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THE EFFECT OF THE 4TH INDUSTRIAL REVOLUTION TECHNOLOGIES ON SUPPLY CHAIN INNOVATION IN KOREAN TRADING COMPANIES

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The purpose of this paper is to empirically analyze the effects of the acceptance of new technologies related with the 4th Industrial Revolutionfor supply chain innovationand performance improvement inKorean trading companies. In summary, it is expected that new technologies in the 4th Industrial Revolution era, including smart factory, AI, IoT, big data, cloud and so forth, will have significant impacts on the global supply chain structure of Korean trading firms. This paper can suggest many useful insights in relation with current status of Korea's preparation for the 4thIndustrial Revolution and improving performance of Korean trading companies.

Từ khóa*: Technology Acceptance, SCM Innovation, The 4th Industrial Revolution, Korean Trading Company*

1. Introduction

According to the report of Korea Institute for Industrial Economics &Trade(KIET) in July, 2017, recently, the global supply chain length of the leading group of the 4th industrial revolution including the United States and Germany has not been extended any longer. This implies that the introduction of innovative technologies presented in the 4th industrial revolution has begun to have a substantial impact on the restructuring of supply chain structure.

The leading group of the 4th industrial revolution such as U.S. and Germany already hastened the policies to prepare for this change and have actively implemented support for their domestic companys technology acceptance.Korean governmentsuggested “Manufacturing innovation 3.0”, first timein 2014, in order to keep up with these international innovations. This Manufacturing Innovation 3.0 policy was designed to imitate the German Industrie 4.0 policy and to provide support for Korean companies to stay in line with the restructuring of the global supply chain through technology acceptance.

Therefore, the purpose of this paper is to examine the current status and empirical result of the Korean tradingcompanies supply chain restructuring by technology acceptance in response to the 4th industrial revolution.In this paper, to achieve the purpose, we apply a modi-

fied technology acceptancemodel referring Davis (1989) TAM (Technology Acceptance Model) and develop a new model by adding the outcome variables of supply chain innovation and performance. In addition, we examined the technology acceptance status of Korean trading enterprises and analyzed the effect of technology acceptance on the innovation in supply chain structure of companies through empirical study.

2. Literature Review

2.1 The 4th Industrial Revolution and Response of Korean Manufacturing Industry

Like the previous flow of industrial revolutions, it is no exaggeration to say that the change of the 4th Industrial Revolution is caused by the change of the industrial structure and the innovation of the supply chain due to the development of innovative technology together with industrys technology acceptance. By referring toleading countries counter measures, Korean governments “Manufacturing Innovation 3.0” policy of 2014 was improved to “Smart Manufacturing Innovation Vision 2025 : 30,000 Smart Factory Initiative” in April, 2017. The policy has focused on Korean manufacturing industrys adoption of new technology including Smart factory.

According to recent news report, by the end of November in 2017, a total of 3,984 companies had been supported by smart factory distribution projects, and 905 factories have been under construction. Totally, since Korean governments first policy lunched in 2014, 4,889 smart factories have been constructed. The result appeared to be such outstanding performances as increased productivity by 23%, decreased defect rate by 46%, cost reduction by 16% and decreased delivery time by 35%.As well as smart factory technology, Korean government started to propel upgraded projects with the technologies of Could, IoT(Internet of Things) and Big data. In fact, Korean companies are making their efforts to innovation in supply chain management by utilizing the core technologies of the 4th Industrial Revolution including Smart Factory, Big data analysis, Artificial intelligence(AI), IoT, 3D printing, 5G communication, Robot, VR platform, etc.

At this point, it is considered that Korean companies need to review the current status of their technology acceptance and examine the performance of supply chain innovation efforts. Especially, reflecting Koreas high level of trade dependence, this study would like to focus on Korean trading companies status of technology acceptance.

2.2 Technology Acceptance and SCM Innovation

Since the advent of IT technology, a lot of research has been interested in technology acceptance. Among them, the most widely referred research model is Davis (1989)s Technology Acceptance Model (TAM). Since then, the technology acceptance model has been applied in many cases and developed into various models such as TRAM model or UTAUT model (Jaehyun You & Cheol Park, 2010).

However, as most of the advanced research has focused on individuals technology acceptance, thisstudy referred the recent study by Sunwoo Lee &Heesang Lee (2014), which analyzed about companies adoption of Big data system, to construct the technology acceptance variable on the position of companies.

Meanwhile, there have been many studies regarding companys supply chain management. Until recently, most of research regarding SCM has been focused on its innovation. As in XinmeiCao (2017), the existing research has been interested in identifying the determinants of SCM innovations and analyzing the result of SCM innovation and performances.

In the 4th Industrial Revolution era, the innovation of supply chain is inevitably caused by companys innovative technology acceptance and is recognized as an essential requirement to survive in the global competition. This study, referring the above advanced research, constructed the research model to find out the relationship between technology acceptance and SCM innovation and its effect on the companys performance empirically.

3. Research Model and Methodology

3.1 Research Model and Hypotheses

In this study, we have analyzed the effect of companys technology acceptance on its performance and innovation in supply chain management. Referring the advanced studies, the research model is suggested as Figure 1.

of supply chain management, the SCM Innovation variable is added. According to Ross(1998), change in supply chain management structure from the standpoint of company can be considered as great challenge which can affect the companys performance. As the supply chain can be divided in 5 parts, indicators of each 5 part and another indicator of total result are applied to measure the SCM Innovation variable. Finally, SCM Innovation is applied as intermediary variable.

In this research model, those 3 performance variables are effected by Technology Acceptance variable. The Technology Acceptance variable appeared in Davis(1989)s study as a variable to analyze individual acceptance of IT. This study applies this variable in companys technology

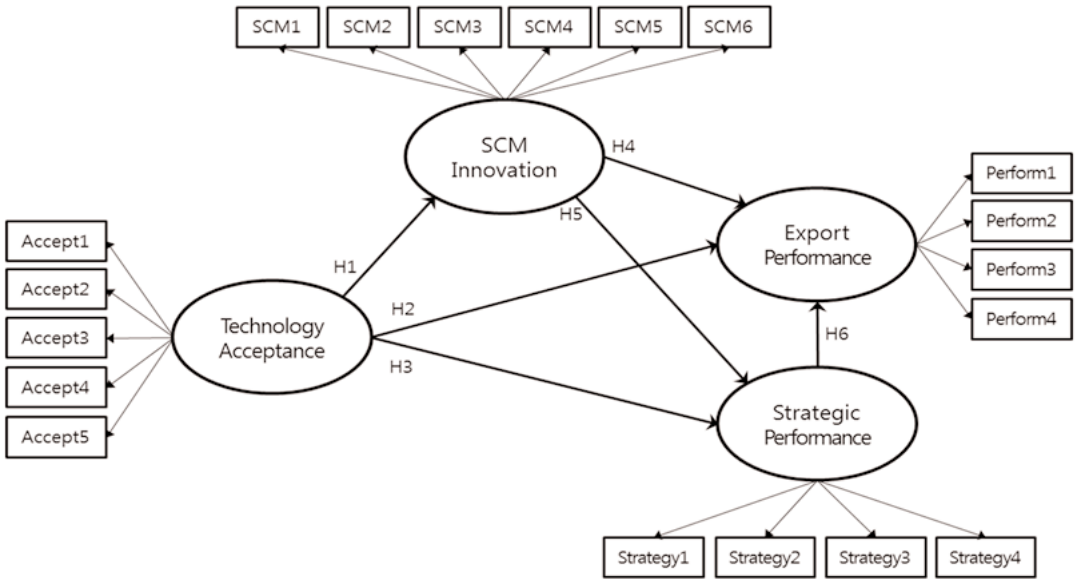

Figure 1: *Research Model*

The Export Performance and Strategic Performance are variables related to companys sales income in directly and indirectly. As variables to examine the business performance of the company, they are applied as result variables each. To confirm another performance in innovative change

acceptance by modifying the indicators. Weve expected the companys Technology Acceptance can effect positively on its performance. Therefore, the hypotheses of research model and operational definition of each variablecan be summarized as follows and Table 1.

Table 1: *Operational Definition*

Variable	Operational Definition and Indicators		Reference
Technology Acceptance	Company's Technology Adoption and Acceptance	Accept1 : Degree of technology acceptance Accept2: Continuously use for business Accept3: Intention to expand business process Accept4: Period of technology acceptance Accept5: Satisfaction with accepted technology	Davis(1989) Cheol Woo Park(2012) Lee&Lee(2014) Soon Cheon Jeon(2014)
Supply Chain Management Innovation	Company's Innovative Change and Performance in Supply Chain Management	SCM1:Total performance in SCM innovation SCM2:Cost reduction in SCM operation SCM3: Efficiency Increase in SCM process SCM4: Development of process mechanism SCM5: Easy to exchange with suppliers SCM6: Improved management with customers	Ross(1998), Jon&Won(2007) Chang-Bong Kim(2013) Doo Won Choi(2016) Xinmei Cao(2017)
Export Performance	Performance factors Directly affect the Company's Sales Income	Perform1: Overall sales increase Perform2: Increase in trade transactions Perform3: Increase in trade with overseas market Perform4: Reduction in total cost	Jon&Won(2007) Chang-Bong Kim(2013) Tae-Woo Gim(2014)
Strategic Performance	Performance factors Indirectly affect the Company's Sales Income	Strategy1: Increase in customer satisfaction Strategy2: Increase in market share Strategy3: Securing market competitive advantage Strategy4: Improvement in company's image	Jon&Won(2007) Chang-Bong Kim(2013) Tae-Woo Gim (2014)

H1 :There is positive(+) relationship between the Technology Acceptance and SCM Innovation.

H2 : There is positive(+) relationship between the Technology Acceptance and Export Performance.

H3 : There is positive(+) relationship between the Technology Acceptance and Strategic Performance.

H4 : There is positive(+) relationship between the SCM Innovation and Export Performance.

H5 : There is positive(+) relationship between the SCM Innovation and Strategic Performance.

H6 : There is positive(+) relationship between the Strategic Performance and Export Performance.

3.2. Research Methodology

In this study, survey was conducted on Korean trading companies which have accepted new technologies those are called core technologies of the 4th Industrial Revolution in Korea, such as Smart Factory, Big Data analysis, Artificial intelligence(AI), IoT, 3D printing, 5G communication, Robot, VR platform and so on. The survey samples are collected by Korean professional survey agency from April 10th 2017, for two weeks.

5 Likert scale type of questionnaire was used and 500 companies were selected randomly for the survey. With the collection rate of 30%, the sample data was collected and 108 samples, finally, were applied into final analysis after refinement process of samples. According to the collected samples, 63% of samples were collected from metropolitan area such as the companies located at Seoul or Kyunggi-do. More than 67% of samples responded that they belong to manufacturing industry. These results reflect the capital structure of Korean industry and the concentration of industry in metropolitan area. Interestingly, 71% samples responded that their company accepted at least 2 technologies at the same time and the mainly accepted technologies are Smart Factory, AI and Big data. Besides, 46% of samples responded that the period of technology acceptance took less than 6 month and only 16% have experience of more than 3 years.

The research model is analyzed using SPSS 24 program and AMOS 24 program. First, to confirm the validity of each variable, the Exploratory Factor Analysis was conducted using Principal Component Analysis, the rotation method of varimax with Kaiser Normalization. Second, to check the research models reliability and validity, the confirmatory factor analysis is conducted using AMOS 24. Third, the correlations analysis is conducted to check whether there is multi-collinearity between variables for the last step before the final analysis. The last step is about the structuralequation modeling for analyzing the result of hypotheses.

Based on theresult of this study, we would like to suggest some implications forKorean government and Korean trading companies for urging their intention to technology acceptance.

4. Research Results

4.1. Exploratory Factor Analysis

Before analysis of the research model, the model and variables need to be checked if they are appropriate for analysis. First, here, weve conducted the exploratory factor analysis to confirm the variablesvalidity. Each variable is properly converged and the factor load values of each indicator are checked as higher than 0.4 which are acceptable. Including Eigen-value of each variable, the exploratory factor analysis result can be seen as Table 2.

4.2. Reliability and Confirmatory Factor Analysis

Secondly, to check the research models goodness of fit, the internal consistency analysisof each variable and confirmatory factory analysis were conducted. The result can be seen in Table 3.

Table 2: *Exploratory Factor Analysis Results*

Indicators Variables	SCM Innovation	Export Performance	Technology Acceptance	Strategic Performance
SCM1	**0.766**	0.194	0.186	0.151
SCM2	**0.745**	0.319	0.127	0.132
SCM6	**0.729**	0.302	0.005	0.179
SCM4	**0.719**	-0.012	0.313	0.139
SCM3	**0.665**	-0.012	0.362	0.116
SCM5	**0.657**	0.446	0.057	0.134
Perform1	0.252	**0.771**	0.197	0.158
Perform4	0.243	**0.752**	0.113	0.272
Perform3	0.154	**0.723**	0.168	0.252
Perform2	0.203	**0.547**	0.421	0.376
Accept4	0.219	0.190	**0.789**	0.103
Accept2	0.155	0.214	**0.727**	0.300
Accept5	0.118	0.432	**0.701**	-0.203
Accept3	0.275	0.101	**0.631**	0.327
Accept1	0.124	0.026	**0.628**	0.316
Strategy4	0.196	0.160	0.254	**0.774**
Strategy3	0.284	0.380	0.135	**0.723**
Strategy2	0.190	0.442	0.216	**0.651**
Strategy1	0.127	0.538	0.282	**0.555**
Eigen-value	3.600	3.345	3.184	2.629
% of Variance	18.950	17.607	16.756	13.836
Cumulative %	18.950	36.557	53.313	67.150

According to the result, CR value of every indicator are shown as bigger than ±1.96 (significant at p=0.05) and SMC values are also acceptable (>0.3) which mean that every indicator has sufficient explanatory power, except in Accept 5 indicator of Technology Acceptance. That indicator was rejected at the final research model because it was confirmed as inhibiting model fit. Except that indicator, every values of standard loading are shown as higher than the reference value (>0.5).

Besides, the result of convergent validity (VE>0.5) analysis and internal consistency analysis (Cronbachs Alpha (α)>0.7) appeared that every variables validity and reliability can be secured. Therefore, the result can be confirmed that every indicator that constructs the each variable is acceptable for analysis (Table 3).

Moreover, the result value of model fit also appeared that the research model can be applied. Although the Goodness-of Fit Index(GFI=0.835) is lower than the criteria (>0.9), when referring to RMR = 0.046 (<0.05), Comparative Fit Index(CFI) =0.921 (>0.9), Incremental Fit Index(IFI) =0.923 (>0.9) and Root Mean Square Error of Approximation

Table 3: *Confirmatory Factor Analysis Results*

Variable	Indicator	Estimate	Standard Loading	SE	CR	SMC	á	VE
Technology Acceptance	Accept1	1.006	0.617	0.179	5.622	0.380	0.829	0.537
	Accept2	1.390	0.853	0.192	7.231	0.728		
	Accept3	1.219	0.764	0.181	6.745	0.584		
	Accept4	1.000	0.676	-	-	0.457		
	Accept5	Rejected by inhibiting Model Fit						
Supply Chain Management Innovation	SCM1	1.000	0.828	-	-	0.685	0.869	0.508
	SCM2	1.044	0.840	0.109	9.533	0.706		
	SCM3	0.647	0.593	0.104	6.237	0.352		
	SCM4	0.774	0.638	0.114	6.813	0.407		
	SCM5	0.728	0.659	0.103	7.077	0.435		
	SCM6	0.731	0.681	0.099	7.367	0.464		
Export Performance	Perform1	1.000	0.787	-	-	0.620	0.850	0.590
	Perform2	1.143	0.790	0.134	8.545	0.624		
	Perform3	1.062	0.734	0.135	7.836	0.538		
	Perform4	1.113	0.761	0.136	8.184	0.580		
Strategic Performance	Strategy1	1.149	0.799	0.143	8.048	0.639	0.871	0.628
	Strategy2	1.164	0.822	0.141	8.277	0.675		
	Strategy3	1.078	0.811	0.132	8.172	0.658		
	Strategy4	1.000	0.734	-	-	0.539		
Model Fit	$\div^2$= 211.067(df=127, p=.000), RMR=.046(<0.05), GFI=.835(>0.9), CFI=.921(>0.9), IFI=.923(>0.9), RMSEA=0.079(<0.1)							

(RMSEA) = 0.079 (<0.1), this research model is considered as fully acceptable.

4.3. Correlations Analysis

For the last confirmation before structural equation modeling, to check multi-collinearity between variables, the correlation analysis is conducted using SPSS 24 program. The summary of the resultcan be confirmed in Table 4.

=0.923(>0.9) and RMSEA=0.079(<0.1), which are shown as higher or lower than criteria.

Five hypotheses of six are confirmed as supported. As can be seen in Table 5, hypotheses H1, H3, H4, H5 and H6 are supported with the significant result (p-value=0.05) which can be confirmed also by CR(t) value, higher than ±1.96(criteria). H2 needs to be rejected because of low value result

Table 4: *Correlations Analysis Results*

Variable	Average	Standard Deviation	Correlations				Multi-Collinearity Statistic	
			1	2	3	4	Tolerance	VIF
Technology Acceptance	3.6833	0.62300	1.000				0.615	1.627
SCM Innovation	3.3719	0.69698	0.520**	1.000			0.641	1.561
Strategic Performance	3.3194	0.76643	0.566**	0.540**	1.000		0.597	1.676
Export Performance	3.3657	0.75846	0.570**	0.570**	0.725**	1.000	-	-

The correlation values between each variable appeared as higher than 0.5 which means the variables are related to each other. For all that, according to Durbin-Watson Value(=2.194) of regression model which is close to 2 (criteria), it can be deemed that there is no multi-collinearity between variables. Also, the Tolerance (>0.1) and VIF(<10) values explain the degree of correlation is sufficiently acceptable (Table 4).

4.4. Result of Research Model Analysis

After the measurement of research model, here is the result of structural equation modeling analysis. The result can be summarized as following Figure 2. And the simple path load also can be easily confirmed in Figure 2.

First of all, the model fit result is confirmed that this research model can be applicable, RMR=0.046(<0.05), CFI=0.921(>0.9), IFI of CR(t)=0.626. Besides, the p-value is shown as not significant (<0.05) at the 95% significance level.

Among the supported hypotheses, the path load of H6 is confirmed as the highest. The second one is of H1 and H3, H5 and H4 are followed in order. That means Technology Acceptancecan effect on SCM Innovation and Strategic Performance. And its SCM Innovation can effect on Export and Strategic Performance positively.

5. Discussion and Conclusion

This study is about Korean trading companies status of technology acceptance to prepare for the world trend of the 4th Industrial Revolution and the effect of their technology acceptance on supply chain innovation and performance. According to the collected survey data, Korean trading companies are actually recognizing the need for it and

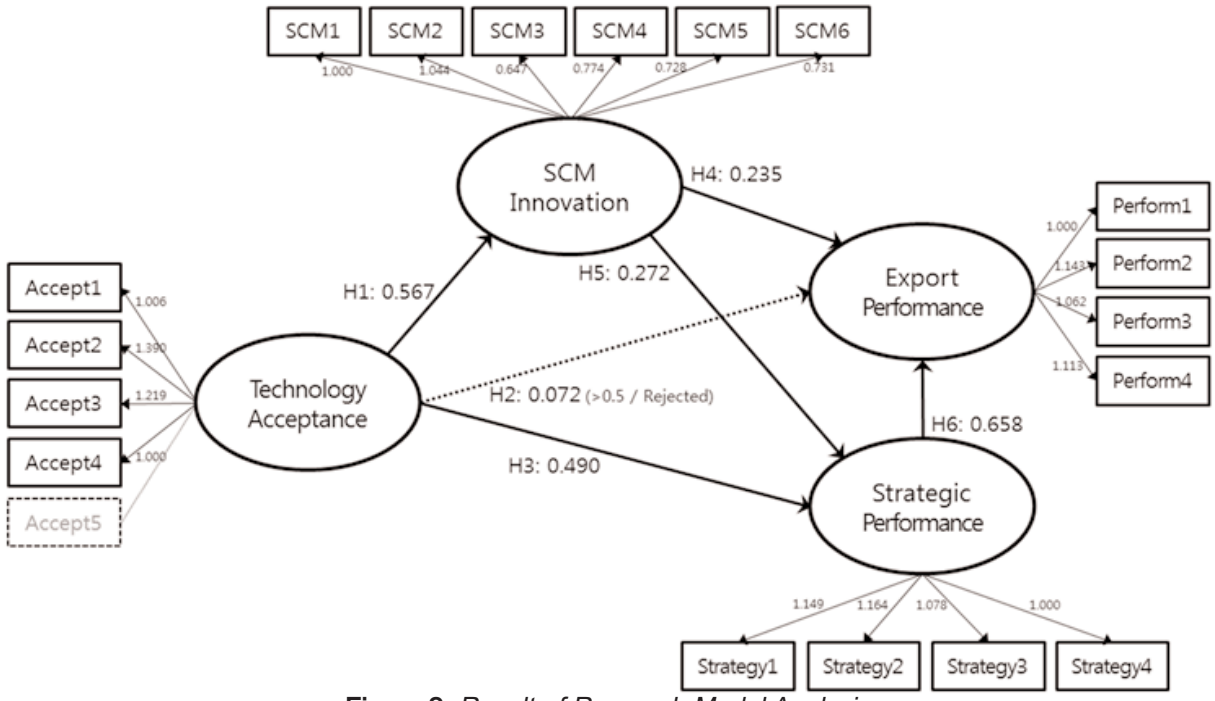

Figure 2: *Result of Research Model Analysis*

implementing technology acceptance. This result can be considered as part of their efforts to keep up with the flow of huge structural change in the world.

Depending on the result of the research model analysis, in case of Korean trading company, the technology acceptance leads to the innovation in supply chain management. Of course, this result can be considered obvious because, when they accept new technology, the companies already have intention to change its production and supply structure. But the more interesting result of this research is that the companys technology acceptance can effect on its strategic performance. It means that only their technology acceptance can increase the companys market share, improve its brand image or secure its competitive advantage.

Never the less, it is founded that there is no significant relationship between technology acceptance and export performance. According to the case of Korean trading companies, it can be considered that those who accept new technologies are in initial stage of technology acceptance because Korea has relatively shorter history in preparing for the4th Industrial Revolution. The companies can be seemed as starters of new technology era.

However, the innovation in SCM that caused by technology acceptance is found that effect positively on the companys export performance and strategic performance. Besides, the companys strategic performance also effect on export performance significantly. In the long term, the companys technology acceptance can be expected to have a positive and significant impact on export performance. In this respect, the technology acceptance can be meaningful and profitable challenge in the long run business and competition in the world market.

Based on these results, this study would like to suggest some implications for Korean government and trading company to require more active action

Table 5: *Structural Equation Modeling Results*

Path		â	SE	CR(t)	P	Result
H1	Technology Acceptance -> SCM Innovation	0.567	0.184	4.661	0.000	Supported
H2	Technology Acceptance --> Export Performance	0.072	0.145	0.626	0.532	Rejected
H3	Technology Acceptance --> Strategic Performance	0.490	0.167	3.729	0.000	Supported
H4	SCM Innovation --> Export Performance	0.235	0.086	2.286	0.022	Supported
H5	SCM Innovation --> Strategic Performance	0.272	0.098	2.782	0.005	Supported
H6	Strategic Performance --> Export Performance	0.658	0.139	4.729	0.000	Supported
Model Fit		÷^{2}=211.067 (df=127, p=0.000), RMR=0.046(<0.05),GFI=0.835(>0.9), CFI=0.921(>0.9), IFI=0.923(>0.9), RMSEA=0.079(<0.1)				

for preparing the near future. If the current world trend continuous, the global structure of supply chain will face huge change. It can be not only opportunity but also treat. Especially for Korean small of medium trading enterprises, to survive in the world competition, more aggressive and concrete attitudes toward global trend and technology acceptance will be required.

We would like to suggest the limit and future research project of this study. In this study, only 108 samples are used for analysis. Although it is applicable and the research model was also acceptable, that number can be seemed as not enough to reflect the exact status of Korean trading companies. If more samples are further secured, much accurate research will be implemented to further validate the study.

Also, this study didnt treat the features of technologies accepted. Depending on each technology, its application, features or characters can be different. By considering the technologys feature, such as usefulness, innovativeness or connectivity, more meaningful research could be implemented.◆

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Summary

Mục tiêu bài viết là phân tích thực nghiệm tác động của việc chấp nhận công nghệ mới liên quan đến cuộc Cách mạng công nghiệp lần thứ 4 đối với đổi mới và cải tiến hiệu quả chuỗi cung ứng tại các công ty thương mại Hàn Quốc. Tóm lại, theo kỳ vọng, các công nghệ mới trong kỷ nguyên Cách mạng công nghiệp 4.0, gồm nhà máy thông minh, trí thông minh nhân tạo (AI), Internet vạn vật (IoT), dữ liệu lớn, điện toán đám mây, v.v. sẽ có tác động đáng kể tới cấu trúc chuỗi cung ứng toàn cầu của các công ty thương mại Hàn Quốc. Bài viết cũng trình bày nhiều kiến thức chuyên môn hữu ích có liên quan tới thực trạng quá trình chuẩn bị của Hàn Quốc cho cuộc Cách mạng công nghiệp lần thứ 4 và nâng cao hiệu quả của các công ty thương mại Hàn Quốc.