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Does the Industry 4.0 have any impact on the relationship between Agile Strategic Supply Chain and the Supply Chain Partners Performance

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The primary objective of this study is to examine the moderating role of industry 4.0 in the relationship between agile supply chain strategy and the supply chain partner performance. In addition, the study has examined the mediating role of supply chain performance in the relationship between agile supply chain strategy and the supply chain partners performance. Regarding technology adoption, it is important to examine the possible Industry 4.0 impacts on the overall supply chain (SC). It is suggested to involve practices, including processing customer response, managing customer complaints, and interacting with customers, thereby enabling firms to manufacture customised products and services, and address the flexibility attributes of the SC. It has also been argued that it allows firms to track and address customer preferences and variations in their demand, which refers to addressing the responsiveness attribute of the SC. A preliminary analysis is presented by this paper regarding the impact of Industry 4.0 on the SCM. In addition, the paper also attempts to consider supply chain 4.0. The research analysis is confined to only four SC functions, namely transport logistics, order fulfilment, procurement, and warehousing. These are included in the research analysis as the key performance indicators. The findings of this research are expected to offer innovative pathways for future studies and would present a bigger and better illustration and analyse such impacts. The textile industry of Thailand is chosen as a sample of the study.

Key words: *Agile supply chain, industry 4.0 textile, Thailand.*

Introduction

In a focal firm, supply chain agility acts as an essential element to produce in accordance with the changing needs of customers. For a firm to produce desirable customer demanded products, there must be supply chain agility; the ability of quickly responding to short product cycles and volatile demand (Gligor, Esmark, & Holcomb, 2015). Thus, supply chain agility plays a critical role to quickly respond to the changing needs of customers by rapidly launching new and differentiated products and effectively responding against delivery requirements, such as time and quantity (Tarafdar & Qrunfleh, 2017; Wu, Tseng, Chiu, & Lim, 2017). Considering the case of Zara, it has a highly responsive SC that allows it to introduce new designs every week and makes it possible for product to reach its stores around the globe in a minimum period of 15 days (Singh, Garg, & Sachdeva, 2016). In another example, 7-eleven restocks a wide range of its products in adequate volume within 12–hours of order placing by its customers (Singh et al., 2016). This high responsiveness is due to the supply chain agility of both companies. Supply chain agility is represented as the agile SC strategy (Hofmann, Schleper, & Blome, 2018). The term agile supply chain (ASC) strategy refers to the strategy of effectively and quickly responding to volatile needs of the customer. The academic literature emphasises upon the association among focal firm performance and ASC strategy, and the ASC's product attributes and the agility factors (Gligor et al., 2015).

Although, the literature does not provide evidence of enhanced supply chain performance through ASC strategy. In a recent study — which was conducted using a SC practitioner's perspective — it revealed that although 89 per cent of the survey respondents were aware of the significance of ASC strategy, only a few had fully understood the means for achieving better performance in the SC. Thus, the objective of this paper is to demonstrate the SC performance improvement by adopting the ASC strategy. This objective will be addressed using two theoretical lens or concepts. Firstly, the relationship between SC practices and SC strategy. It is suggested in this research that SC practices contribute to the ASC strategy through creating a positive mediating linkage among SC performance and ASC strategy. Secondly, a firm's information processing view (Srinivasan & Swink, 2018). The current research analyses whether the capability of information systems (IS) when applied to achieve agility bring stronger SC mediation impact.

In the past few decades, a noticeable revolutionary progress has been witnessed in information technology (IT) systems, which has eventually influenced all aspects of life. A radical shift towards smart devices for using infrastructure services is one of the progressive changes in the information technology (IT) sector. This has given rise to a new internet era, which has become noticeable with the occurrence of global computing systems and integrated computer-oriented systems, linked with a wireless internet network. Such developments have enabled the unending virtual possibilities of interlinking machines and human beings with a context of a cyber-physical system and direct engagement of machines. Such network implementation in the operations and production environment is referred to as the Industry 4.0. Integrating Industry 4.0 to the production sector poses several effects on the overall SC. Thus, SC collaboration is essential among manufacturers, customers, and suppliers for enhancing SC transparency at each step, including from point of dispatching order to the end-of-life of a product. Collaboration is also crucial for incorporating automatic and digitalised processes in the SCM structure. For developing a clear understanding of the potential threats and opportunities of new technology adoption, it is important to examine the possible Industry 4.0 impacts on the overall SC. A preliminary analysis is presented by this paper regarding the impact of Industry 4.0 on the SCM. In addition, the paper also attempts to consider supply chain 4.0. The research analysis is confined to only four SC functions, namely transport logistics, order fulfilment, procurement, and warehousing. These are included in the research analysis as the key performance indicators. The findings of this research are expected to offer innovative pathways for future studies and would present a bigger and better illustration and analyse such impacts.

Therefore, the research questions were attempted in order to answer and address the research objectives:

1) Is the ASC strategy and SC performance relationship mediated by SC practices?
2) Does IS capability have a positive mediation impact on mediating relationships?
3) Does the industry 4.0 play any role in enhancing the partners performance from an agile supply chain?

Literature Review

There are three objectives of ASC strategy adoption: a) delivering those products which possess a variety of configurations, such as, sizes, colours, features and options (Dubey et al., 2018); b) quick response against customer demand changes, such as responsiveness (Tarafdar & Qrunfleh, 2017); and c) ability of effective handling during a sudden product life cycle and technological changes, such as adaptability (Khan & Wisner, 2019). Therefore, it is hypothesised that customer relationship, strategic supplier partnership, and customer postponement are the SC practices which are essential for meeting the underlying ASC strategy objectives. The strategic supplier partnership refers to the activities that are required to develop long-term and close associations among suppliers and organisations (Khalil, Khalil, & Khan, 2019). Such close associations particularly focus upon continuous improvement programs, and planning and problem solving with only a few selected suppliers. In addition, it enables greater coordination among suppliers and organisations. Furthermore, it allows knowledge exchange for product development and for launching new product designs, thereby ensuring SC flexibility. These relationships allow the estimation and proactive detection of technological and product changes, resulting in SC adaptability and improved responsiveness (Khan & Wisner, 2019). Meanwhile, customer relationship activities referred to the focal firm's activities and processes to create and effectively manage close and long-term customer relationships. It was also suggested to involve practices, including processing customer response, managing customer complaints, and interacting with customers, thereby enabling firms to manufacture customised products and services, and address the flexibility attributes of the SC. It has also been argued that it allows firms to track and address customer preferences and variations in their demand, which refers to addressing the responsiveness attribute of the SC (Tarafdar & Qrunfleh, 2017). Postponement refers to moving one or more SC activities or operations (such as, sourcing, delivering or making) ahead to a later point, keeping SC products in generic form until the point of receiving customer orders (Sabri, Micheli, & Nuur, 2017).

The term SC performance refers to the degree of a SC to effectively satisfy the requirements of its customers, such as on-time delivery or product availability (Sabri et al., 2017; Tarafdar & Qrunfleh, 2017; Chienwattanasook & Jermsittiparsert, 2018; Sutduean, Harakan, & Jermsittiparsert, 2019; Sutduean, Prianto, & Jermsittiparsert, 2019). Through the above mentioned three practices, ASC strategy creates an influence on the SC performance. The impact of ASC strategy is transmitted to the SC performance through strategic supplier partnership, in the following ways. Firstly, taking part in strategic supplier partnerships enables firms to successfully achieve process integration relationships among suppliers. It facilitates firms to adopt certain initiatives, like new market opportunities' identification, sharing ideas, adopting a continuous improvement approach among suppliers, and developing knowledge for raw materials (Srinivasan & Swink, 2015). The wider and greater depth of supplier interactions allows innovative and flexible handling of the competitive opportunities and pressures by the focal firms. Secondly, the strategic supplier partnership ensures the involvement of suppliers in the whole product cycle, including procurement, design, delivery, engineering and recycling. Thus, readily providing inputs which are associated to tools, product design, or materials (Tarafdar & Qrunfleh, 2017), increases the process time, and prevents delays that occur because of re-work or changes. Thirdly, frequent information sharing among suppliers allows them to rapidly respond and analyse the information about lead times. Fourthly, the improvement in information sharing and SC integration among partnering firms, SC cooperation, collaboration and trust also improve over time and result in certification programs, joint decision-making, and design teams. Strategic supplier relationships bring ease in all such activities and improve the SC partners' ability of enhancing overall responsiveness of supplier-interface processes. Such as, Cisco hears the market voice and effectively and rapidly manages the strategic supplier association with the firms' ASC strategy (Tarafdar & Qrunfleh, 2017). Thus, it shows the positive relationship among SC performance and ASC strategy, partially by strategic supplier partnership.

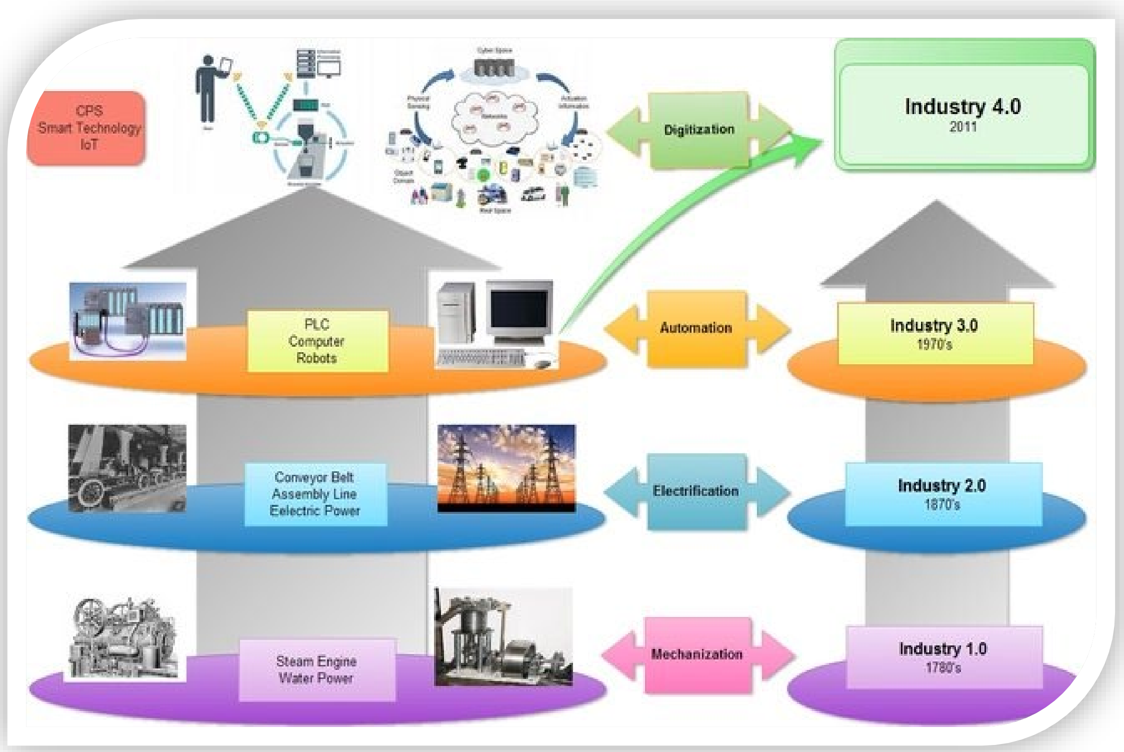
In several ways, the customer relationship effectively mediates ASC strategy's positive effect on the SC performance. A close firm-customer relationship enhances the sharing of information about the means by which focal firms meet and determine the changing requirements of their customers (Tavana, Shabani, & Singh, 2019). Close relationships also enable analysis of the customers' always changing needs, product-market options, and competitive actions through a continuous process, as well as provide opportunities to seek the feedback of customers and observe their expectations and level of satisfaction. For instance, a study (Tavčar, Demšar, & Duhovnik, 2018) has shown empirical evidence that customers' feedback and involvement in the product design process allows the timely and accurate exchange of information, leading to enhancement of on-time delivery and fewer delivery-based errors. Frequent customer interactions also allow better understanding and anticipation of customer preferences and expected changes in customer demand with time. Therefore, Ralston, Blackhurst, Cantor, and Crum (2015) stated that it provides the SC the ability of coping with market changes through proactively responding and meeting the specifications and demands of customers. Thus, SC performance and ASC strategy were found to be positively associated, partially by the customer relationship.

Gligor et al. (2015) mentioned that another important ASC strategy dimension is its wait-and-see approach in terms of demand, which refers to no production activity until the estimated demand is known. It explains that firms keep undifferentiated materials with them until they receive orders from customers, which increases the SC responsiveness and flexibility and allows a wide product variety. Thus, keeping inventory in a generic form acts as a necessary element for the ASC strategy, where generic form may involve basic, semi-finished, or standard constituents which can be assembled in no time after receiving customer orders (Sindi & Roe, 2017). One such way is to adopt postponement, which does not require fully specified customer orders during the production or ordering processes (Hsu, Tan, & Mohamad Zailani, 2016; Tarafdar & Qrunfleh, 2017). According to Zhang, Guo, Huo, Zhao, and Huang (2019), focal firms are capable of processing the modular or generic parts beforehand, and add customised attributes later during the final assembling process, thereby enabling them to readily produce and then deliver a wide product range to their customers. For example Dell, its SC possesses the ability of developing agility by permitting focal firms to prepare an order, following the standard modules and by holding undifferentiated materials until realising the customer demand (Boscari, Danese, & Romano, 2016). Thus, postponement bridges the gap between SC performance and ASC strategy through adding responsiveness and flexibility in the SC.

H1: The AGSCS has a significant relationship with the SCHP
H2: The SCPR has a significant relationship with the SCHP
H3: The AGSCS has a significant relationship with the SCPR
H4: SCPR mediates between AGSCS and SCHP

Industry 4.0 encompasses how manufacturing shop floors operate after a radical shift, such as the adoption of internet and digitalisation, which is defined as a global transformation in the manufacturing sector (Haseeb, Hussain, Slusarczyk, & Jermsittiparsert, 2019; Sae-Lim & Jermsittiparsert, 2019; Syazali, Putra, Rinaldi, Utami, Widayanti, Umam, & Jermsittiparsert, 2019). Such transformations observe significant design and process improvements, as well as improvements in manufacturing systems and operations. Although it originates in Germany, the Industry 4.0 notion shares several commonalities of European countries' developments, which were labelled as Smart Industry, Industrial Internet of Things, Advanced Manufacturing, or Smart Factories (IIoT). A smart factory is the use of digital technology through adopting new and innovative developments, such as artificial intelligence, advanced robotics, cloud computing, hi-tech sensors, digital fabrication, Internet of Things, data analytics, and new marketing models — such as platforms for directing motor vehicles using algorithms — and setting all such elements into a global interoperable value chain, being shared among several companies around the globe. Considering an Industry 4.0 context, it is expected that the future factory will offer a human and machine's connection in Cyber-Physical-Systems. Such systems integrate their maximum resources to introduce those industrial processes and intelligent products, which provide industry the ability of dealing with quick shopping pattern changes (Zhong, Xu, Klotz, & Newman, 2017).

Figure 1. Industry 4.0 (The world of industrial automation technology)



Source: Khan et al., (2017)

Although the term Industry 4.0 has not yet been defined conclusively (Schuh, Frank, Jussen, Rix, & Harland, 2019), it generally has four features:

- Horizontal integration through developing new global value chain networks: CPS implementation in smart factory demands certain networks, business models and strategies for achieving horizontal integration, that offer higher flexibility, and enable a faster response by the company. Value chain transparency allows manufacturing firms to identify customer preferences, changes in their requirements, and to carefully consider these requirements in each step of production, including from product development until its distribution.
- Vertical networking: This networking type is established upon CPSs for developing adaptable factories which possess flexibility towards changing customer demand. However, in a smart factory, manufacturing processes may carry out mass customisation.
- Engineering support throughout the whole value chain: Technical improvements and innovations are involved in the product design, manufacturing processes and development. These technicalities enable the ability to develop innovative production systems and new products by using big-data or large volumes of information.
- Adopting exponential technologies: Adopting innovative technologies can facilitate in the product customisation process, in increasing flexibility and reducing costs. Industry 4.0 considers the automated systems, such as drones, artificial intelligence (AI), nanotechnologies, robots, and a variety of those materials which allow flexibility, rapid manufacturing and customisation.

Such revolution expects the type of environment in which smart machines can communicate with each other, enabling production automation and understanding and observing certain production related issues, having minimum or no involvement of humans for problem solving. Although, initially it was expected to influence manufacturing industry the most, these innovations are now expected to influence companies, service providers and the retailers as well.

H5: The industry 4.0 has a significant relationship with the SCHP
H6: The industry 4.0 moderates between AGSCS and SCHP

Methodology

For the collection of data, we have used a questionnaire survey method in this study. We distributed 600 questionnaires across different construction organisations. Soft reminders through phone call and SMS were provided to achieve a higher response rate. This resulted in 520 questionnaires being received, including 21 responses that were not useable or were incomplete. This included a lack of information from participants in these 21 questionnaires.

The total of remaining 499 questionnaires were taken for further analysis. The total valid response rate was 83 per cent; a response rate that is considered sufficient for the current study. For the purpose of assessing the conceptual model relationships between the constructs, a SmartPLS was employed as it is a second-generation statistical method which provides appropriate methodological features, which are the best alternative to first-generation techniques. The multiple regression is a first-generation technique which deals with a set of independent variables, with only one dependent variable. On the other hand, SEM can take in a set of both independent and dependent variables (Boscari et al., 2016) for simultaneously estimating the relationships. The SEM has received great interest and attention from researchers due to its predicting power, particularly in the field of the behavioural sciences. The reason of such popularity is due to its ability of integrating multiple unobserved variables and applying analytic path-modelling.

All latent variables and their respective indicators were expected to be examined through this research. The term latent variable is the one which cannot be directly measured and takes in a set of indicators to estimate it (Boscari et al., 2016). For this purpose, structural equation modelling is employed, since it incorporates both inner and outer models. In the measurement model, each construct is assigned with a set of items or indicators, and in the structural model, the structural relationship is determined between the set of endogenous and exogenous variables.

Moderated mediation analysis was applied on the data that was collected from 205 manufacturing firms' senior executives, procurement roles and material management, and structural equation modelling was used to test the hypotheses.

Results

According to Dijkstra and Henseler (2015), SEM allows to predict, measure, and describe the existing relationships between the set of variables. In view of Henseler, Hubona, and Ray (2016), the goodness-of-fit measure does not adequately assess the validity of the underlying model. Therefore, other measures, such as item validity, content validity, composite reliability, convergent validity and discriminant validity must be observed to determine the measurement model (Hair, Sarstedt, Hopkins, & G. Kuppelwieser, 2014). Hair, Hult, Ringle, and Sarstedt (2016) suggested that assigning one or two items is not sufficient. Therefore, for each latent construct, at least two indicators must be added, thereby increasing the degrees of freedom in the complex model estimation.

Figure 2. Measurement Model

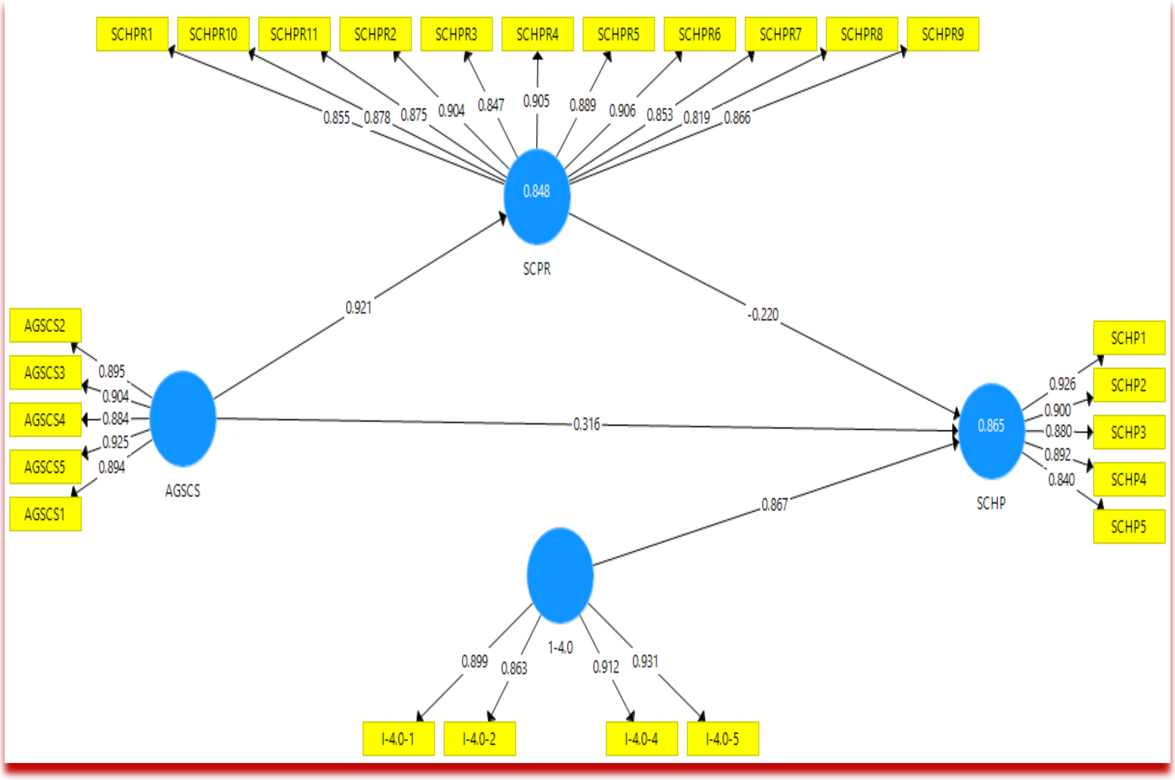


Table 1: Outer loading

	1-4.0	AGSCS	SCHP	SCPR
AGSCS2		0.895		
AGSCS3		0.904		
AGSCS4		0.884		
AGSCS5		0.925		
I-4.0-1	0.899			
I-4.0-2	0.863			
I-4.0-4	0.912			
I-4.0-5	0.931			
SCHP1			0.926	
SCHP2			0.900	
SCHP3			0.880	
SCHP4			0.892	
SCHP5			0.840	
SCHPR1				0.855
SCHPR10				0.878
SCHPR11				0.875
SCHPR2				0.904

SCHPR3				**0.847**
SCHPR4				**0.905**
SCHPR5				**0.889**
SCHPR6				**0.906**
SCHPR7				**0.853**
SCHPR8				**0.819**
SCHPR9				**0.866**
AGSCS1		**0.894**		

The research analysis begins with the confirmatory factor analysis, which explains the variability between the observed variables, i.e. theoretical model (measurement model) is compared to the actual model. The obtained result must also correlate with the construct's validity. Afterwards, a composite reliability test was performed, which is the measure for checking the internal consistency of scale items. However, in SEM, it measures the overall reliability of loaded items of the constructs. The value for CR ranges from 0–1, although the recommended value for CR is equal to or greater than 0.70, since it explains good reliability. Besides, Cronbach alpha is the internal consistency measure; it measures how the items are correlated as a group and is also known as the scale reliability measure (Mayer, 2015). According to a general rule of thumb, the Cronbach alpha value with 0.70 or above is considered good. Thus, all model constructs for this study indicated value consistent with the recommended value.

Table 2: Reliability

	Cronbach's Alpha	**rho_A**	**CR**	**(AVE)**
1-4.0	**0.923**	**0.924**	**0.945**	**0.813**
AGSCS	**0.942**	**0.943**	**0.955**	**0.811**
SCHP	**0.933**	**0.934**	**0.949**	**0.789**
SCPR	**0.969**	**0.969**	**0.972**	**0.762**

The measurement or outer model analysis also assess the convergent and discriminant validity of the measuring constructs. The term convergent validity shows whether the measuring item or indicator exhibit a positive correlation with other indicators of the same variable. The average variance extracted (AVE) values were observed to confirm the convergent validity. The AVE values for all indicators exhibited greater than 0.50 value, which shows the adequate convergent validity. Hair et al. (2014) mentioned that if items of the model constructs show less than 0 value, then it means that there are still additional errors involved in the model constructs.

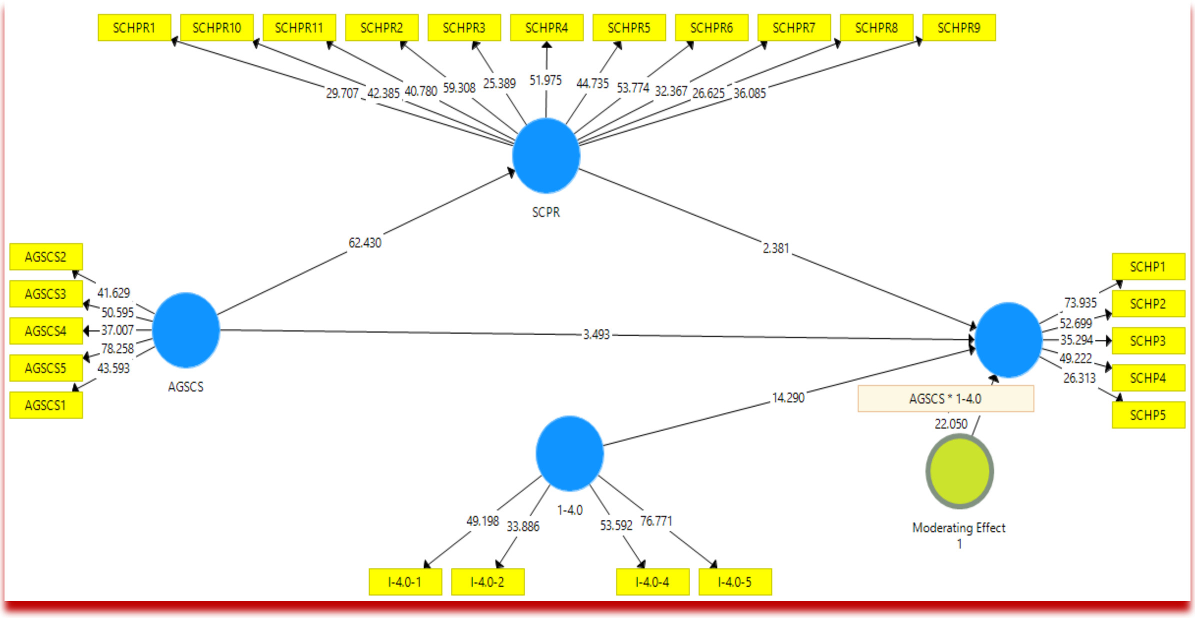
Discriminant validity tests whether the model constructs are empirically different from one another. This measure is generally employed to assess whether the two concepts are correlated or partially correlated (Hair et al., 2014; Ngah, Zainuddin, & Thurasamy, 2017). The Fornell-Larcker criterion is a relevant measure to confirm the discriminant validity. Sarstedt, Hair, Ringle, Thiele, and Gudergan (2016) suggested that the constructs must explain its own variance instead of describing another construct's variance. Therefore, a comparison is made between the AVE's square roots with the correlations of the latent constructs. The AVE's square roots must indicate greater values as compared to the correlations (Hair et al., 2016). The results validate the adequate discriminant validity for the model constructs, as shown in Table 3.

Table 3: Discriminant validity

	1-4.0	**AGSCS**	**SCHP**	**SCPR**
1-4.0	0.901			
AGSCS	0.767	0.801		
SCHP	0.821	0.791	0.888	
SCPR	0.712	0.781	0.788	0.873

To begin with the inner model estimation, the first step is to check collinearity between the indicators, as the correlation between indicators may bring problematic results. Therefore, the related measure to assess collinearity is the variance inflator (VIF). With respect to PLS-SEM, the value for VIF must be greater than 5 and tolerance level must be greater than 0.2, as a less than or equal to 0.2 tolerance level represents the collinearity issue in the data (Hair et al., 2016). The range for VIF and tolerance level confirmed the absence of multicollinearity in this research data. In the next step, the structural model is estimated by observing the key measures and structural relationships of the inner model. These key measures include significance of relationships and path coefficients, predictive power of the model, predictive relevance and the effect size.

Figure 3. Inner model



After analysing the measurement model, a systematic analysis was also performed for estimating the structural model. Thus, the model observed the direct associations between the independent and dependent variables to estimate the inner model. Subsequently, the size of path coefficients was also calculated through carrying out the bootstrapping procedure by employing the PLS-SEM Algorithm. For performing the bootstrapping method, 5000 samples were sued, keeping the original number of cases. In addition, SmartPLS was also employed to check the significance of structural associations (Hair et al., 2016; Hair et al., 2014; Henseler et al., 2016).

Table 4: Direct and moderating effect

	(O)	(M)	(STDEV)	T	P V
1-4.0 -> SCHP	0.861	0.850	0.060	14.290	**0.000**
AGSCS -> SCHP	0.297	0.295	0.085	3.493	**0.000**
AGSCS -> SCPR	0.921	0.921	0.015	62.430	**0.000**
Moderating Effect 1 -> SCHP	0.732	0.034	0.025	4.270	**0.000**
SCPR -> SCHP	0.212	0.200	0.089	2.381	**0.009**

Figure 4. Moderating effect of industry 4.0

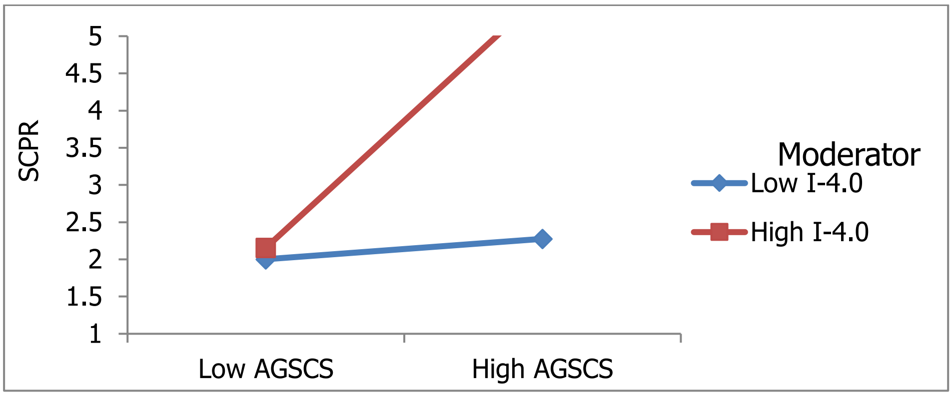


Table 5: Mediating effect of SCPR

	(O)	(M)	(STDEV)	T	P V
AGSCS -> SCPR -> SCHP	0.195	0.184	0.082	2.385	**0.009**

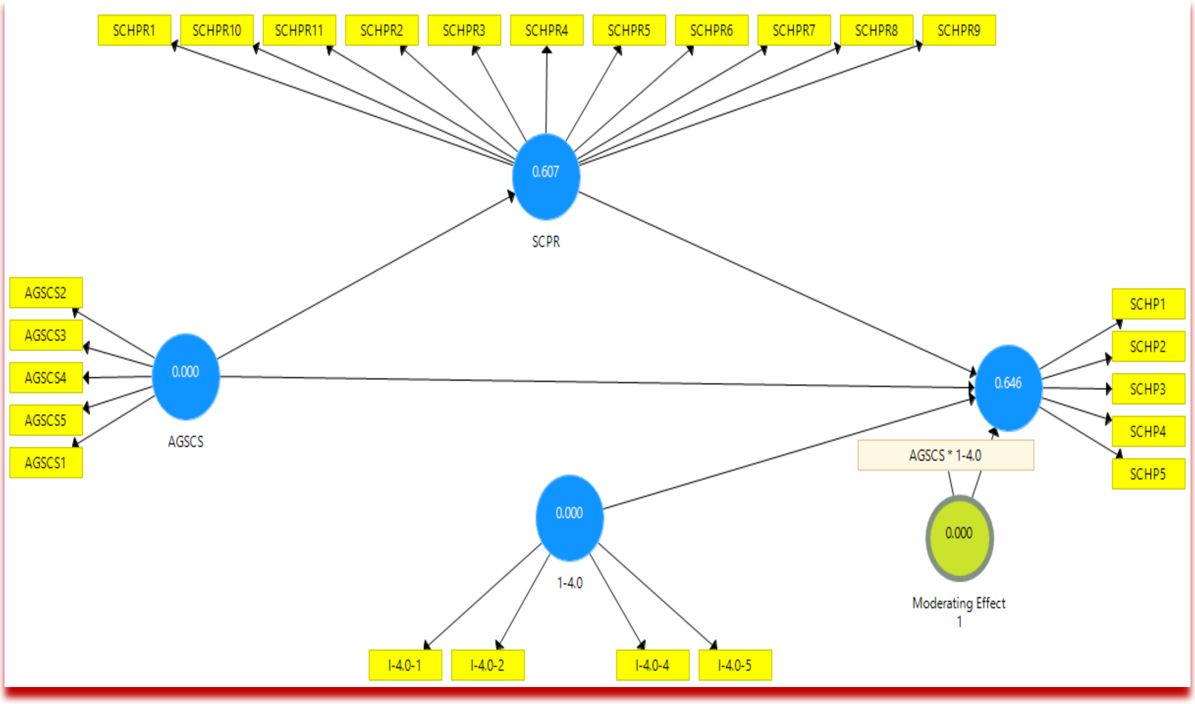
Afterwards, the R^2 value, also known as coefficient of determination, was computed to assess predictive power of the model. The value of R^2 shows the proportion of variation in the endogenous variable that can be explained by one or more independent variables involved in the model. According to Hair et al. (2016), the R^2 value may lie between 0–1. R^2=0 indicates that there is no predictive accuracy and R^2=1 indicates greater accuracy. For the current model, the endogenous variable was 48.7 percent predictable by the exogenous variables.

Table 6: R-square

	R Square
SCHP	0.865
SCPR	0.848

Lastly, a Stone-Geisser test (Q^2) or a cross-validated redundancy measure was used to analyse the predictive relevance of exogenous constructs (Hair et al., 2016; Shmueli et al., 2019).

Figure 5. Blindfolding



For this purpose, a blindfolding procedure was performed, since the Q^2 value obtained through the blindfolding method shows whether the path model can well predict the originally observed set of variables. The threshold level for Q^2 is above 0.5, where $Q^2<0.5$ indicates that the model has no predictive relevance and $Q^2>0.5$ shows that the model has some predictive relevance (Shmueli et al., 2019). The following are the Q^2 values for the structural model.

Table 7: Q-square

	SSO	SSE	Q² (=1-SSE/SSO)
1-4.0	868.000	868.000	
AGSCS	1,085.000	1,085.00 0	
Moderating Effect 1	217.000	217.000	
SCHP	1,085.000	383.828	0.646
SCPR	2,387.000	938.789	0.607

Conclusion

The result of the analysis indicates that applying certain technologies, for instance 3D-prining and simulation, augmented and virtual realities, would ultimately result in better opportunities. Contrarily, cybersecurity, big data analytics, the loT, cloud technology, ADC, robotics, RFID, nanotechnology and drones, electronic miniatures, and BI and M2M could act as both threats or opportunities for companies, since all areas are interconnected having no definite boundaries. Therefore, the positive or negative associations of these technologies depend on the area where it is analysed. However, adoption of Industry 4.0 also identifies some of the benefits. Thus, flexibility, productivity, efficiency, and quality standards are the most expected benefits of Industry 4.0, which allows mass customisation and as a result, enables firms to constantly create value through new services and product offerings in the market while also meeting the demands of the customers. Furthermore, humans and machine collaboration could socially influence the life of future workers, particularly in terms of effective decision making.

The ability of quickly adjusting focal firms’ production processes largely depends on the SC’s ability to quickly change key operational aspects, such as schedule and delivery. Supply chain agility is the organisational ability of rapidly modifying the operations and organisational tactics, thereby enabling firms to manufacture in order to be adaptive towards sudden product variety and product volume changes, and to detect and respond to changing market requirements. However, understanding how performance is affected through supply chain agility is another significant contribution of present research. That is, how firms effectively produce and deliver during uncertain changes in demand, short product cycles, and dynamic markets.

Little empirical evidence is currently available, which provides the nature of association among SC performance and SC agility (Gligor et al., 2015). This paper attempts to describe the ways information processing capabilities and SC practices influence a positive SC performance and ASC strategy relationship, with a purpose of contributing to research which aims to identify how a firm responds and engages in production while faced with varying markets and customer demands. The following are the main contributions of this study: 1) it captures the relationship between two concepts; specific SC practices and ASC strategy, which offers understanding on how SC performance can be improved by ASC strategy, with the mediation impact of SC practices; 2) it shows that information sharing for SC agility involves focal firm’s applications. For example, facilitating IS among SC partners and suppliers assists in launching new products and market scanning and assessing potential scenarios in the future, as well as boosting mediation impacts. To observe IS, a previous study by Chan, Ngai, and Moon (2017) has observed the inter-firm concepts, like innovation, trust, knowledge sharing and collaboration. However, the SC practices and IS relationship —

that is exchanging information to achieve agility supports the SC practices' impact for improving SC performance — is an under studied area, which is another contribution of this study.

The study has given rise to a new internet era, which has become noticeable with the occurrence of global computing systems and an integrated computer-oriented system, linked with a wireless internet network. Such developments have enabled the unending virtual possibilities of interlinking machines and human beings with a context of cyber-physical systems and direct engagement of machines. Such network implementation in the operations and production environment is referred to as the Industry 4.0. Integrating Industry 4.0 to the production sector poses several effects on the overall SC. Thus, SC collaboration is essential among manufacturers, customers, and suppliers for enhancing SC transparency at each step, including from the point of dispatching an order to the end-of-life of a product. Collaboration is also crucial for incorporating automatic and digitalised processes in the SCM structure. For developing a clear understanding of the potential threats and opportunities of new technology adoption, it is important to examine the possible Industry 4.0 impacts on the overall SC.

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