Supply Chain in Digital Era: Role of IT Infrastructure and Trade Digitalization in Enhancing Supply Chain Performance

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Abstract--- Digitalization is knocking at the door of all industries but manufacturing industry is responding comparatively lesser than the other sectors. Poor IT infrastructure can lead towards diminishing performance at all fronts including financial, operational, marketing and supply chain. Trade digitalization can emerge as a savior in industry digitalization era. This study is focused to analyze the influence of IT standardization and integration on supply chain performance in mediating role of trade digitalization. Questionnaire-based survey was conducted in Thailand's manufacturing industry where almost 47 firms' employees were taken as sample and their responses were analyzed on SPSS and AMOS for statistical findings. Findings have revealed that both dimensions of IT infrastructure have significant impact on supply chain performance and mediating role of trade digitalization was also flagged significant. None of the previous studies had checked trade digitalization's mediating role in respective relationship which was the originality of this study. Study has its implications for academia, industry and government as IT infrastructure has to be developed in not only Thailand's industry but in all countries locating at Asian belt to enhance supply chain performance.

Key Words: IT Infrastructure. IT Standardization, IT Integration, Trade Digitalization and Supply Chain Performance

1. Introduction

The infrastructure of any organization consists of several pillars on which the performance of the organization relies [1]. The performance is always measured based on a series of events. The infrastructure consists of several factors like the marketing expertise of the organization, the advertisement capabilities of the organization, the profitable and right financing by the organization and the right kind of investments made by the organization. Out of all these things the information technology sector of any organization is the most important one as this is known as the brain of any organization. Information technology expertise are the ones that are required by every organization in order to build up their competitive advantages and in order to be superior in the market [2]. Trade digitalization refers to the digitalization of all of the processes that are required in the trading process. All of the steps are integrated in such a way that they can be accessed from any place and can be controlled. The digitalization process enables the organizations to digitally control and digitally operate the trading and the basic functioning involved in the trading process. Because of this ability of any organization the organizations have no more need to keep data at several places and in different databases. The organizations are becoming modern and so are their methods of doing things [3]. The organizations are implementing trade digitalization process in order to improve the supply chain process. The supply chain process can be controlled and can be moved forward with the help of the trade digitalization process in the order to take everything with the same pace on a common ground. The problem is that most of the three manufacturing industries of Thailand named as electronic industry [31; 36], transportation industry, and machinery industry are unsure of the fact that whether they should implement trade digitalization in the industry or not. This study is being conducted in order to know whether there is any need of implementing and improving the IT infrastructure and whether or not there is any need of the implementation of the trade digitalization or not.

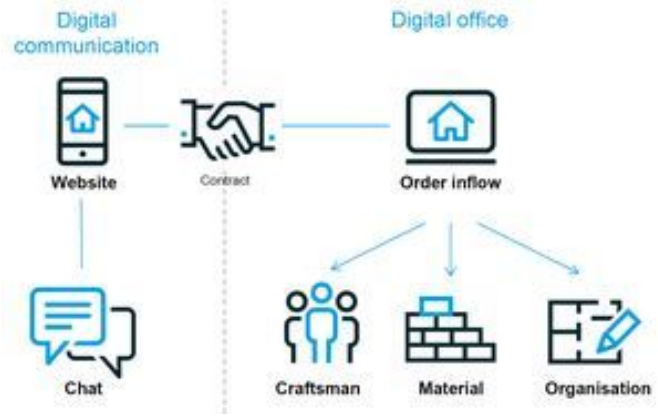


Figure 1: Trade Digitalization
(Source: Kommission Arbeitsschutz und Normung (KAN))

The study will be assessing the role of IT infrastructure and trade digitalization in enhancing the supply chain performance [4, 32]. The present study is totally novel because of the variables involved in it. The present study involves all of the variables which have not been discussed in the past studies before. Trade digitalization is a naive concept that it almost discussed no where in the past so this study has taken these novel variables and a novel problem in account. This study will be analyzing the impact of IT infrastructure on the supply chain performance and this study will be analyzing the impact of trade digitalization on the supply chain performance. Because of this, this research will importantly increase the literature material. The data will be enhanced about the knowledge of this topic. People can get important data and knowledge about the problem being debated in this paper [5]. This research will be positively subsidizing to governmental strategies. The governmental authorities can make decisions regarding this problem and also formulate and implement different and effective strategies. This study can be applied in practical life. The manufacturing industries can learn from this research and get benefits and solutions for their problems. The optimistic impact of IT infrastructure on supply chain performance can improve the performance of the manufacturing sectors. The past studies also kept into account the present problems and variables but did not define them in such a novel way in the context of supply chain performance [6, 33-35]. The past studies did not emphasize much on the trade digitalization process because the manufacturing sector of Thailand is still unsure to convert all of the trade into a digitalized format and integrate all of the trade and trade related functions into a digital way because as it simplifies all of the steps involved in trading, such systems are also complex and are also difficult to operate sometimes. Such implementations also impact the budget of any organization in a great way, so the studies about implementation are yet found to be nowhere [7].

2. Literature review

2.1. Digitization and Business Model:

To apply theoretical screening criteria to the process of Digitization and business model [8], only conceptual and empirical evidences and studies explain the effect of trade digitization that is related to the technical or IT sector to enhance the applications produced by business model in the field of supply chain performance. Commercialization is the basic aspect of digitization[9] and certain business model elements that explains perceived amount of prominent contribution to an understanding of digitization and business performance. This topic of the study has been widely published and researched with wide array of research disciplines. Business model [10] particularly focuses on production, marketing, and innovation management that further elaborate the idea of sustainability and social change. Along with the emerging literature on digitization and business model in the business-to-business context which draws quiet widely from diverse theoretical perspective. Leading journals regarding digitization and business model promotes discussion on certain

related topics like production economics, technology and social change, innovation management, industrial marketing, technology in society, industrial management, service business and strategic changes. Maintaining the sustainability changes that display the theoretical perspective [11] regarding network theory, platform literature, transition theory, and transition cost economics. Network theory [12] exposes the dynamic capabilities and service-dominant logic within the criteria of supply chain management (SCM) as well as supply chain capabilities (SCC) that further affects the efficiency of IT infrastructure. For the understanding of digitization, this enables business model innovation (BMI) and implementation on the field of IT infrastructure [13]. It's the role of the company's resources and capabilities in sustaining its competitive advantage. Many studies discuss the role of existing capabilities regarding the company's performance that explicitly and implicitly emphasis the investment made by companies for sustaining its competitive advantage. Studies show the need for new capabilities, new development, new investments and skills which develops a relation with the customers and big data connection. It infrastructure co-creates capabilities with IT standardization and IT integration. [14] Dynamic capabilities usually designs business model to integrates the use of IT related information, knowledge and resources to increase business performance that will enhance productivity of products and services. Dynamic capabilities along with business innovation model also address the rapidly changing environment that identifies digitization framework for sensing, seizing and reconfiguration of business model elements.

2.2. IT Standardization Relationship with Supply Chain performance

According to past literature [15], IT infrastructure is divided into two important aspects consisting of IT standardization and IT integration which develops a positive impact on the capabilities of performance related to supply chain. Literature explains the affectivity of external and internal supply chain integration (SCI) that has a strong influence on the development of supply chain management [16] and supply chain performance (SCP). IT standardization knowledge and information are required by multiple companies where they use the latest technology and techniques regarding the IT infrastructure, to create sustainability performance. However, due to the Era of Globalization and the Era of advanced IT capabilities use of IT and digital systems in different organizations and companies is very necessary. This era depends upon new technology and innovation infrastructure that will make business work, practices and functions easier with the help of supply chain performance. Information Technology is an important tool which highly supports the use of and implications of SCI and SCP [17] via information sharing techniques, including planning and coordination and mainly for the control of the production of goods and services at every level of product development processes. IT capabilities influences better use of materials, enhances informational communication, and improves the product and service development, while it basically focuses on the criteria as well as procedure of the IT related implications and implementations in the workplace where IT infrastructure is largely required. Nonetheless, IT standardization is also involved in the speedy recovery of tasks related to IT fields; it is also responsible for developing speedy communications system between employees, managers, suppliers and customers to enhance the ability of supply chain. Reliability and flexibility of the delivery process can only be achieved if IT standardization [18] increases the delivery speed of supply chain performance, integrated by IT infrastructure. Thus, the following hypothesis is proposed

H1: IT Standardization has a significant impact on Supply chain performance.

2.3. IT Integration Relationship with Supply Chain performance

Literature study by [19] develops a relationship between IT integration and SCP within the workplace where IT infrastructure is largely utilized. Integration of supply chain and data standards that evolves due to the implementation and integrated applications to increase the information flow from one department to another moreover, which develops a reliable and flexible communication systems as well as coordination system between different departments which will work across geographical locations, and which will further facilitate [20] the innovators or network partners. IT integration functions as value

keeping and maintaining between network partners. As per business model [21] based conceptual evidences that highlights the working of IT platform which enhances the network of modern supply chain management that builds up on an effective IT structure and framework to support the efficiency of IT integration, IT capabilities, and supply chain strategies. However, it is a fact that with the introduction of IT infrastructure in the business and firm network IT has transformed the performance of organizational supply chains that further deals with the emerging technicalities produced through maintaining the connection between IT integration with its partners, who further manages organizational operations and which responds directly to its customers. Therefore, supply chain can only manage their IT integration through developing a strong connection with their regular demanding customers and suppliers due to the global and environmental changes. Thus, the following hypothesis is proposed:

H2: IT integration has a significant impact on Supply chain performance.

2.4. Mediating Role of Trade Digitization between IT standardization and supply chain performance

Studies suggest that [22], trade digitization gain importance due to cultural change, environmental change of the business society and business workplace because of the influence of IT infrastructure within these organization that develops a relationship between IT standardization and SCP with the help of the mediator. Trade digitization [23] acts as a mediator because of business capabilities that are being enriched with IT infrastructure and IT performance, to facilitate the upbringing of IT business in manufacturing sector. Business model elements manage the IT supply chain because IT supply chain improves the affectivity of business in gaining competitive advantages. Business climate can emerge with latest methods and IT techniques because of more exposure towards stabilizing the SCP with the help of trade digitization. Trade digitization introduces IT standardization [24] programs and planning in the organization and firms' to increase the impact of IT on firm operational and financial performance. Latest research studies, shows the implementation of IT programs and performance that focuses on alternate antecedents related to IT capabilities. Trade digitization enables IT capabilities across the supply chain domains of performance and integration, which can easily identify the dynamics of supply chain that might increase the proficiency in performance of IT logistics as well as operations. Thus, the following hypothesis is proposed:

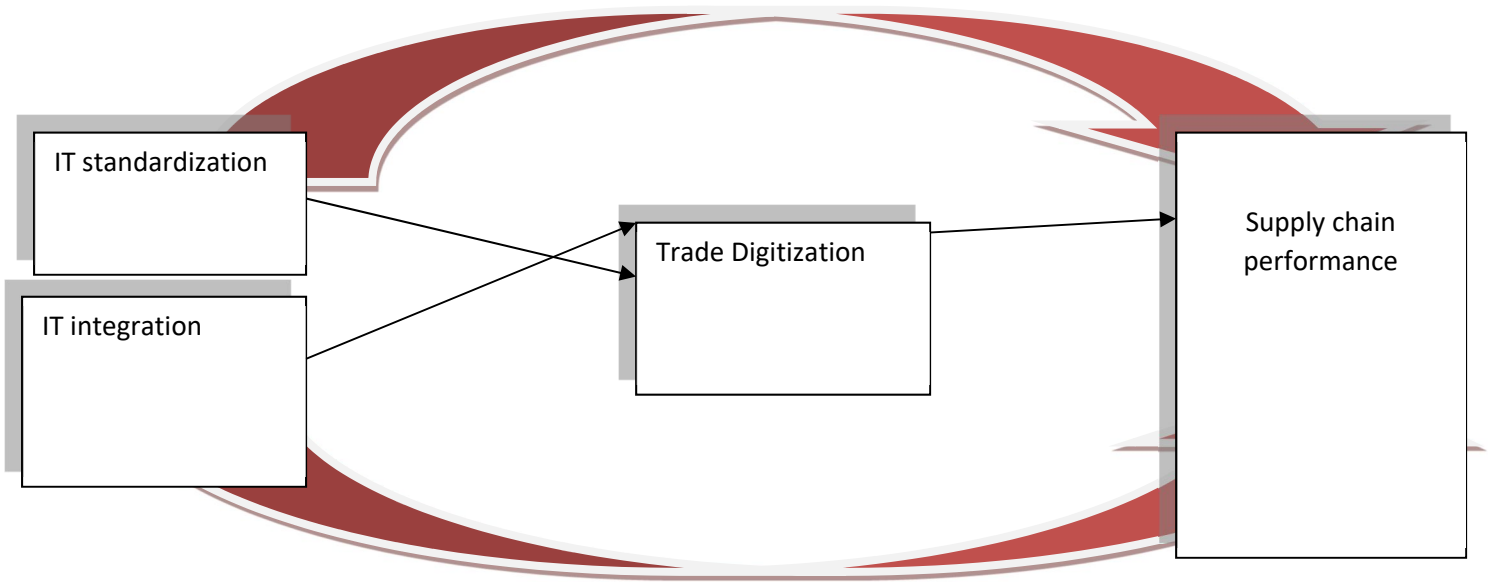
H3: Trade digitization has a significant mediating role between the relationship of IT standardization and SCP.

2.5. Mediating Role of Trade Digitization between IT integration and supply chain performance

Literature of past studies [25], believe that business model innovation develops a common theory of transition and network with the help of which trade digitization can probably effect the performance of IT integration and SCP, related to certain organizational operations and capabilities. However, IT capabilities and IT usages are used in creating various performance capabilities that certainly recognize the capabilities [26] produced by supply chain. Trade digitization enhances those capabilities produced by IT integration and SCP. Trade digitization can reduce challenges faced by IT integration process and SCP network. Therefore, due to reduction in challenges faced by SCP, it allows supply chain network to mount an efficient and effective response to the circumstances. IT services [27] develops certain accomplishment goals to achieve efficient and massive production with the help of trade digitization in the manufacturing sector and also in IT sector. Trade digitization and IT capabilities works in collaboration to enhance the affectivity of SCP that will help eliminate all waste products from the manufacturing sector of productivity. Trade digitization finds alternative ways to satisfy the employee working in an organization, while correspondingly it also works to satisfy customers along with satisfying them with fulfilling their needs rapidly. Hardy [28] believes that trade digitization designs the acquire information in such a way that systems are forced to create superior IT architectures to make advancement in the performance of supply chain while integrating IT platform reconfiguration capabilities. Thus, the following hypothesis is proposed:

H4: Trade Digitization has a significant mediating role between the relationship of IT integration and SCP.

Model:



3. Research methodology

3.1. Population and Sample Selection Criteria

Researcher has been examined the role of IT infrastructure and trade digitalization in improving the supply chain performance in manufacturing sector of Thailand. As the electronic, automotive and agriculture industries of Thailand are the major contributors of economy and most of the GDP of Thailand earned by these industries. Moreover, these manufacturing industries export all the manufactured products to different countries, they need to develop strong supply chain network that's why the IT infrastructure and trade digitalization has been contributed in enhancing the supply chain performance. To observed the impact of this study, researcher selects the managerial employees of these industries by using purposive sampling techniques because they can better explain how the supply chain performance has been enhanced in digital era. Further, sample size has been selected by using the idea of (Klein, 2015) which entails that figure obtained through number of questions*10 is the accurate sample size. Data has been collected from 300 managerial employees but the valid and accurate responses were only 281.

3.2. Data collection techniques

Questionnaire is best suitable option for data collection as the data is in numeric form and researcher can easily analyzed it by statistical analysis techniques. In the questionnaire, researcher asked the questions about demographic information of respondent, impact of IT infrastructure on supply chain performance and asked about mediating role of trade digitalization in this relationship. Before finalizing the questionnaire, researcher has to ensured that language must be understandable by managerial employees of Thailand. Moreover, content validity of scale has been checked with the help of industrial practitioner. Questionnaire emailed to the respondent and they conveniently solved it on the bases of their opinions regarding the study.

3.3. Analysis of validity, reliability and common bias

Analysis of reliability and validity has been done through SPSS and AMOS respectively. Criteria used for analysis of reliability states that composite reliability and Cronbach's α have to be greater than 0.70. As satisfactory level of internal consistency and desirable level of reliability have been achieved when its values were higher than 0.70. For convergent validity assessment three criteria have been used, one is items loading α it has to exceed than specific value 0.70 because its values were strong at 0.75 or at above, second is composite constructs reliability and its threshold range is greater than 0.80 and third is average variance extracted it has to be greater than

0.50 (Fornell & Larcker, 1981). For the analysis of discriminant validity, criterion has been examined states that square root of the average variance extracted has to be greater as compared to other correlated constructs.

Coming towards common bias, it has been generated in the study when common variance method has been used for the evaluation of both dependent and independent variables. Mostly, it has been happened that respondents used same measures recommended by common rater (Donaldson & Grant-Vallone, 2002; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003) for the both dependent and explanatory or independent variables. This research study has following dependent and independent variables which are supply chain resilience, trade digitalization and IT infrastructure. In order to checked the presence or absence of common bias, Harman's single factor test has been conducted. In this test, researcher observed whether single factor used in accounting of most of the constructs or multiple factors. According to test outcomes, researcher came to know that multiple factors have been used for accounting of the most of constructs. Such as, 79% of variance accounted for by factors solution and 19% of variance accounted for by one factor. Therefore, it has been ensured that common bias has not been observed in this research study.

3.4. Hypothesis testing

For testing the hypotheses, structure equation model has been used which runs on AMOS. Relationships among different hypotheses of study have been tested in order report which relationship is positively related or which relationship is negatively related. AMOS used covariance-based approach in order to practically implicate the SEM. In this study, SEM has been run in order to observed the impact of IT infrastructures on supply chain performance, in mediating role of trade digitalization. Direct, indirect and total effect and significance of relationship have been assessed in order to report the acceptance or rejection status of hypotheses.

3.5. Measures

ITS was measured with the scale developed by [21] with the help of five items that were taken on a five-point Likert scale. Then ITI was assessed by the scale developed by the researcher [23] and here four items were taken on a five-point Likert scale and were assessed. TD was measured by a scale developed by [24], four items were taken and measured on a five-point Likert scale. Finally, SCP was measured by the scale developed by [28] and five items were taken which were measured on a five-point Likert scale.

4. Empirical findings

4.1. Demographical results

The information was collected from 300 participants and was used and responses of 281 respondents were included in the analysis after screening blank and missing responses. The relationships with the help of a self- directorial questionnaire were analyzed by using SPSS and AMOS. It is a requirement of inspection to run precondition analysis in order to check the reliability, normality, and validity of the data. The researcher applied the frequency distribution test in order to check the respondent profile. The findings showed that 123 males and 158 females participated in this study. 23 respondents have graduation degree, 143 have done post-graduation, whereas, 106 respondents have master's degree, and 9 respondents have another degree. The respondents who participated in this study are mostly young and their age lies between 21 to 30 years whereas 44 respondents have age ranging from 31 to 40 years, 24 were of the age range 41 to 50 years and only 1 respondent has age more than 50 years.

4.2. Descriptive statistics

The table below is showing the results of the descriptive statistics of the study:

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
ITS	281	1.00	5.00	3.6263	1.04651	-.935	.145
ITI	281	1.00	5.00	3.6317	1.09321	-.880	.145
TD	281	1.00	5.00	3.6343	1.08066	-.915	.145
SCP	281	1.00	5.00	3.4662	1.11332	-.551	.145
Valid N (listwise)	281						

Table no. 1 is showing that there is no out lair in the given data as the maximum values lie in the threshold range of 5-point Likert scale, as the skewness value is somewhere between -1 and +1 which is the threshold range of normality assumption and so the data is normal and is valid to go for further testing.

4.2. Rotated Component Matrix

Table 2. Rotated Component Matrix

Rotated Component Matrix[a]				
	Component			
	1	2	3	4
ITS1	.707			
ITS2	.770			
ITS3	.835			
ITS4	.828			
ITS5	.817			
ITS6	.801			
ITI1			.793	
ITI2			.837	
ITI3			.826	
ITI4			.821	
TD1				.805
TD2				.853
TD3				.865
TD4				.804
SCP1		.828		
SCP2		.855		
SCP3		.863		
SCP4		.870		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

The above table is showing the RCM values, almost all of the indicators are showing the factor loading more than 0.7, it means that all of the indicators are eligible to be added in the further hypothesis testing because all factor loadings are in suitable threshold level and in a suitable and valid range. moreover, there is no cross-loading data shown in RCM so, data is good to go for further testing.

4.3. Convergent and discriminant validity

Table 3. Convergent and discriminant validity

	CR	AVE	MSV	MaxR(H)	TD	ITS	ITI	SCP
TD	0.932	0.775	0.371	0.933	**0.880**			
ITS	0.941	0.726	0.437	0.969	0.573	**0.852**		
ITI	0.933	0.778	0.437	0.978	0.609	0.661	**0.882**	
SCP	0.927	0.762	0.297	0.983	0.494	0.545	0.434	**0.873**

The results of convergent and discriminant validity show that the overall model is a good fit because the composite reliability of each variable is more than 70% and average variance extracted is more than 50% while the discriminant validity shows that loading of each variable discriminates from others. Every variable has maximum loading with itself as compared to with others so these validities prove the authenticity of collected data.

4.4. Confirmatory Factor Analysis

Table 4. Confirmatory Factor Analysis

Indicators	Threshold range	Current values
CMIN/DF	Less or equal 3	1.747
GFI	Equal or greater .80	.818
CFI	Equal or greater .90	.979
IFI	Equal or greater .90	.932979
RMSEA	Less or equal .08	.052

The above values are showing that the observed values are in the range limit. CMIN is less than 3, GFI is greater than .80, the value of CFI is greater than .90, IFI value is greater than .90 and RMSEA is less than .08. So, these indicators prove that model is a good fit. The following figure is the Screenshot of CFA:

4.5. Structural Equation Modeling

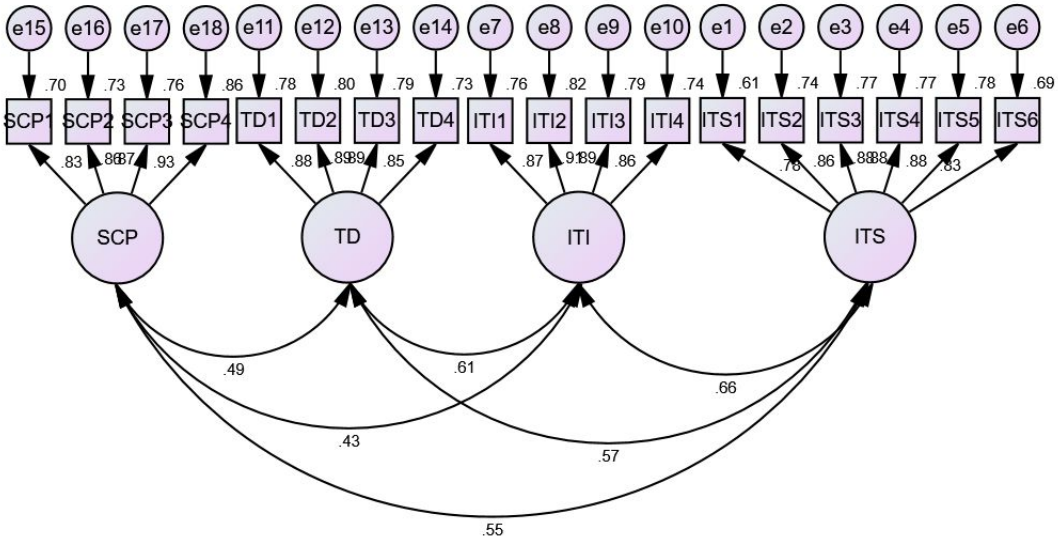


Figure 2: Screenshot of CFA

Table 5. Structural Equation Modeling

Total effect	**ITI**	**ITS**	**TD**
TD	.386***	.298**	.000
SCP	.138**	.421***	.250**
Direct effect	ITI	ITS	TD
TD	.386***	.298**	.000
SCP	.041	.347***	.250***
Indirect effect	ITI	ITS	TD
TD	.000	.000	.000
SCP	.097**	.075**	.000

The above table is showing the results of structural equation modeling, the results are showing that ITI has a significant and positive impact of 38.6% on TD it means that with one unit increase in ITI, TD increases by 38.6% and same impact of 13.8% on SCP. ITS has a significant and positive impact of

29.8% on TD and a same impact of 42.1% on SCP. Whereas, TD has a significant and positive impact of 25% on SCP. Directly, ITI, ITS and TD have same impact on TD while, ITI impacts 4.1% on SCP, ITS impacts 34.7% on SCP, and TD have same impact on SCP as total effect. Indirectly, ITI, ITS and TD have no impact on TD whereas, ITI impacts SCP with 9.7% and ITS impacts SCP with 7.5%, it means that with every one unit increase in ITS there is an increase of 7.5% in SCP.

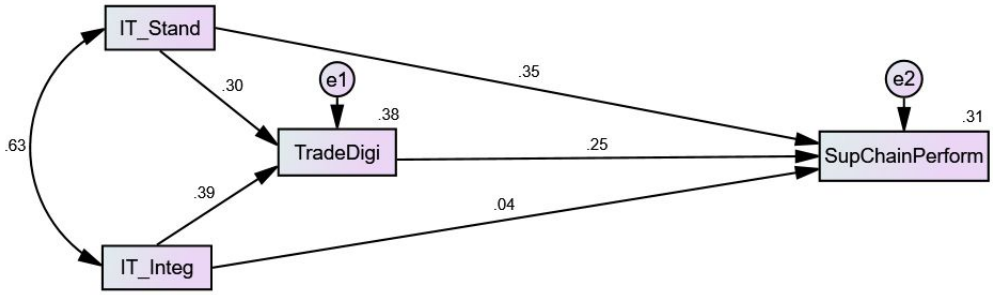


Figure 3: SEM

5. Discussion and Conclusion

5.1. Discussion

Aim of this study was to have a deep insight to know about the relationship between Information Technology Standardization (ITS) and Supply Chain Performance (SCP). The aim was also to know about the relationship and impact of IT Integration (ITI) on SCP [29]. The term IT infrastructure included two aspects ITS and ITI. Another purpose of this research was to know the mediating role of Trade Digitalization (TD) between ITS and SCP and between ITI ad SCP. As the research conducted the hypothesis test and this study suggested some hypothesis. The hypothesis number one suggested that "ITS has a significant impact on SCP". This hypothesis was accepted. "Avelar Sosa" proposed a theoretical work which suggested that ITS enhances the production ways and competencies, in this way the SCP increases. The second hypothesis was suggested that, "the impact of ITI on SCP is positive". This hypothesis was also accepted. The famous author "Garcia Alcaraz" introduced an index for competences and relationship ITS and SP [9]. Their relationship improved the company's performance. The hypothesis number three suggested that, "There is a significant mediating role of TD between ITS and SC". This hypothesis was also accepted. Different researchers stated in different researches that the mediating variable played a role significantly between IT infrastructure and SCP. The fourth hypothesis recommended that, "TD significantly mediates between ITI and SCP" [30]. The hypothesis was accepted as well. As per the study of "Abdul Rahmat", it suggested that the firms with the improved TD resulted in an excellent performance in quality delivery, quality and excessive production.

5.2. Conclusion

The study was done in Thailand. The goal of the study was to know about the association between ITS and SCP and also to know about the relationship between ITI and SCP. The objective was also to know about the mediating role of IT infrastructure between ITS and SCP, between ITI and SCP. The data was collected from three manufacturing industries of Thailand named as electronic industry, transportation industry, and machinery industry. 300 people were selected from these three industries as a sample in order to gather data, 281 responses were valid. The instrument was a questionnaire for data collection. The theory test was successful, and all the hypothesis were accepted due to their positive and vital relationship between different variables.

5.3. Implications of the study

This research importantly increased the literature material. The data enhanced knowledge about this topic. People can get important data and knowledge about the problem debated in this paper. This research positively subsidized to governmental strategies. The governmental authorities can make a decision regarding this problem and also formulate and implement different and effective strategies. This

study can be applied in practical life. The manufacturing industries can learn from this research and get benefits and solutions for their problems. The optimistic impact of IT infrastructure on SCP can improve the performance of the company.

5.4. Limitations and future research indications

One of the major constraints of this research was that it selected a small sample of 300 people. And selected only three manufacturing sectors, machinery, electronic and transport sector. The future researchers can enhance the sample size investigators can select more than three hundred people as sample and more than three manufacturing industries, because the big sample may provide effective and more suitable data. The tool was a questionnaire, which is used to collect data, future students can use different tools like, interviews, feedback through internet, door to door investigations, etc. to collect the data. This study can be conducted worldwide not only Thailand is having the same situations and industrial calamity. The international community can get helpful knowledge from this research.

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