International Journal of Smart Business and Technology
Vol.6, No.2 (2018), pp.25-30
http://dx.doi.org/10.21742/ijsbt.2018.6.2.03

The Factors of Smart Factory Construction- Empirical Evidence from Korean Metal Working Firms

Shan Yue Jin[1], Ji Suk Lee[2]

[1]*Gachon University, Korea*
[2]*Korea Institute of Industrial Technology, Korea*
[1]*jsyrena0923@gachon.ac.kr*, [2]*jslee82@kitech.re.kr*

Abstract

The Smart Factory is being proposed as a challenge for the manufacturing industry in the 4th Industrial Revolution. In the absence of empirical analysis of the status of smart factories, we analyze the factors of building smart factories in the metalworking industry, which is the base of the manufacturing industry. As a result, the CEOs' intentions and firm size are the main factors for innovative and leading investment activities such as smart factories. Also, we find that the level of a smart factory is different according to the industrial characteristics by analyzing the factors of the smart level into five working areas (Product Process Design, Operation Management, Quality Management, Equipment Management, and Procurement & Logistics). In analyzing the factors of a smart factory construction plan, the firm with high production manpower plans for the low level of the smart plant. It shows that the negative aspects of clever factory construction are strong at the production site.

Keywords: *4th industry, CEO, Metalworking firms, Smart factory, SME*

1. Introduction

The recent controversy over the 4th Industrial Revolution has created a wave of innovation in the manufacturing industry. The discussion is being concluded at the smart factory in the manufacturing industry as we pursue connectivity, intelligence, and autonomy based on technologies such as IoT, AI, Cloud, and Big Data. In advanced countries such as Germany, the U.S., and Japan, global companies are leading to make the manufacturing process smart. On the other hand, the organization to support small and medium-sized enterprises' factories to be smart has been launched by the government in Korea [8]. The cost and manpower problems are still causing small and medium-sized enterprises to underinvest in [1]smart plants [4], although the need for smart factories is growing.

Nevertheless, some Korean enterprises are early to recognize and take the lead in coping with the change. This paper empirically analyzes which companies are investing in smart factories and pursuing innovation using data from Korean metalworking firms. While the concept definition of smart factories has not been concluded, this paper is the first paper in Korea to explore the direction of smart factory construction according to the characteristics of companies.

Article history:
Received (May 4, 2018), Review Result (July 2, 2018), Accepted (August 24, 2018)

Print ISSN: 2288-8969, eISSN: 2207-516X IJSBT
Copyright ⓒ 2018 Global Vision Press (GV Press)

2. Preliminary research and hypotheses

A few researches have been done on smart factories. While contributions and announcements to smart factories are actively being discussed, we particularly find very little research in business management. Merely studies on relevant trends in production manufacturing technologies are gradually coming up.

In this study, we try to discover the main factors that influence the construction of smart factories that are considered innovations in the manufacturing industry. Above all, the CEO's intention is expected to have the most significant impact on corporate innovation [2], and also firm size, growth in sales, level of research, and investment may be the factors in the establishment of a smart factory because smart factory construction requires a lot of money and connection with information and communication technology. [3] also suggests that the companies with sales of more than 1 trillion won, the ability to invest more than 10 billion won and executives and employees' enthusiasm for innovation can go to smart factories.

Also, the smart process depends on industry characteristics according to [3]and [6], so we expect each industry to have different levels of smart factories. In addition, we investigate the main factors that affect the plan of constructing a smart factory in this paper. The level of planned smart factories is also expected to vary depending on the CEO's intention, the size of the company, and the industry. In particular, enterprises with a large proportion of production manpower that can be replaced by smart equipment will likely want higher levels of smart factories. The hypotheses to verify these are as follows.

H1: The CEO's intention has a positive impact on the (planning) level of smart factories.
H2: Firm size has a positive impact on the (planning) level of smart factories.
H3: Firm growth has a positive impact on the level of smart factories.
H4: R&D activity has a positive impact on the (planning) level of smart factories.
H5: Smart factories' (planning) level varies depending on the industry.
H6: The proportion of production manpower has a positive impact on the planning level of smart factories.

3. Research methods and results

3.1. Research methods

In this paper, we analyze the 2015 Smart Factory Level survey data that were examined for the metalworking firms (Casting, Molding, Forming, Welding, Surface Treatment, and Heat Treatment). Questions on the smart level are made on a 5-point scale, and the smart level status was investigated by dividing the manufacturing process into five categories (Product Process Design, Operation Management, Quality Management, Equipment Management, and Procurement & Logistics). Smart levels in each category are not significantly different. Still, on average, they are estimated at 1.5~1.8 points between contracting no smart device and collecting data (saving the data manually). Of the five working areas, Product Process Design and Operations Management had slightly higher levels than the others.

Key explanatory variables such as the CEO's intention, industry, and proportion of production manpower are also the results of surveys such as smart level, and we use the KED database, which is Korea's largest corporate information database of about 8 million, to define the financial and ownership variable. The variables are described in Table 1.

Table 1. Definition of variables

Variable	Definition	Formula
Smart factory Level (Current, Plan)	① Product Process Design	5 point scale
	② Operation Management	
	③ Quality Management	
	④ Equipment Management	
	⑤ Procurement & Logistics	
CEO's Intention	CEO's commitment to build a smart factory	5 point scale
Firm size	Size of Enterprise	ln(Total Asset)
Growth	Recent sales growth	The past three-year average sales growth
R&D	R&D Ratio	R&D expense/ Total Sales
Industry Dummy	Casting, Molding, Forming, Welding, Surface Treatment, Heat Treatment	Dummy Variables
Debt Ratio	Soundness of Enterprise	Total Debt/Total Asset
Large shareholder	Largest Shareholder Ownership Ratio	Largest Shareholder Ownership Percentage
Production manpower	Field Workers' Ratio	Field Workers/Total Workers

3.2. Results

We use 122 corporate data for this study and present the results of multiple regression analyses on the level of smart factories in Table 2. The results show that the CEOs' intentions and firm size have a positive impact on the level of smart factories, supporting hypotheses 1 and 2. Also, we find that the level of smart factories is different according to the industrial characteristics supporting hypothesis 5. In particular, casting firms are analyzed to be higher than other industries in quality management, molding, and forming firms are higher in product process design, and surface treatment firms are higher in operation and quality management and procurement & logistics. However, contrary to our expectations, sales growth, and R&D activity do not impact the smart level.

Table 2. The results of the regression analysis

Variables	Dependent Variables: Smart factory Current Level				
	①	②	③	④	⑤
Constant	-1.386 (-1.50)	-0.802 (-0.97)	-0.798 （-1.09）	-1.090 （-1.45）	-1.895* （-1.89）
CEO's intention	0.297*** (3.85)	0.221*** （3.20）	0.338*** （5.50）	0.175*** （2.79）	0.314*** (3.76）
Firm size	0.108** (2.06)	0.088* （1.90）	0.055 （1.32）	0.108** （2.54）	0.119** （2.11）
Growth	0.576 (1.60)	0.360 （1.12）	0.177 （0.62）	0.097 （0.33）	-0.289 （-0.74）

Copyright ©2018 GV School Publication

R&D	-1.784 (-0.45)	-3.660 （-1.03）	-1.313 （-0.42）	-1.549 （-0.48）	-1.806 （-0.42）
Casting	0.575** (2.28)	0.389* （1.73）	0.591*** （2.95）	0.366* （1.78）	0.184 （0.68）
Molding	0.691*** (2.81)	0.245 （1.12）	0.191 （0.98）	0.104 （0.52）	0.119 （0.45）
Forming	0.574** (2.35)	0.437** （2.00）	0.384** （1.98）	0.233 （1.17）	0.183 （0.69）
Welding	0.322 (1.18)	0.152 （0.63）	0.258 （1.19）	-0.120 （-0.54）	0.329 （1.12）
Surface Treatment	0.464* (1.93)	0.612*** （2.85）	0.633*** （3.31）	0.375* （1.91）	0.537** （2.06）
Debt Ratio	-0.176 (-0.61)	-0.170 （-0.66）	-0.137 （-0.60）	-0.073 （-0.31）	0.045 （0.14）
Large shareholder	-0.179 (-0.79)	-0.050 （-0.25）	-0.051 （-0.04）	0.117 （0.63）	0.026 （0.10）
No. of Obs.	122	122	122	122	122
Adj. R2	0.27	0.21	0.31	0.18	0.17
F value	5.12	3.99	5.83	3.49	3.18

In analyzing factors of a smart factory construction plan, the CEO's intention has the greatest impact, just like the result of analysis on the current smart level. Firm size is also analyzed as the main factor that affects the smart factory's planning level factors, although the impact is weaker than on the current smart level. Significantly, casting, molding, and forming firms are analyzed among metalworking firms to plan to build higher-level smart factories.

On the other hand, it is analyzed that companies with high production manpower make plans for low-level smart plants. The result could be interpreted as the companies with more production staff having difficulties promoting smart plants [6]. It shows that the negative aspects of smart factory construction are strong at the production site.

4. Conclusion

While there is no doubt that smart factory construction is the way to prepare for the 4th manufacturing industry, the extent to which it should be preceded according to the corporate characteristics is not discussed. Since smart factory construction requires a lot of money and effort, the industry needs to consider the plans for smart factories for successful investment. So, in this study, we analyze the impact of corporate characteristics on the level of smart factories in the manufacturing sector, especially the metalworking industry.

As a result, the CEO's willpower and firm size are the main factors determining innovative and leading investment activities, such as smart factories. In addition, we confirm that the smart level of the manufacturing process is different depending on the industry characteristics.

Meanwhile, the regression result of companies with high production manpower making a plan on the low level of smart factories suggests that it should not be overlooked that a smart factory is not simply built and completed with smart systems but can evolve through collaboration on the production site.

References

[1] C. Schroder, "The challenges of industry 4.0 for small and medium-sized enterprises," **(2016)**
[2] D. C. Hambrick and P. A. Mason, "The Academy of Management Review," (**1984**), vol.9, no.2, pp.193-206
[3] H. G. Park, "Smart factory strategy conference," (**2018**), July 3: Seoul, Korea
[4] H. J. Lee, Y. J. Kim, J. J. Yim, Y. W. Kim, and S. H. Lee, "Journal of the Korean Society for Precision Engineering," (**2017**), vol.34, no.1, pp.29-34
[5] H. Y. Park, "The Journal of the Korean Institute of communication sciences," (**2015**), vol.33, no.1, pp.24-29
[6] H. Y. Lee and J. Y. Chang, "The Journal of the Korean Institute of Communication Sciences," (**2018**), vol.35, no.4, pp.35-42
[7] T. G. Kang and Y. R. Kim, "Indian Journal of science and Technology," (**2016**), vol.9 (S1)
[8] T. J. Lee and Y. J. Kim, "Proceedings of the Korean Society of Computer Information Conference," **(2017)**, vol.25. no.2, pp.191-194
[9] KPIC, "Survey report on smart factory level of metalworking firms, **(2015)**

Copyright ©2018 GV School Publication

Authors

Shan Yue Jin
Gachon University
Assistant Professor

Ji Suk Lee
Korea Institute of Industrial Technology
Researcher