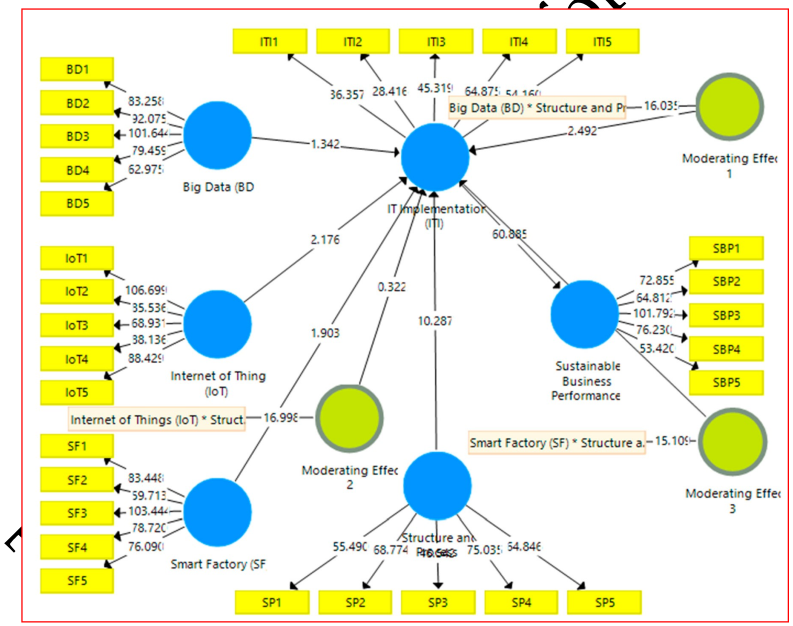

Figure 9. Structural Model Assessment (Moderation Effect).

Moreover, Figure 7 highlights that r-square (R^2) value is 0.779 for sustainable business performance. Thus, all the constructs have the tendency to bring 77.9% change in sustainable business performance which is good (Chin 1998). Additionally, predictive relevance (Q^2) shows the quality of the model, should be above zero (Chin 1998), and it is shown in Table 9.

Table 8. Moderation Effect.

	(O)	(M)	SD	T Statistics	*p* Values
Moderating Effect 1 -> IT Implementation (ITI)	0.039	0.035	0.016	2.492	0.021
Moderating Effect 2 -> IT Implementation (ITI)	0.036	0.035	0.113	0.322	0.748
Moderating Effect 3 -> IT Implementation (ITI)	0.048	0.056	0.019	2.519	0.020

Table 9. Predictive Relevance (Q^2).

	SSO	SSE	Q^2 (=1 − SSE/SSO)
IT Implementation (ITI)	1060.00	444.819	0.58
Sustainable Business Performance	1060.00	416.76	0.607

5. Discussion

The results of the study discovered that Industry 4.0 has a significant contribution to overcome technological challenges and increase sustainable business performance. Industry 4.0 factors, big data, IoT and smart factory, have an important effect on sustainable business performance in Thai SMEs. These results are consistent with the literature. All these factors have a significant relationship with products and services, and these increase the performance (Imran et al. 2018). It is proven by various studies that Industry 4.0 has a positive effect on production (Brettel et al. 2014; Weyer et al. 2015; Zawadzki and Żywicki 2016), which increases the business performance.

Generally, big data has a better advantage to implement new technology. It has a significant relationship with technology adoption (Dhar and Mazumdar 2014; Raguseo 2018). The same results are found by the current study. Big data has a positive effect on IT implementation. Therefore, the implementation of big data can overcome various technology-related challenges. It delivers better technology, which promotes better ways to store data efficiently (Gu et al. 2014; Lynch 2008). Consequently, SMEs must ensure better big data technology in their companies.

Moreover, it is found that IoT also has a significant contribution towards technology implementation in SMEs. Introduction of IoT technology increases IT implementation as it is revealed by the literature that IoT has a significant relationship with latest technologies (Fortino and Trunfio 2014; Pang 2013; Patel and Patel 2016; Suresh et al. 2014; Yun and Bu 2010), which affect positively on business performance. For that reason, better introduction of IoT technology is most crucial in Thai SMEs.

Furthermore, consistent with the results of the current study, Stock and Günther (2016) have clarified that the key applications of Industry 4.0 are smart factory (SF), which manufactures various smart products. This study also found that IT implementation has a positive effect on sustainable business performance. As it is explained by the literature that technology implementation and business performance has important connection with each other (Epelbaum and Martinez 2014; Malhotra 2005). Moshiri and Simpson (2011) mentioned that advancement in IT can dramatically change individual and organizational performance such as transform business organization, increase competition, and foster innovation. Technological advancement plays a significant role in various sectors of the economy (Ali and Younes 2013; Shpak et al. 2017; Šavareikiene˙ and Rasa 2018; Durana et al. 2019). So, better implementation of IT has major role in boosting sustainable business performance. Additionally, the moderation effect of structure and processes is also examined by the current study that is shown in Figures 10 and 11.

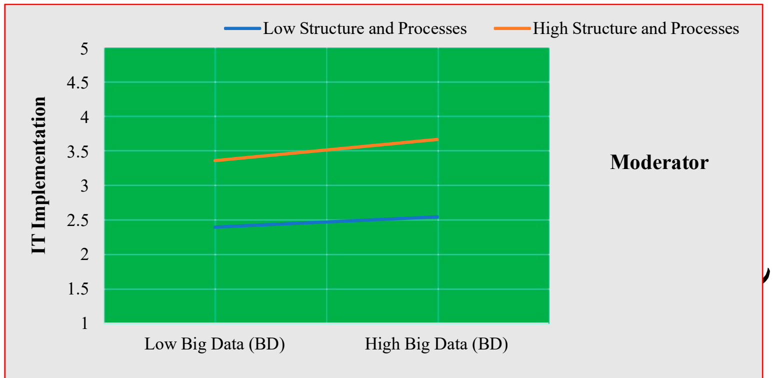

Figure 10. Moderation effect of structure and processes between big data (BD) and IT implementation which is strengthening the relationship.

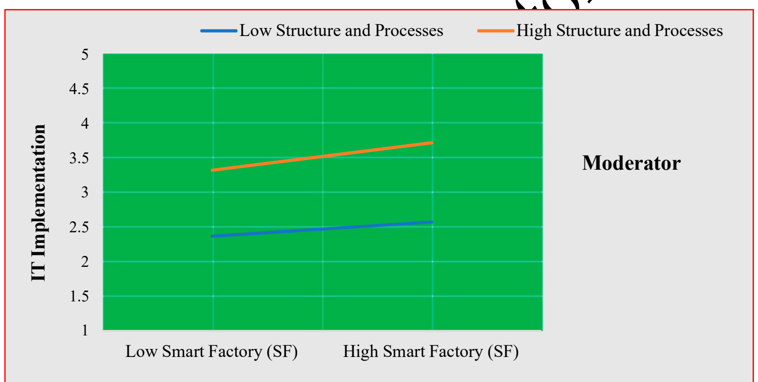

Figure 11. Moderation effect of structure and processes between smart factory (SF) and IT implementation which is strengthening the relationship.

Figure 10 shows that structure and processes as a moderating variable strengthen the relationship between big data (BD) and IT implementation. Consistent with these results, Figure 11 shows that structure and processes as a moderating variable strengthen the relationship between smart factory (SF) and IT implementation. Therefore, insufficient or unsuitable structures and processes can affect negatively on the success of IT in firms (Delone and McLean 2003). Structure and process of an organization show a strong relationship with IT implementation (Heracleous and Barrett 2001).

6. Conclusions

The objective of this study is to identify the role of Industry 4.0 to promote sustainable business performance in Thailand's SMEs as the Thai SMEs are facing various technology challenges. This study has attempted to address the solution of various technology challenges through Industry 4.0. The study considers three major elements of Industry 4.0, big data, IoT and smart factory. This study has examined how big data, IoT and smart factory are helpful in IT implementation. Additionally, this study reveals the role of organization structure and processes in IT implementation. To achieve this, a cross-sectional research design is used for a survey.

Findings reveal that Industry 4.0 is key to the growth of sustainable business performance among SMEs. Elements of Industry 4.0 such as big data, Internet of Things and smart factory have a positive role in promoting information technology (IT) implementation, which contributes to sustainable business performance. Big data, IoT and smart factory help to implement new technology. Implementation of new technology enhances business performance. However, for the implementation of new technology and to benefit from Industry 4.0, the structure and process of the organization must be supportive. If the structure and process of organization are not supportive, it will create the constraint in the way of technology implementation and affect negatively on sustainable business performance.

6.1. Limitation of the Study

The current study provides valuable insights for practitioners; however, this study also has limitations. As the study is limited to Thai SMEs, therefore, the results cannot be generalized, because the business environment in each country is different based on competition and resources. Thus, it is quite difficult to apply the results of the current study in any other business environment. Moreover, this study is based on survey questionnaires which is one of the limitations of this study. Because, face to face interviews with employee of SMEs may provide the better outcomes. Another limitation of this study is that, since Industry 4.0 has latest technology, therefore, due to lack of resources, SMEs are unable to implement Industry 4.0 completely, in this case the results can be better obtained by applying the current model on High-Tech SMEs.

6.2. Future Research

This study used survey questionnaires in which face to face interaction with managerial employees was not possible. Therefore, the future research should be carried out with the help of a mixed method approach. The interviews with managers may lead to the better results. Moreover, since the small-scale SMEs have limited resources, therefore, the current model should be applied on High-Tech SMEs. Additionally, future research should consider other elements of Industry 4.0 such as interoperability and cyber physical system.

6.3. Implications of the Study

How to overcome the technical challenges in organizations is one of the important questions, and it urges the organizations to investigate the possible ways. In this way, the current study is most significant for organizations to handle various technology-related issues. This study is beneficial for practitioners to overcome different issues of data handling and increase efficiency. Therefore, by taking help from the current study, the organizations may solve various issues. Notably, this study is beneficial for Thai SMEs. Theoretically, this is one of the first studies to deal the relationship between Industry 4.0 and technology challenges with the help of the survey. Thus, this study provides a survey-based platform to use Industry 4.0 as a remedy to overcome various technical challenges. Moreover, as this study contributed in the body of knowledge by examining the role of Industry 4.0 in technology management and the current study is one of the pioneer studies which discussed the role of Industry 4.0 in technology management, this study opens new discussion for scholars. This study adds to the empirical literature by investigating the role of Industry 4.0 in technology management which is more effective to conduct future research in the field of the fourth industrial revolution.

6.4. Policy Recommendation

It is always difficult to solve various challenges related to the latest technology, especially for those organizations with minimal resources, such as SMEs. In this direction, this study is recommended to the Thai SMEs to manage technology issues with the help of Industry 4.0 features.

It is recommended that the Thai SMEs implement the big data technology, IoT and smart factory to manage issues. Better implementation of these elements has the ability to manage various challenges. Before implementation of these technologies, SMEs must develop a supportive culture and infrastructure to support new technology.

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