Supply chain integration and its impact on supply chain agility and organizational flexibility in manufacturing firms

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Abstract

Purpose – This study investigates the impact of environmental uncertainty and organizational ambidexterity on supply chain integration and its relationship between supply chain agility and organizational flexibility in the manufacturing firms.

Design/methodology/approach – The data were collected from 526 managers in services and manufacturing industry in Kuala Lumpur. The partial least square (SmartPLS 3.0) tool was applied through the use of the structural equation modeling (SEM) technique.

Findings – The results revealed that a strong relationship exist between environmental uncertainty and supply chain integrations including customer, supplier and internal integration. Organizational ambidexterity has a significant relationship with supply chain integration. Supply chain integrations were shown to have a positive impact on the firm's supply chain agility and organizational flexibility.

Originality/value – The findings may assist to establish a set of key drivers for enhancing supply chain agility and organizational flexibility as a supply chain management initiative in the manufacturing and service industry.

Keywords Supply chain integration, Supply chain agility, Organizational flexibility, Manufacturing firms

Paper type Research paper

1. Introduction

The context of supply chain had undergone several transformations since the term "supply chain management" was first mooted by Oliver and Weber (1982). In its more traditional approach, a supply chain is often linked to the process of getting the most out of the manufacturing process with the resources made available (Ellram and Cooper, 2014; Amin and Zhang, 2012; Yeoman and Santos, 2019). Christopher and Towill (2001) and Birasnav and Bienstock (2019) stated that a complex network of supply chain processes is organized by lean assumptions. The move into the Fourth Industrial Revolution (Industry 4.0) had changed the way we look at traditional supply chain management and influenced future roles and jobs whilst pushing the boundaries of our capabilities to develop new areas of techno-commercial skills to drive higher values derived from more efficient consumption of resources. Despite these resources and wide-ranging rates of adoption and realization of benefits from the adoption of Industry 4.0, there is a variation between services and manufacturing sectors, and

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it came as no surprise that there was a limited supply of past research works and literature around the subject. This is even more apparent in researches linking the impact of supply chain integration to increased business performances (Zhao *et al.*, 2008; Wiengarten *et al.*, 2019) and the role of Industry 4.0 in enabling and increasing supply chain integration. With that, the question lies in how much can the level of integration increases the agility and flexibility of companies? What are the environmental and internal factors that allow companies to integrate better?

In a volatile, uncertain, complex and ambiguous termed as "VUCA" environment of today. Resilience does not merely concern a company's rise from the ashes, but transformation and evolution, thereby requiring both innovation and creativity (Maguire and Cartwright, 2008; Birasnav and Bienstock, 2019). Resilience relates mutually to the notion of rejecting the status quo in which a return to the situation before any crisis would leave the company equally susceptible and exposed to the next one. Similarly, in the transformation perspective, resilience is concerned with the concepts of renewal, regeneration and reorganization (Folke, 2006; Schriber *et al.*, 2019). Organizational resilience has been a key to subject matter in organizational studies and has been subjected to many discussions and studies all over the world (Al-Abrrow *et al.*, 2019; Rehak, 2020). Experts are obsessed with finding out how organizations can survive the highly volatile and unpredictable external environments of the modern era. The performance of companies remains as one of the key determinants of organizational resilience.

This study is considering the various elements and variables affecting organizational performance with a particular interest in the scope of environmental uncertainty and supply chain relationships. Accordingly, the focus of this study explores how uncertainty in the external environment creates a high need for ambidexterity and drives the motivation for supply chain integration. In discussing innovation and the industry with the tools, capabilities remain to not only be competitive but also to perform better than others in withstanding the growing challenges in the VUCA environment of today, it is called to look at the Industry 4.0. The first industrial revolution was made significant by the transition from hand production methods to machines with the increased use of steam power, which is characterized by the merging and synthesis of technologies that blurred the lines between physical, digital and even biological spheres. The emergence of Industry 4.0 is often associated with a sleuth of technological breakthroughs which includes artificial intelligence (AI), robotics, the Internet of Things (IoT), quantum computing, nanotechnology and additive manufacturing.

This trend was mirrored in Malaysia and the Ministry of International Trade and Industry (MITI) announcement of its plan to introduce the country's inaugural National Industry 4.0 Policy Framework, to indicate the progressive nature of the document as a roadmap to transform Malaysia's manufacturing and services industry. Given the growing interest on the subject of Industry, this study contributes to the impact of the adoption of Industry 4.0 that will enhance supply chain integrations, agility and organizational flexibility among Malaysia's services and manufacturing industry players. Given the sporadic discussions on the subject of Industry and its impact on increasing the rate of supply chain integration among services and manufacturing companies in existing literature, this study investigates the constructs that drive supply chain integration among services and manufacturing companies and ascertain whether Industry 4.0 technologies could enable these companies to achieve better supply chain performances, in the face of growing external uncertainties and challenges.

This study includes from the earlier literature review and theoretical foundations (section two) following the supply chain agility model of Swafford *et al.* (2006) and Li *et al.* (2008) that evaluates the effect of uncertainties and organizational ambidexterity on supply chain integration, its impact on supply chain agility and organizational flexibility. It assesses the

significance of supply chain integration among managers in Malaysian service and manufacturing firms. Section three explains the research methodology related to survey instruments and data collection procedures. In section four, we assess the data analysis and results including respondents' information, measurement model assessment, structural model assessment and hypotheses relationships among the constructs. Section five describes the findings and links with previous empirical results. Section six explains the implications of highlighting the theoretical and managerial contributions of the existing study. In the next sections, we highlight the limitations, future study and concluding remark of the study.

2. Literature review

2.1 Uncertainties

Uncertainty refers to the external and internal ambiguities that may impact the respondent's organization's ability to achieve its objectives and goals. Clampitt and Williams (2017) indicate that uncertainty is like the plague that circulates throughout the organization and infuses it with complexity and ambiguity (Clampitt and Williams, 2017). Both external and internal uncertainty are taken into consideration by contemporary scholars while developing models and analyzing the impact on supply chain performance (Wang and Song, 2017; Chang *et al.*, 2019) integration (Flynn *et al.*, 2016) and sustainable supplier sourcing (Chen *et al.*, 2020). The study of Chen *et al.* (2020) states the necessity to simultaneously consider both internal and external uncertainty to come up with a systematic methodology. Chen and Paulraj (2004) explained a deeper understanding of the organizational uncertainties and supply chain integration. Supplier uncertainties refer to external uncertainties and volatilities in a company's capability to produce its products and services (Jia *et al.*, 2020). In this research, supplier uncertainties are brought about by the suppliers' incoherent capability to meet the requirements set by the Malaysian services and manufacturing companies and the rate of consistency of the suppliers to meet production quality. The supply chain is commonly linked with organizational uncertainties by customer demand on one end, and suppliers on the other (Lu *et al.*, 2018; Birasnav and Bienstock, 2019; Selim *et al.*, 2019). Flynn *et al.*'s (2016) study postulated that supply and demand uncertainties cover the supplier and customer-end and act as interrelations between internal and external knowledge processes which are regarded as a new type of dynamic capability. Uncertainties present a new and robust in terms of factors affecting a company's supply chain integration efforts. Uncertainty in the organization is one of the key external driving forces instrumental to the development of supply chain management (Betts and Tadisina, 2009). The uncertainty surrounding supply chains can be attributed to three sources: supplier uncertainty; demand uncertainty and technology uncertainty. Epidemic outbreaks (i.e. COVID 19/SARS/ Mars etc.) also induce notable supply chain risk that comes with a high uncertainty which eventually disrupts the upstream and downstream parts of the supply chain, in another word, disrupts the SC integration. Hence, high uncertainty stemming from epidemic outbreaks concurrently disrupts supply, demand and logistics (internal and external) infrastructure or overall SC integration (Ivanov, 2020). This study suggests that integration provides greater benefits to the supply chain when environmental uncertainties exist. Based on the contingency and organizational information processing theories, Wong *et al.* (2011) heightened the relationship between uncertainty and customer, supplier and internal integration. Rahman and Zailani (2017), Kim and Chai (2016) presented empirical support for the important role of supply chain practice in uncertain business conditions. They found that uncertainty significantly affects the implementation of supply chain integration. Thus, this study proposed that:

H1a. Uncertainty positively affects customer integration.

H1b. Uncertainty positively affects supplier integration.

H1c. Uncertainty positively affects internal integration.

2.2 Organizational ambidexterity

Organizational ambidexterity as the company's ability to exploit its existing competencies while being simultaneously adaptable to explore new opportunities (Nazir and Pinsonneault, 2011; Venugopal *et al.*, 2020). Organizational ambidexterity as the ability to continue both exploitative and exploratory innovations for organizational survival and prosperity (Mom *et al.*, 2019; Junni *et al.*, 2013). Zimmermann *et al.* (2018) postulated that organizational ambidexterity emerges from distinct but complementary approaches that are embedded in the innovation stream and decision-making processes, which help to achieve competitive advantage (Mom *et al.*, 2019). Furthermore, Nazir and Pinsonneault (2011) and Venugopal *et al.* (2020) have referred to this complementary effect between supply chain integration and the adoption of Industry 4.0 as organizational ambidexterity that ranges from having the ability to generate an outside the box approach to problem-solving, innovating the processes and finding creative ways to satisfy customers' needs. Ambidextrous companies hold the capabilities to adopt new approaches and drive real and lasting values from them (Partanen *et al.*, 2020). Focusing on supply chain integration, this study proposes the effect of organizational ambidexterity on supply chain integration (Birasnav and Bienstock, 2019), particularly customer, supplier and internal integration in Malaysian services and manufacturing companies to be adaptive to its ever-changing environment. The integration capabilities, as highlighted by (Rai and Tang, 2010) synergistically create a capacity for readiness to change in processes that are provided by organizational ambidexterity. With a structured inter-organization system (IOS), a firm can develop process adaptability via flexibility and integration that would support supply chain ambidexterity. Hence, balancing the contradictory terms of flexibility and integration can drive ambidexterity in the supply chain (Pu *et al.*, 2018). The basic premise of Nazir and Pinsonneault's (2011) research model showed that ambidexterity allows the business process to draw on the benefit of integration and reconfiguration. Therefore, we propose that:

H2a. Organizational ambidexterity positively affects customer integration.

H2b. Organizational ambidexterity positively affects supplier integration.

H2c. Organizational ambidexterity positively affects internal integration.

2.3 Supply chain integration and agility

The supply chain is defined as the network of organizations connected via vertical sequences or upstream and downstream linkages of interconnected transactions/processes that add value to the final products and services delivered to the end consumer, where the network is actively governed by the buying organizations (Christopher and Towill, 2001; Singh and Verma, 2018; Wang and Song, 2017). Communication and manufacturing industries can heighten their competitive edge via supply chain activities (Liao *et al.*, 2017), where supply chain capability works as a building block and a major source of competitive advantage (Newaz *et al.*, 2020; Kumar *et al.*, 2017). Being aligned with Lee *et al.* (2007) and Kumar *et al.* (2017), this study also considers customer integration, supplier integration and internal integration under the umbrella of supply chain integration (SCI). Supply chain integration with customers covers close alignment (Jia *et al.*, 2020; Kalyar *et al.*, 2019) and coordination within a company's supply chain with its key customers involving activities such as sharing of key information (e.g. demand forecast, inventory level and production plans) over an established shared communication channel. Supply chain integration with the supplier is a form of close alignment and coordination within a company's supply chain management

(Birasnav and Bienstock, 2019). Some critical information shared across an established shared network and communication channels includes the demand forecast, inventory level and production plans. Internal supply chain integration is referred to the integration inside the firm's boundaries and over the internal supply chain activities (Turkulainen *et al.*, 2017). Further, Flynn *et al.* (2010) noted internal SCI as important since it works as the foundation from which supplier and customer integration are developed, although, so far it is poorly understood (Frankel and Mollenkopf, 2015).

Flynn *et al.* (2016) argued that integration brings about the additional dependency on stakeholders, both internal and external to the companies. Prior literature has discussed the supply chain integration and its relationship to business and organizational performance (Ralston *et al.*, 2015; Elmuti *et al.*, 2008; Green *et al.*, 2008; Spekman *et al.*, 1998) which indicated that supply chain integration requires companies to share and relinquish control over what once might have been considered proprietary information and to entrust the information with their supply chain partners with the hope that they will act in their best interest. Lu *et al.* (2018) extended that notion and added that supply chain integration affects operational performance and the degree of integration also influences cost and efficiency along with the collaboration with suppliers and customers. According to Kumar *et al.* (2017), SCI improves the performance of the supply chain. The previous literature (Flynn *et al.*, 2010; Betts and Tadisina, 2009) examined the relationship between supply chain integration and agility, finding that an agile supply chain faced with environmental externalities, cooperation and integration will exert a larger impact on its performance. Fayezi *et al.* (2017) assumed that both internal and external (customers and suppliers) integration are instrumental to establish agility in an organization's supply chains. This study also marked supply chain agility (SCA) as a strategic capability that enables a company to rapidly sense and react to external and internal uncertainties through effective supply chain integration. An agile company can convert challenges and change quickly into opportunities. Agility, while critical and necessary, needs to be leveraged and maintained across the supply chain to create sustainable success for a business (Fayezi *et al.*, 2013).

Christopher and Towill (2001) and Jia *et al.* (2020) focused on the migration of supply chain from lean and functional to agile and customized and proved that supply chain agility includes a network-wide concept characterized by highly competitive competences; where, sensitivity to the market, process and network integration and presence of cybernetic cooperation are the key determinants of relationship integration. Supply chain agility is also a measure of the supply chain's ability to respond or responsiveness (Fayezi *et al.*, 2017). It determines the speed one organization takes to respond to an externally generated motion, as opposed to the capability and performance of the supply chain itself which is often driven by internal factors (Swafford *et al.*, 2006; Alvarado-Vargas and Kelley, 2019). As economies changed and trading dependencies increased, it has become more crucial for companies with an agile supply chain to form a network of partners (Fayezi *et al.*, 2017). The ability to form win-win relationships with external alliances is a crucial ingredient of agility and makes perfect sense in environments that are highly unstable and volatile. The companies can take stock of its external changes and environment, forming mutually beneficial alliances with stakeholders, customers, suppliers and responding to these changes with considerable speed compared to its competitors that will earn them a competitive edge in the new environment. Based on these discussions, the study argued that:

H3a. Customer integration positively affects supply chain agility.

H3b. Supplier integration positively affects supply chain agility.

H3c. Internal integration positively affects supply chain agility.

2.4 Supply chain integration and organizational flexibility

Organizational flexibility is an inwardly-focused competency that refers to the company's ability to withstand a finite amount of changes without suffering from serious disjunction (Shukla and Sharma, 2019). Both flexibility and stability if exploited properly can result in a definitive source of competitive advantage in an ever-increasing competitive marketplace (Khoobiyan *et al.*, 2017; Laser, 2020). When effective supply chain integration exists flexibility works as an operational ability that promotes companies to change (both internally and across the key partners) efficiently in response to market externalities. Gosling *et al.* (2010) and Dubey *et al.* (2019) maintained flexibility to be one of the key determinants of supply chain integration that would unlock companies' adoption to transformative technologies: for instance, Industry 4.0. This, in turn, will help them to come up with new approaches to their businesses and allow them to form new winning strategies. Flexibility, in most part, is related to machines, processes, routing, parts, and manpower, so on and so forth in a manufacturing system (Khoobiyan *et al.*, 2017). Organizational flexibility is one of the strategic dimensions in response to supply chain integration and external environment to sponge up uncertainty (Khoobiyan *et al.*, 2017) which incorporates four elements: range-number, range heterogeneity, mobility and uniformity. Swafford *et al.* (2006) reduced the number of dimensions from four to two to measure manufacturing flexibility. Manufacturing flexibility and sourcing flexibility were then measured on these two dimensions. (Zhang *et al.*, 2003) and Dubey *et al.* (2019) analyzed the relationships between supply chain integration and organizational flexibility perceived by the customer, supplier and internal supply chain integration. Thus, we hypothesized that:

H4a. Customer integration positively affects organizational flexibility.

H4b. Supplier integration positively affects organizational flexibility.

H4c. Internal integration positively affects organizational flexibility.

2.5 Theoretical foundations

This conceptual framework (Figure 1) is developed after synthesizing the theoretical foundations of the supply chain agility model of Swafford *et al.* (2006), Li *et al.* (2008) and the related pieces of literature highlighted in this study. Based on Betts and Tadisina (2009) and Shamim *et al.* (2017), a theoretical model is also carefully chosen as an underlying foundation to develop the conceptual framework of this study due to the robustness and relevance to this subject and the objectives of this research. The model underlines the impact that uncertainties and organizational ambidexterity have on supply chain integration and how that, in turn, influence supply chain performance toward agility and organizational flexibility. Betts and Tadisina (2009) especially focused on the role supply chain flexibility and agility plays driving supply chain performance.

Taking the model of Betts and Tadisina (2009), Swafford *et al.* (2006), Li *et al.* (2008) and Shamim *et al.* (2017) into consideration, this study argues that environmental uncertainty and

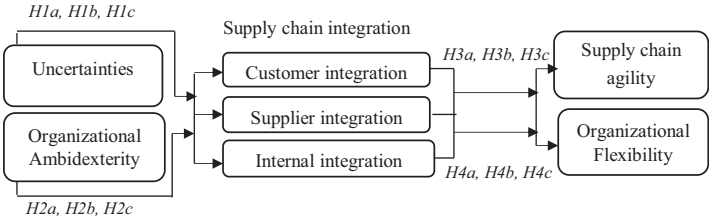


Figure 1.
Conceptual model

organizational ambidexterity influence supply chain integration which, in turn, stimulates supply chain agility and organizational flexibility. We have considered the fact that not all constructs will remain within a company's control threshold, which is why "uncertainty" remains as an important construct to this model. Based on the findings of Betts and Tadisina (2009) and Shamim *et al.* (2017), uncertainty and supply chain integration will have a positive correlation and suggesting the higher the level of external uncertainties lead to the better supply chain integration. Organizational ambidexterity is an innovative capability in this study, which denotes that ambidextrous companies would naturally be more open and susceptible to adopting new technologies, such as technologies offered by the Industry 4.0. Hence, this will drive a more robust supply chain integration, which in turn results in stronger supply chain performance. Supply chain agility and organizational flexibility are presented as dependent constructs in this study. The study proposes that the independent variable uncertainty and ambidexterity positively influence supply chain integration.

3. Research methodology

3.1 Data collection

The study used quantitative method and data were collected through purposive sampling (from August to October 2019) from Malaysian services and manufacturing industry managers. Purposive sampling is a technique widely used in qualitative research for identifying and selecting individuals who are especially knowledgeable or experienced with a phenomenon of interest (Cresswell and Clark, 2011; Palinkas *et al.*, 2015) and use of limited resources. The purposive sampling is used to collect the data from participants through several procedures such as email, online survey platform, social media and physical distribution methods. Firstly, the digital survey forms were emailed to the targeted respondents based on a database of email addresses of industry leaders and relevant respondents. Then, the web-based and online survey platform, the Google Forms, was utilized to further extend the reach of this questionnaire. The link of this Google Forms was then further distributed to the research's target population via social media applications such as the WhatsApp; and given the professional focus of this research, online professional networking platform, LinkedIn, was also utilized for the same intent. Hardcopies of the same questionnaires were distributed to the target population by hand individually and via professional networking platforms such as workshops, industry conferences and meetings. The researchers of this study opted for this method due to its reliability and simplicity in reducing the results' ambiguity.

The study conducted an age group of 18 years old and above since they must satisfy a set criterion for their input to be considered for this study. The participants were managers who operated at a minimum level of junior management hierarchical level within the services and manufacturing sector in Malaysia. The respondents were purposively chosen from a database of 1,000 manufacturing industries including construction and building materials, agriculture, ICT, technology and digital, wholesale and retail, automotive, government and public administrations, power and retail estate, tourism, transport and logistics, oil and gas and finance and banking. We requested to the person in charge of the respective companies for approval of data collection. After obtaining permission to collect data, we distributed questionnaires to managers of the companies. The questionnaire was a plain language statement of the project and a survey, which took around 25 minutes to complete. The respondents were ensured that their participation in this study was completely voluntary and their anonymity guaranteed. We did not provide any cash incentive as a gift to participants of this study. A total of 1,000 questionnaires were distributed, 740 were returned, a response rate of 74%. Some managers of the companies

are busy with their corporate meeting; therefore, some participants may not be able to return the questionnaire. Out of 740 returned surveys, 526 were sufficiently completed for data analysis, a useable response rate of 52.6%.

3.2 Measures

This study used a self-administered research instrument, in the form of a questionnaire developed from previously validated measures and scales and adapted to the topic set. All items of this study were measured on a seven-point Likert scale that used in this research ranges from −3 to +3 with the value indicating the respondent's level of agreeability to each of the questions posed to them. A selection of −3 would indicate the respondent is least agreeable to the question or statement posted to them, whereas a selection of +3 denotes that they are most agreeable to the same question or statement. Lewis and Erdinç (2017) found that seven-point scales result in stronger correlations. Since we used existing scales to measure variables that were written originally in English, we used translated scales in Bahasa Malay. We used two sets of the questionnaire and an expert on the topic who were bilingual. Opinions and feedback from respondents were taken into consideration in the designing of the final research instrument. The instruments were pre-tested using six experts who commented on items that were difficult to understand. A minor adjustment was made to the final English and Bahasa Malay version. During the distribution questionnaires, we followed the recommended procedure to provide statements to respondents that the current study will use only study purposes, responses were confidential and there was no correct and wrong response.

To measure supply chain integration, 15 items were adapted from Flynn *et al.* (2010), broken into three main categories were adapted to measure the supply chain integration construct. Supply chain integration refers to the actions undertaken by the respondent's organizations to align or synchronize their business processes with stakeholders to achieve the same business objectives and goals. Respondents were requested to rate the extent of integration or information sharing between their organizations, and their stakeholders were grouped into three defined categories of key customers (assigned the code of "SCC"), key suppliers (assigned the code of "SCS") and internal (assigned the code of "SCI"). Respondents are required to record their input to these questions on a seven-point Likert scale ranging from −3 which denotes a "not at all integrated" response, to +3 which corresponds to "very integrated".

The supply chain agility was developed from Swafford *et al.* (2006) and Betts and Tadisina (2009) by adapting eight items. Supply chain agility refers to how quickly the respondent's organization's supply chain reacts and responds to the changes in its business environment. Respondents were requested to indicate the level of impact, to speed, the adoption of Industry 4.0 technologies had on their organization's supply chain agility (assigned the code "SCA"). They recorded their input to these questions on a seven-point Likert scale ranging from −3 indicating "slow" speed impact, to +3 which corresponds to "fast".

Organizational flexibility refers to the respondent's organization's ability to make internal changes to respond effectively to the changing outward environment. The "Organizational Flexibility" construct was designed by adapting five items from the questionnaire developed by Johnson (1999), Rai *et al.* (2006) and Moon *et al.* (2012). Respondents were requested to rate their opinion and level of agreeability on the presented statements and relate them to their own organization's flexibility (assigned the code "SCF"). Environmental uncertainty refers to the external and internal ambiguities that may impact the respondent's organization's ability to achieve its objectives and goals. Seven items were adapted from Chen and Paulraj (2004), to evaluate the environmental uncertainties. Respondents were requested to rate their opinion and agreeability on the presented statements on their organization's supplier, demand and

technology uncertainties (assigned the code "UNCER"). The organizational ambidexterity was developed by adapting nine items from Nazir and Pinsonneault (2011). Organizational ambidexterity refers to this study as the respondent's organization's ability to exploit existing competencies while being simultaneously adaptable to explore new opportunities. Respondents were requested to rate their opinion and agreeability on the presented statements on their organization's ambidexterity (assigned the code "AMB"). The respondents were required to record their input to the questions on the construct of organizational flexibility, environmental uncertainty and organizational ambidexterity, both on a seven-point Likert scale ranging from −3 indicating a "disagree strongly" response, to +3 which corresponds to "agree strongly". We used several procedures for measuring the common method of bias for this study. The study used Harman's one-factor test to identify the problem of common method bias. Factor analysis was used on 7 factors whose eigenvalues were above 1. The first estimated 38.12% of the total variance and with all factors accounting for 58.23% of the total variance, which indicates that common method bias is not an issue in the data.

4. Results

4.1 Demographic profile

Out of 526 useable samples, the proportion of females and males was 51.1% and 48.9%, respectively. It implies that the scale is slightly skewed toward females. A majority of the respondents originated from the oil and gas industry at 43.3%. This is followed by finance and banking at 17.8% and construction and building materials at 17.2%. All three of oil and gas, finance and banking and construction and building materials constitute approximately 78.3% of the respondents, and the rest 5.6% of agriculture, followed by 3.3% ICT, technology and digital, 3.3% wholesale and retail, 2.8% automotive, 2.2% government and public administrations, 2.2% power and utilities, 1.1% property and real estate, 0.6% tourism and 0.6% of transport and logistics industry, respectively. In terms of the respondents' seniority and hierarchical level within their companies, 73.3% of them reported that they hold senior management roles such as vice president, general manager and head of department, which bodes well with the intent this study to record survey inputs from leaders of the industry. The top management position was 14.4% followed by 7.2% middle management and 5.0% of them holding junior management capacities in their respective companies.

Looking at the departments the respondents operate within their respective services, and manufacturing companies yielded a more balanced distribution with 31.1% of them indicating they are part of their companies' procurement and purchasing functions. This is another positive indicator of the success of this field study, as the intent of this research is to focus on functions related to the supply chain and procurement and purchasing industry. This is followed by general management at 26.1%, business development and sales and marketing, both at 13.9%, which followed by 4.4% research, analysis and strategy, 2.8% operations and logistics, 2.2% others, 1.7% audit risk and compliance. Human resource, ICT, PR, media and communications both at 1.1% followed by 0.6% of accountancy and finance industry.

A staggering 92.8% of the respondents indicate that they are involved in and hold some level of responsibility in purchasing decisions in their respective companies with 36.7% indicating they hold the purchaser/buyer responsibility, with a further 28.3% indicating they are the decision-makers of their companies when it comes to purchasing decisions, which followed by the 27.8% of influencer and 7.2% of end-user. The remaining demographic characteristics saw a combined total of 64.4% of the respondents originating from Malaysian services and manufacturing companies with employees (managers) of 1,000. The rest 35.6%

of respondents indicated that on average their companies have built professional relationships spanning more than 10 years with their key suppliers, and 38.9% of the respondents indicated that on average their companies work on more than 10 projects with their key suppliers. Table 1 shows the summarized result of respondents' information. Before running the measurement model assessment, we used the Kaiser-Mayer Olkin (KMO), Measure of Sampling Adequacy (MSA) and Bartlett's Test of Sphericity (BTS) that are conducted on raw data to access the suitability of the further analysis. The findings reveal that Bartlett's test of sphericity is significant at p-value <0.05, while the KMO index is 0.74 that is greater than 0.60 (Hair *et al.*, 2010).

4.2 Measurement model

We have used the structural equation modeling (SEM) technique employing SmartPLS 3.0 to assess the model. Chin *et al.* (2003) postulated that PLS is a component-based method, and it

Constructs	Characteristics	%	Constructs	Characteristics	%
Gender	Male	48.90	Industry	Oil and gas	43.30
	Female	51.10		Finance and banking	17.80
Position	Top management	14.40		Construction and building materials	17.20
	Senior management	73.30		Agricultural	5.60
	Middle management	7.2		ICT, technology and digital	3.30
	Junior management	5.0		Wholesale and retail	3.30
Department	Procurement and purchasing	31.10		Automotive	2.80
	General management	26.10		Government and public administration	2.20
	Business development and sales	13.90		Power and utilities	2.20
	Marketing	13.90		Property and real estate	1.10
	Research, analysis and strategy	4.40		Tourism	0.60
	Operations and logistics	2.80		Transportation and logistics	0.60
	Audit risk and compliance	1.70	No. of Employees	1–49	3.3
	Human resources	1.10		50–99	3.3
	ICT	1.10		100–499	8.9
	PR, media and communication	1.10		500–999	20.0
	Accounting and finance	0.60		1000–4999	35.0
	Others	2.20		Above 5000	29.4
Purchase responsibility	Influencer	27.8	Average duration with key suppliers	Less than 1 year	1.1
	Purchaser/buyer	36.7		1–4 years	11.7
	Decision-maker	28.3		4–7 years	22.2
	End user	7.2		7–10 years	29.4
Average no. of projects with key suppliers	1–4	17.8		Above 10 years	35.6
	4–7	15.6			
	7–10	27.8			
	Above 10	38.9			

Table 1.
Demographic profile

consists of three major sets of relationships. For example, (1) the outer/measurement model, which specifies the relationships between the latent constructs and their associated observed variables, (2) the inner/structural model, which indicates the relationships between latent constructs and (3) the weight relationships upon which the case values for the latent variables can be evaluated. Gefen *et al.* (2000) argued that the good model fit in PLS is established with a significant path coefficient, acceptably high *R*-square values and internal consistency/construct reliability should be greater than 0.70 for each construct. Braunscheidel and Suresh (2009) point out that PLS does not use fit indices, unlike covariance-based SEM. Table 2 showed the summary results of convergent validity analysis for all the constructs. Cronbach's alpha minimum value of 0.70 was considered acceptable for current scales, and value 0.60 is deemed suitable for newly developed scales (Nunnally, 1978). The existing Cronbach's alpha values were ranged from 0.785 to 0.897, indicating a higher bound estimate of reliability (Gefen *et al.*, 2000). The average variance extracted (AVE) tends to be more conservative than composite reliability (CR). Fornell and Larcker (1981) recommended that AVE should be at least 0.50, the existing study values were ranged from 0.488 to 708. Gefen *et al.* (2000) indicated that all the constructs AVE values are not equally weighted measures, thus the value tends to be a lower bound estimate of reliability. Besides, AVE value 0.488 assumes closer to 50% of the variance is explained by the indicator of the latent variable. The CR values were greater than 0.60 (ranged from 0.850 to 0.924), factor loadings were significant and above 0.60, which shown sufficient convergent validity (Fornell and Larcker, 1981) and the cut-off values of rho_A were greater than 0.70 (ranged from 0.794 to 0.899), indicating enough for composite reliability (Dijkstra and Henseler, 2015). Table 3 summarized the correlations between the latent variables and the square root of AVE is shown on the top of each column. The square root of AVE is greater than the correlation among the latent variable scores, for its corresponding row and column values, which showing sufficient levels of discriminant validity. The results of the measurement model are shown in Figure 2.

4.3 Structural model

The results from the evaluation of the structural model were reported in Figure 3 and Table 4. The results revealed that the standardized path coefficient of environmental uncertainty has significant impact on customer integration (0.391; $p < 0.01$), internal integration (0.386; $p < 0.01$) and supplier integration (0.212; $p < 0.05$). Thus environmental uncertainty is found to exhibit a high level of customer integration and internal integration followed by supplier integration, lending support to H1a, H1b and H1c. The path coefficient from organizational ambidexterity to customer integration is significant (0.303; $p < 0.01$), but supplier integration is not associated with it (0.083; $p > 0.05$); however, internal integration has significant relationship with it (0.150; $p < 0.05$). Hence, we found support for H2a and H2c, but not for H2b. Likewise, the standard path from customer integration to supply chain agility is significant (0.284; $p < 0.01$), but supplier integration (−0.009; $p > 0.05$) and internal integration (0.093; $p > 0.05$) are not significant with supply chain agility. Thus, hypothesis H3a is supported, whereas hypotheses H3b and H3c are not supported. Customer integration has high significant impact on organizational flexibility (0.250; $p < 0.01$), but supplier integration (0.145; $p < 0.05$) and internal integration (0.145; $p < 0.05$) have less strong significant impact on organizational flexibility. Therefore, it can be stated that a firm's supply chain integration practices have a positive influence on the organization's agility and flexibility; therefore H4a, H4b and H4c are supported.

Dimension, items and sources	Code	Drop item	Factor loading	Alpha	CR	AVE	rho_A
Uncertainties (UNC), Chen and Paulraj (2004)				0.867	0.905	0.656	0.869
The suppliers consistently meet our requirements	Uncer01		0.756				
The suppliers produce materials with consistent quality	Uncer02		0.777				
Our master production schedule has a high percentage of variation in demand	Uncer03		0.870				
Our demand fluctuates drastically from week to week	Uncer04		0.867				
Our supply requirements vary drastically from week to week	Uncer05		0.770				
Our industry is characterized by rapidly changing technology	Uncer06	drop	*0.364*				
If we do not keep up with changes in technology, it will be difficult for us to remain competitive	Uncer07	drop	*0.459*				
Organizational ambidexterity (OA), Nazir and Pinsonneault (2011)				0.794	0.850	0.488	0.811
We look for new technical ideas by thinking "outside the box"	Amb01		0.630				
We build success on the ability to explore new technology	Amb02	drop	*0.486*				
We create products or services that are innovative for us	Amb03		0.673				
We look for creative ways to satisfy customer needs	Amb04		0.682				
We aggressively invest in new market segments	Amb05		0.804				
We actively focus on new customer groups	Amb06		0.751				
We commit ourselves to try to improve quality and reduce costs	Amb07	drop	*0.248*				
We continuously improve the reliability of our products and services	Amb08	drop	*0.344*				
We look for new technical ideas by thinking "outside the box"	Amb09		0.633				
Customer integration (SCC), Flynn *et al.* (2010)				0.843	0.888	0.615	0.856
The level of linkage with our major customers through information networks	Scc01		0.846				
The level of computerization for our major customer's ordering	Scc02		0.837				
The level of sharing of market information from our major customers	Scc03		0.777				
The level of communication with our major customers	Scc04		0.717				
The establishment of quick ordering systems with our major customer	Scc05		0.734				
Supplier integration (SCS), Flynn *et al.* (2010)				0.897	0.924	0.708	0.899

Table 2.
Convergent validity

(*continued*)

Dimension, items and sources	Code	Drop item	Factor loading	Alpha	CR	AVE	rho_A
The level of information exchange with our major supplier through information networks	Scs01		0.842				
The establishment of quick ordering systems with our major supplier	Scs02		0.844				
The level of a strategic partnership with our major supplier	Scs03		0.850				
Stable procurement through the network with our major supplier	Scs04		0.848				
The participation level of our major supplier in the process of procurement and production	Scs05		0.822				
Internal integration (SSI), Flynn *et al.* (2010)				0.785	0.852	0.535	0.794
Data integration among internal functions	Sci01		0.668				
Enterprise application integration among internal functions	Sci02		0.722				
Integrative inventory management	Sci03		0.743				
Real time searching for the level of inventory	Sci04		0.779				
Real time searching for logistics-related operating data	Sci05		0.741				
Supply chain agility (SCA), Swafford *et al.* (2006), Betts and Tadisina (2009)				0.818	0.868	0.525	0.832
Reduce manufacturing lead times	Sca01		0.797				
Reduce product development cycle time	Sca02		0.817				
Increase the frequency of new product introductions	Sca03		0.735				
Increase the level of customization	Sca04		0.719				
Adjust worldwide delivery capacity/ capability	Sca05		0.628				
Improve the level of customer service	Sca06	drop	*0.438*				
Improve delivery reliability	Sca07	drop	*0.445*				
Improve responsiveness to changing market needs	Sca08						
Organizational flexibility (SCF), Moon *et al.* (2012)			0.646	0.786	0.854	0.585	0.867
We do not think about our own organization's long-term strategy when we make plans with our key suppliers	Scf01	drop	*0.363*				
Our supply chain has a good number of suppliers for raw materials supply	Scf02		0.848				
Our supply chain has greater scope for new product development	Scf03		0.892				
Our supply chain has ample scope for changing distribution facilities	Scf04		0.857				
Our supply chain has enough scope for changing delivery modes and schedules	Scf05		0.818				

Table 2.

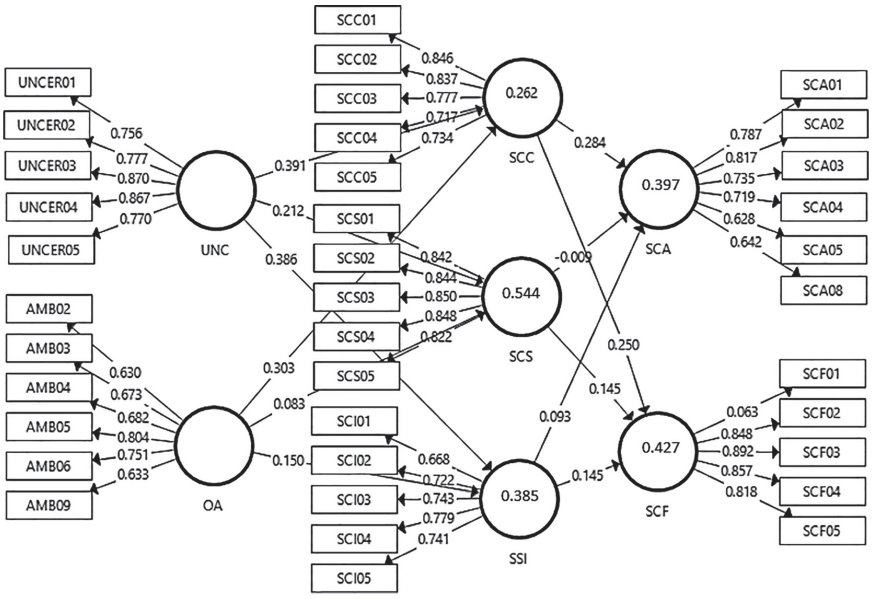
5. Discussion

Environmental uncertainty is one of the contributions of this study that entails external uncertainties and volatilities in a company's capability to produce its products and services.

The findings reveal that uncertainty has a highly significant impact on supply chain integration that consists of customers, suppliers and internal integration. This result empirically validates the assertions of Wong *et al.* (2011), who pointed out that environmental uncertainty has a significant effect on the relationships between there dimensions of supply chain integration such as customer integration, supplier integration and internal integration. The supply chain is commonly linked with external environment uncertainties by customer demand on one end, and suppliers from the other end (Prater *et al.*, 2001). The three sub-dimensions support this notion and added the dimension of supply and demand uncertainties, which covers both the supplier and customer. Eisenhardt and Martin (2000) found that uncertainties present a wholesome view of external factors impacting a company's supply chain integration efforts. The products or services are innovative and creative to satisfy customer needs. Therefore, under the influence of uncertainties, customer, supplier

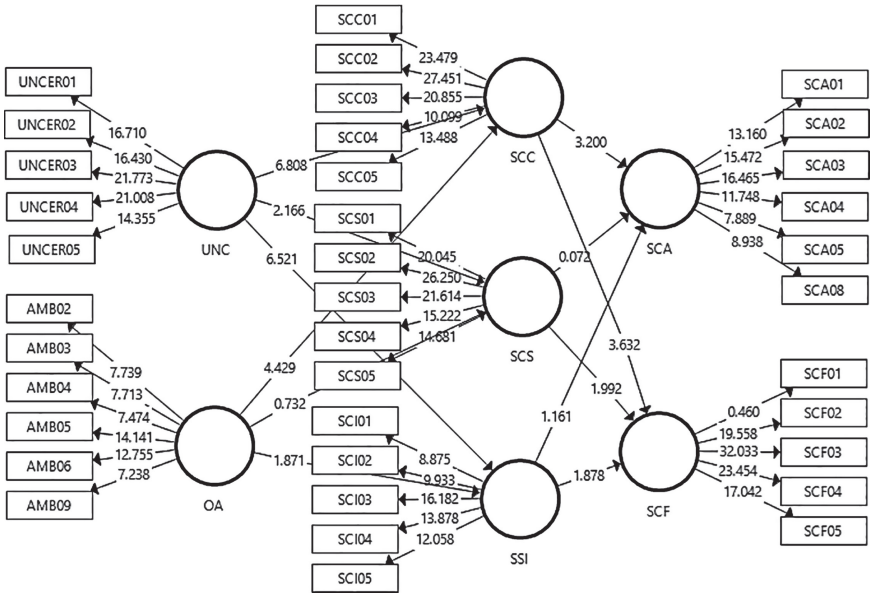
Table 3.
Discriminant validity

Constructs	OA	SCA	SCC	SCF	SCS	SSI	UNC
Organizational ambidexterity (OA)	0.698						
Supply chain agility (SCA)	0.448	0.725					
Customer integration (SCC)	0.331	0.324	0.784				
Organizational flexibility (SCF)	0.044	0.200	0.377	0.765			
Supplier integration (SCS)	0.098	0.143	0.413	0.302	0.841		
Internal integration (SSI)	0.178	0.222	0.465	0.315	0.370	0.732	
Uncertainties (UNC)	0.072	0.140	0.413	0.436	0.218	0.397	0.810



Note(s): Uncertainties (UNC), Organizational ambidexterity (OA), Customer integration (SCC), Supplier integration (SCS), Internal integration (SSI), Supply chain agility (SCA), Organizational Flexibility (SCF)

Figure 2.
Measurement model



Note(s): Uncertainties (UNC), Organizational ambidexterity (OA), Customer integration (SCC), Supplier integration (SCS), Internal integration (SSI), Supply chain agility (SCA), Organizational Flexibility (SCF)

Figure 3.
Structural model

Hypo	Relationship	Beta (β)	SD	*t*-value	Comments
H1a	Uncertainties (UNC) → Customer integration (SCC)	0.391	0.057	6.864**	Supported
H1b	Uncertainties (UNC) → Supplier integration (SCS)	0.212	0.097	2.184*	Supported
H1c	Uncertainties (UNC) → Internal Integration (SSI)	0.386	0.061	6.331**	Supported
H2a	Organizational ambidexterity (OA) → Customer integration (SCC)	0.303	0.068	4.429**	Supported
H2b	Organizational ambidexterity (OA) → Supplier integration (SCS)	0.083	0.115	0.722	Not Supported
H2c	Organizational ambidexterity (OA) → Internal Integration (SSI)	0.150	0.084	1.785*	Supported
H3a	Customer integration (SCC)→ Supply chain agility (SCA)	0.284	0.089	3.200**	Supported
H3b	Supplier integration (SCS)→ Supply chain agility (SCA)	−0.009	0.125	0.070	Not supported
H3c	Internal integration (SSI) → Supply chain agility (SCA)	0.093	0.078	1.190	Not supported
H4a	Customer integration (SCC)→ Organizational flexibility (SCF)	0.250	0.069	3.643**	Supported
H4b	Supplier integration (SCS) → Organizational flexibility (SCF)	0.145	0.074	1.944*	Supported
H4c	Internal integration (SSI) → Organizational flexibility (SCF)	0.145	0.079	1.831*	Supported

Note(s): Uncertainties (UNC), Organizational ambidexterity (OA), Customer integration (SCC), Supplier integration (SCS), Internal integration (SSI), Supply chain agility (SCA), Organizational flexibility (SCF), *t-value ≥ 2.32 considers significant level at 0.01 and t-value ≥ 1.64 considers significant level at 0.05*

Table 4.
Hypothesis testing

and internal behaviors are most profound, and this supports the significance of supply chain integration in this study.

The result also shows that there exists a significant relationship between organizational ambidexterity and supply chain integration of customer and internal integration. This is in line with the assertion that organizational ambidexterity is intended to improve responsiveness in an organization, and ambidexterity is important to firms, as it mitigates the negative impact of customers and internal supply chain integration to enhance business performance (Lee and Rha, 2016). To take advantage of organizational ambidexterity through maximizing firm performance, the company may continually search for creative ways to satisfy customer needs and adapt to the fast-changing business environment through the internal supply chain integration. These findings also add to the result of Swafford *et al.* (2006), which demonstrated that organizational ambidexterity is the major antecedent of supply chain integration. A somewhat counter-intuitive finding is reported that there is no significant relationship between organizational ambidexterity and supplier integration. This result may seem to differ from studies such as Lee and Rha (2016), which have suggested a strong relationship between organizational ambidexterity and supplier integration. Ambidexterity is relevant to the study of supply chain integration because it requires customer, supplier and internal integration process as well as integration across organizational boundaries (Raisch *et al.*, 2009). The literature (Flynn *et al.*, 2010; Frohlich and Westbrook, 2001) suggested that this newfound theoretical foundation could also explain existing findings supporting the notion that companies with "uniform" or balanced supply chain integration dimensions and those with customer-leaning supply chain integration tend to outperform other companies.

The results of this research strongly support the finding that the supply chain integration dimension of customer integration does affect supply chain agility but the supply chain dimension of supplier and internal integration does not have a significant relationship with supply chain agility. These results may seem to differ from studies such as Fayezi *et al.* (2017), who found a strong relationship between supply chain integration and supply chain agility. This was further supported by Agarwal and Shankar (2002), who concluded that effective supply chain integration and synchronization among partners lead to more agile and flexible companies. Both of these findings support this research's position that when agile companies are faced with high levels of uncertainties, their rate of supply chain agility will increase. Internal integration is more effective in the exploration of knowledge and skills to create innovative products (Tessarolo, 2007). This proved that supply chain integration influences a company's explorative behaviors with supply chain agility and organizational flexibility. This finding is vital, as given the current volatile market environment where recession is rampant and global commodity prices such as oil price crashing to unprecedented levels, it is more astute for companies to exhibit explorative behaviors as compared to exploitative. The reduction in companies' bottom lines brought about by the many external uncertainties will push them to look beyond their normal range of business boundaries. Exploiting their existing business models and approaches with the hope and intent of squeezing maximum value for their businesses are no longer sufficient. Companies will have to dig deep and look farther than their norm and diversify their business to not only within their respective industries.

Customer integration covers efforts to align and coordinate a company's supply chain with its key customers involving activities such as linking market information and establishing common ordering systems over an established shared network or communication channels. Similarly, albeit in a slightly different manner, supplier integration is a form of close alignment and coordination within a company's supply chain with its suppliers. This involves forming strategic partnerships with key suppliers, relinquishing control over what once was seen as proprietary information, with these supply

chain partners (Spekman *et al.*, 1998). These include the collaboration and sharing of inventory levels, production capacity, production schedule and involving major suppliers in the company's product design stage.

Internal supply chain integration within a company colludes to the production of an end product, goods and services to customers. Critical activities within this level of integration include enterprise application integration among internal functions, the use of cross-functional teams in process improvement and real time integration among internal functions from raw material management through production, shipping and sales. McDermott and Handfield (2000) suggested that information exchange between suppliers and internal teams are important in influencing interaction and synergies to design innovative products, providing further evidence and support on the significance of this sub-dimension in contributing to the fulfillment of this research's objectives.

This study put in the position that it is the essence for Malaysian services and manufacturing companies to have a long-term view of their customers' needs and suppliers' capabilities to fulfill those needs and constantly innovate with the enablement of Industry 4.0 technologies adoption to meet not only current demand but future demands as well. Higher levels of supply chain integration increase the level of trust between the suppliers and the companies and between the companies and their customers. This allows Malaysian services and manufacturing companies to collaborate at earlier stages of their production life-cycle such as in product design. Furthermore, the use of new technologies such as computer numerical control machining and three-dimensional printing enables these manufacturers to be more flexible in the products and range of products they can produce. Integration is also important, as it ensures that any design entrusted to the manufacturer can be rapidly produced. This proved the strong influence Industry 4.0 has on supply chain integration which indicates the adoption of these technologies will drive high-level integration in Malaysian services and manufacturing company's supply chain, which in turn drives better and stronger supply chain performance.

The result of this research also suggests that high levels of explorative behaviors will increase supply chain agility in which agile companies explore new product innovations, new ways to satisfy customers and invest in new market segments. These behaviors push the company to be more integrated with both their suppliers and customers to be able to serve them at a more rapid pace. Supply chain agility is imperative for Malaysian services and manufacturing companies to create a more resilient and agile supply chain by developing supply chain intelligence through the adoption of Industry 4.0 technologies at strategic, tactical and operational levels with their respective supply chain partners. This end to end integration enabled by the Industry 4.0 technologies will allow these Malaysian services and manufacturing companies to achieve rapid prototyping and production and drive higher levels of product and services innovation.

6. Implications

6.1 Theoretical implication

This study began with the aim to introduce a few pioneers in the field of supply chain management and digitalization, in the context of the adoption of Industry 4.0 technologies. Given the growing interest in the subject of Industry 4.0 and the many and various discussions on the need for industry players to unlock more values with fewer resources with the adoption of Industry 4.0. In terms of theoretical implication, this study contributes to driving the discussion around the adoption of Industry 4.0 technologies and focuses on the notion that both environmental uncertainties and organizational ambidexterity as being important and significant elements influencing supply chain agility and organizational flexibility. This study contributes that companies' explorative behaviors generate significant

effect among supply chain integration, uncertainties, organizational ambidexterity, supply chain agility and organizational flexibility. Another contribution of this research is the discovery of product integration for customers and suppliers under the supply chain integration. Understanding the notion brought about by this theoretical contribution is critical, as it suggests that companies with a big picture view and an end to end synchronization of their entire value chain covering both their suppliers and customers have the competitive capabilities to not only fulfill their customers' current demands but also innovate for future demands and do so at great speed (agility) and flexibility.

6.2 Managerial implication

The study has significant managerial implication, as the findings ensure the positive effect of supply chain integration on all of the defined constructs, and this notion supports the positive effect on Malaysian services and manufacturing companies' adoption of Industry 4.0 technologies in creating lasting values to not only themselves but also their supply chain managers, suppliers and customers. This finding is useful to businesses, practitioners, and managers not only for those involved in the services and manufacturing industry but beyond, in tailoring their approach to new technologies adoption. The findings imply that when manufacturing and business firms faced with high levels of uncertainties, companies must strengthen their supply chain synchronization with both suppliers and customers. The companies may adopt Industry 4.0 technologies to further strengthen their supply chain integration amid high levels of external volatilities and uncertainties.

7. Conclusion and future study

The study has several limitations as the data collection period was relatively short. This study focuses on industry leaders are the participants to the research questionnaires, it is challenging to obtain a larger sample size in such a short period. With this, the researcher suggests that longer lead time and an expansion of questionnaire participation scope should be considered for future researches. Due to the time and resource constraints faced by the researcher, this study adopted the cross-sectional research design where data were collected at a single point in time. This researcher would like to put forth the suggestion and recommendation that for future researches, the longitudinal research design method should be considered as it would provide more robust forms of the validity of the measurement instruments. Given the researcher's professional background and industry network, the current study yielded a strong majority of oil and gas industry leaders' participation and hence created an industry bias toward the research findings. The expansion of the research design to the longitudinal method should allow the researchers ample time to manage their research design and resources to gather samples across more industries to ensure very little industry biases in the research findings and results. This research solely focuses on carrying out quantitative analysis where all the analyses, findings and conclusions were derived from statistical means. This researcher recommends that qualitative analysis be adopted for future researches to drive more complete and robust research findings that are reflective of the research population. Data from qualitative interviews, for instance, would prove to be invaluable and strong input validation to the results of the surveys, especially as this research focusses on gathering the input from industry leaders.

This study would be interested in understanding whether there are any observable differences between different sizes of companies (such as start-ups, small-medium enterprises, mid-to-large companies, conglomerates, government-linked companies and multinational companies) and the impact of new technologies adoption to the business entities' performances. This study only looks at companies who had, to some degree, adopted

new technologies and studied their perceived benefit from the technology adoption. This researcher posits the future researches to look at pre-adoption and understand the factors for companies to not want to jump into the bandwagon and play a late majority or laggards' role rather than innovators and early adopters to new technologies adoption. The findings of this study may be used to aid researchers in developing a deeper understanding of business entities' rate of adoption of new technologies and how it impacts the ways they do their businesses and forge new business values and drivers.

The reliable multidimensional measures were established and validated in answering the research questions and their associated research objectives. The measures were assessed and validated through proven scientific, statistical and mathematical and research methodologies such as factor analysis and reliability analysis. By analyzing the research results through the rigorously defined and disciplined approach to research methodologies, the constructs in this study achieved unidimensionality, validity and reliability. The structural equation modeling technique was employed by using the SmartPLS tool in the final stage of statistical analysis forming the foundation of statistical efficiency and enabled this researcher to comprehensively assess the relationships systematically and holistically. Among the biggest challenges faced by any researcher in conducting academic research, the literature review proved to be a mountainous task for the researchers given the broad and wide-ranging discussions around the subject matter and the topic of discussion. The paradigms for Industry 4.0 were constantly put in the limelight by governments and business entities alike in their ongoing struggle to explore and exploit the almost bottomless value driven by its adoption, but not many were able to combine this within the context of supply chain integration.

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