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A study on the internal and external factors influencing smart plant construction in perspective of fourth Industrial revolution (Industry 4.0)

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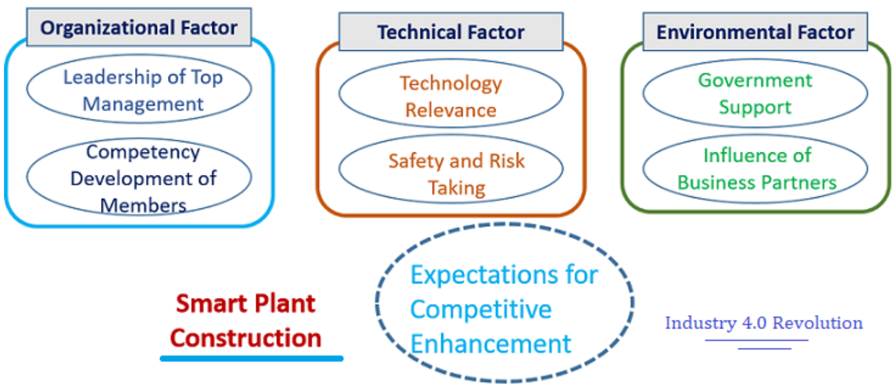
ABSTRACT



This study aims to identify the key factors in Smart Plant construction. In this point, the factors which show influences on expectations for competitiveness were adapted from the previous studies, including organizational factors, technical factors, and environmental factors. In addition, the organizational factors are divided into two sub-dimensions, including leadership of top management, and competency development of organizational members. On the other hand, technical factors are divided into two sub-dimensions, including technology relevance, and risk-taking, while environmental factors consist of government support and influence of business partners. For the empirical study, a survey method has been conducted. To examine the research hypotheses, survey data have been gathered from employees in the related field and the factors have been analyzed by exploratory factor analysis, confirmatory factor analysis, and correlation analysis. Finally, the hypotheses were tested with structural equation model. The results of the study are expected to suggest academic and practical implications to the Smart Plant field.

Keywords: Organizational factor, Technical factor, Environmental factor, competitiveness enhancement, Smart plant construction

INTRODUCTION

The Fourth Industrial Revolution brought about fundamental changes in the economy and industry globally. At the center of the wave, prominent countries are struggling hard to find competitive strategies, for instance, 'Industry 4.0' in Germany, 'Advanced Manufacturing Partnership (AMP)' in the US, and 'Manufacturing Industry 2025' in China. Also, numerous countries are striving to stabilize their industrial competitiveness through industrial policies. South Korea is formulating policies such as the establishment of the Fourth Industrial Revolution Committee.[1] In Europe, the concept of Industry 4.0 is undergoing innovative modifications, such as building smart factories that can integrate information and communication technologies with traditional industries such as manufacturing. Representative technologies in Industry 4.0 include the Internet of Things (IoT), big data, and artificial intelligence.[2] For domestic companies to actively respond to these changes, it is necessary to review the introduction cases of advanced European companies in detail and establish a long-term strategy based on this.

Previous research analyzed the performance of the smart factories in the age of Industry 4.0,[3-6] the fourth industrial revolution and smart plants,[7-9] and smart factories of small and medium-sized enterprises (SMEs).[10] Several works have been done on technologies,[11] and the applications of these technologies do not constitute a digital enterprise. The progress of the company must not only consider the introduction of technology at the same time

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but also should consider organizational and technical resources and environmental factors.

According to the limitations of the previous research, the necessity for research in a new aspect is raised as follows. First, it is necessary to classify and organize common concepts and characteristics for smart factories and smart plants. Second, it is necessary to deviate from the limitations of previous studies that mainly deal with the technical aspect and to take a comprehensive approach that considers the organizational aspect and the environmental aspect from the management aspect. Third, research is needed to empirically verify the impact on the competitiveness of companies while identifying key success factors for a successful introduction of smart plant construction from the perspective of including organizational, environme ntal, and technical aspects.

The purpose of this study is to focus the world's attention on a new paradigm that has recently been emerged as a major issue, namely, the 4th industrial revolution and the new economic growth center on the manufacturing industry. Also, it demonstrates the key success factors for smart plant construction: organizational factors (leadership of top management, competency development of organizational members), technical factors (technology relevance, safety, and risk-taking), and environmental factors (government support, the influence of business partners) and the relationship among the above factors with expectations for competitiveness enhancement, and smart plant construction which have been tested through structural equation model analysis.

THEORETICAL BACKGROUND

FOURTH INDUSTRIAL REVOLUTION

'Industry 4.0' is a motto that German public, private, and academics aimed at innovation in the manufacturing industry since 2011, and it have become a common concept that the Fourth Industrial Revolution is widely known to the public. In other words, the Fourth industrial revolution is based on hyper-connectivity, which is triggered by digital technologies such as artificial intelligence and big data. With the development of the Industrial Internet, the integration of connectivity and a new level of high-tech industrial system is playing a pivotal role to become a key catalyst for the fourth industrial revolution.[12]

The Federal Ministry of Education and Research (Bundes Ministerium für Bildung and Forschung, BMBF), an affiliate of the German Federal Government (Bundesregierung), has established 'The High-Tech Strategy for Germany2020' since 2006 to realize effective long-term growth. Industry 4.0 was started in 2011 as part of The High-Tech Strategy for Germany2020.[13-15] To this end, the German government in 2010 emphasized ideas, innovation, and prosperity, and presented five core areas, ten forward-looking projects, and specific lines of action to implement the project.[16]

SUCCESS FACTORS FOR SMART PLANT

Plant is used in the same term as industrial equipment, and the plant industry includes the equipment industry for machinery and equipment for manufacturing and processing raw materials, and the software industry for engineering and construction, supervision, commissioning, and operation to install it. This means a compound industry.[17]

In other words, it is also a process equipment industry that processes products that can be used or absorbed by humans after separating and refining necessary substances by reacting resources, water, trees, gas, oil, sun, and wind that exist in natural ecosystems, which means another definition for a compound industry.[18] It can be a series of activities in which the results of performing in the process targeting a system in which facilities, people, materials, machines, etc. are integrated, are realized in an optimal form for a purpose.[19]

In this regard, looking into the problems of the existing plant from a social point of view, there is a problem in that it is necessary to utilize manpower of lower skill than in the past due to the retirement and turnover of experienced manpower. In such situation, smart plant can transmit and share technology through remote access with internal and external experts, thereby minimizing the difference in skill level between manpower.[20]

ORGANIZATIONAL FACTORS

Jack Welch, the former CEO of GE, defined CEO as "the person who energizes an organization and makes it more powerful than its predecessors," emphasizing the influence of the CEO.[21,22] In an organization, the CEO performs tasks such as establishing corporate strategy, restructuring, controlling members, and adapting to the external environment. Therefore, the success or failure of an organization depends on the leadership of the CEO who leads the change and innovation of the company.[23]

The role of the CEO is to determine the vision, strategy, and policy, and lead the organization to grow and survive, including decision-making and problem-solving. Moreover, the more important role should be to motivate all members to participate in the management process, and in this process, should be actively supported in all aspects including resources and communication.[24]

Diericks and Cool(1989)[25] defined organizational competency as 'an atypical mechanism by which a firm procures, develops, and allocates resources to outperform its competitors'. According to the study of J.D. Goo (2009),[26] organizational competency in a universal sense can be defined as 'know-how or ability to effectively allocate and utilize organizational resources'.

This means that the characteristics of organizational resources are valuable, rare, inimitable, and irreplaceable. Due to these characteristics, organizational resources become an important factor for a company to have competitiveness, and the competitive advantage of a company can be determined by the level of resource creation and utilization. In other words, a company can secure a sustainable competitive advantage by implementing a strategy that utilizes resources.[27]

H1a: Leadership of top management will have a positive impact on the expectations for competitiveness enhancement.

H1b: The competency development of organizational members will have a positive impact on the expectations for competitiveness enhancement.

TECHNICAL FACTORS

D.L. Goodhue (1995)[28] defines Task Technology Fit (TTF) as an appropriate level of business requirements and personal capabilities and defines the suitability of work and technology. The Task-

Technology Fit Model refers to the degree of support of information technology when individuals perform tasks.

In addition, the Task-Technical Fit Model was classified into 12 dimensions: Accessibility, Assistance, Ease of Use, System Reliability, Accuracy, Compatibility, Level of Dissemination, Presentation, Level of Confusion, Level of Detail, Meaning, and Location. The above task-based strategies could better account for the correspondence between task and technique characteristics, thus enhancing individual performance and skill use.[29]

In general, safety is defined as 'the state of controlling risks and situations that cause physical, psychological, or material harm in order to preserve the health and well being of individuals and communities'.[30]

A. Kusiak (2018)[31] compared the form of traditional manufacturing with smart manufacturing and summarized the characteristics of the continuously developing smart manufacturing. The study emphasizes 'manufacturing digitization', which increases dependence on data, as the first characteristic, and emphasizes that 'cyber security' becomes the most important factor in the development of business competitiveness and smart manufacturing due to the quantitative increase and dependence on data.

H2a: The technology relevance will have a positive impact on the expectations for competitiveness enhancement.

H2b: Safety and risk-taking will have a positive impact on the expectations for competitiveness enhancement.

Environmental Factors

According to J.G. Song and H.J. Kim (2009),[32] government support is a typical means for the government to intervene in market activities. It is common to provide Research and Development (R&D) subsidies or incentives to corporate R&D investment through tax cuts.[33] It has also been confirmed through research that companies that have received government support have positive effects such as increase in R&D intensity and increase in sales.

Y. H. Noh (2014)[34] concluded that the government's R&D support policy had a significant effect on patent applications and registrations of participating companies, but had shown no significant effect on company sales and operating profit. Consumers can have various corporate associations, such as innovativeness, dynamism, and imagination for a company's products.

The study of A. Kusiak (2018)[31] focused on the three associations of corporate innovation, reliability, and corporate social responsibility (CSR), and confirmed that those factors are particularly important in corporate association.

The study of N. Slack and M. Lewis (2015)[35] focused on the effect of partner's innovative association on the relationship performance between partners. Direct and indirect evidence can be found that shows an improvement in a partner's CSR can create an improvement in the partner's innovation.

H3a: Government support will have a positive impact on the expectations for competitiveness enhancement.

H3b: The influence of business partners will have a positive impact on the expectations for competitiveness enhancement.

Expectations for Competitiveness Enhancement

Research on the establishment of smart factories by Park and Khang (2017)[36] indicated the concept of efficient manufacturing of personalized products and related production and manufacturing technology research trends, ICT and existing product manufacturing based on Korea's smart factory. It was emphasized that it was necessary to enhance the value-added of the existing industries and initiate new industries related to smart factories through convergence technologies.

Furthermore, it is necessary to establish a foundation for domestic competitiveness by systematically fostering smart factory-related industries and establishing a smart factory test bed for this, and that a smart factory that can be actually used in the field is needed by reflecting the continuous requirements of the actual manufacturing site in the policy.

H4: Expectations for competitiveness enhancement will play a positive role in the smart plant construction

Research Method

Research Model

This study focuses on the key success factor for Smart Plant construction. In this line, the exogenous variables that would affect expectations for competitiveness were gathered from the related studies, including organizational factors, technical factors, and environmental factors.

Moreover, the organizational factors have been divided into two sub-dimensions, i.e., the leadership of top management and competency development of organizational members. For the technical factors, those also have been divided into two sub-dimensions, i.e., technology relevance, safety, and risk-taking. Finally, two sub-dimensions including government support and influence of business partners have been hired for environmental factors. The research model is shown in Figure 1.

Research Methodology

The analysis method of this study is as follows. First, confirmatory factor analysis and correlation analysis have been

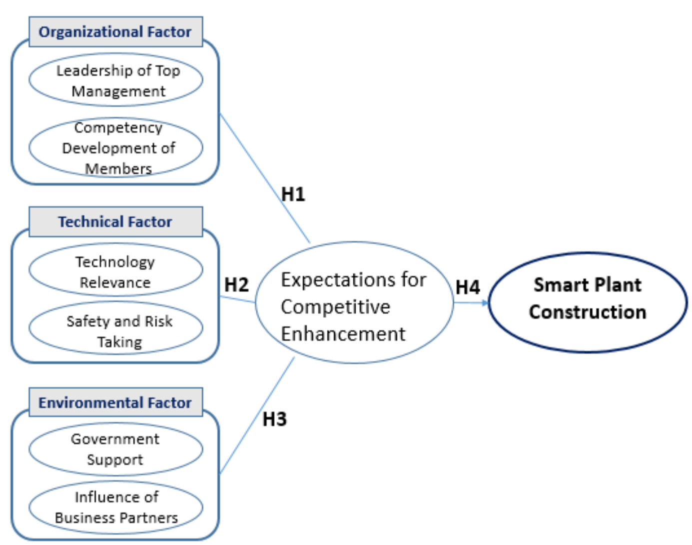

Figure 1. Research Model

Table 1. Measures

Construction		Reference
Organizational Factor	Leadership of Top Management(WM)	[37], [38]
	Competency Development of Organizational Members(OD)	
Technical Factor	Technology Relevance(TR)	[38], [39]
	Safety and Risk Taking(SR)	
Environmental Factor	Government Support(GS)	[40]
	Influence of Business Partners(IBP)	
Expectations for Competitiveness Enhancement(ECE)		[41]
Smart Plant Construction (SPC)		

conducted to verify validity and reliability of the measurement. Second, to test the hypothesis, a path analysis based on the structural equation model was conducted to verify the established hypothesis.

As shown in Table 1, the measurements for organizational factors consists of 8 items for leadership of top management and 4 items for competency development of organizational members.[37,38] For technical factors, 5 items for technology relevance and 4 items for safety and risk taking have been hired from the previous researches,[39] and 4 items for government support and 4 items for influence of business partners have been adopted from the relevant studies for environmental factors.[41]

Moreover, expectations for competitiveness enhancement as a mediating variable in the model consists of 4 items and smart plant construction as a dependent variable in the model consists of 6 items from the previous study in the smart plant field.[41]

RESULTS

For the purpose of empirical study, a survey method has been conducted on entrepreneurs and employees who are currently working in large companies. The data were collected for a month from July 2020 to August 2020. A total of 146 copies of the questionnaire were collected, and the final 137 copies were utilized for analysis, excluding unfaithful responses. And firstly, validity and reliability analysis have been performed using SPSS20.0 and AMOS18.0 and hypotheses were tested by structural equation model testing using AMOS18.0.

The main characteristics of the interviewees were 93.4% for men and 6.6% for women. In the age group, 52.6% were from 31-49 age group, 25.5% were 21-30 age group, and 21.9% were age group over 50. The main characteristics is shown in Table 2.

Table 2. Main characteristics

Variable		Frq.	%
Gender	Male	128	93.4
	Female	9	6.6
Age	20s	-	-
	30s	35	25.5
	40s	72	52.6
	Above 50	30	21.9
Education	High School	1	0.7
	Diploma	8	5.8
	Bachelor’s Degree	101	73.7
	Master Degree	28	20.4
Category of Industry	Iron(Steel)	15	10.9
	Petroleum	7	5.1
	Chemical	8	5.8
Years of Employment	5 – 10 year	23	16.8
	11 - 15 year	46	33.6
	14 – 20 year	22	16.1
	Over 21 year	39	28.5
Job Position	Manager	44	32.1
	Deputy Manager	53	38.7
	General Manager	29	21.2
	Director	5	3.6
	President	6	4.4

RELIABILITY ANALYSIS

Cronbach's Alpha reliability analysis method was performed to test the reliability of the measurement scales. The scales are reliable and internal consistency for the constructs is acceptable when the value of Cronbach's Alpha is above 0.60. As seen from Table 3, coefficients of Cronbach's Alpha are all greater than the suggested value (0.659~0.929). It is clear from these figures that our items

Table 3. Reliability analysis

Construction		Items	α
Organizational Factors	Leadership of Top Management(WM)	8	.906
	Competency Development of Organizational Members(OD)	4	.902
Technical Factor	Technology Relevance(TR	5	.857
	Safety and Risk Taking(SR)	4	.903
Environmental Factor	Government Support(GS)	4	.670
	Influence of Business Partners(IBP)	3	.659
Expectations for Competitiveness Enhancement(ECE)		4	.867
Smart Plant Construction (SPC)		6	.929

have good internal consistency in each scale, in short, our data is meaningful in statistics and has the necessary reliability.

EXPLORATORY FACTORS ANALYSIS

An exploratory factor analysis was performed to identify the appropriateness of the operational definition of the variables used in this study, and the validity was analyzed with an eigen-value of 1 or more and a common value of 0.5 or more as evaluation criteria. The results of the exploratory factor analysis are shown in Table 4.

CONFIRMATORY FACTOR ANALYSIS

A confirmatory factor analysis with covariance matrix as the input by using AMOS18.0 was conducted to evaluate the measurement model. The fit of the measurement model was estimated by various indices as shown in Table 5, where the results

Table 4. Exploratory factor analysis

	1	2	3	4	5	6	7	8
WM1	.048	**.706**	.234	.040	.307	.269	.036	.036
WM2	.096	**.776**	.246	.128	.269	.159	.102	.016
WM3	.246	**.719**	.329	-.048	.033	.001	.054	-.027
WM4	.128	**.855**	.072	.129	.088	.101	.050	.122
WM5	.285	**.759**	.185	.084	-.004	.028	.234	-.084
WM6	.246	**.809**	.090	.126	.095	.044	-.012	.013
WM7	.257	**.720**	.091	-.011	.310	.238	.049	.073
WM8	.297	**.540**	.046	.194	.275	-.141	.226	-.221
OD1	.298	.194	**.756**	.125	.129	.150	.166	-.056
OD2	.119	.190	**.783**	.329	.113	.040	.186	.056
OD3	.168	.254	**.745**	.269	.109	-.032	.176	.142
OD4	.197	.364	**.641**	.213	.102	-.166	.093	.149
TR1	**.724**	.118	.110	.103	.276	.159	-.025	.311
TR2	**.607**	.133	.265	.039	.391	.213	.018	.011
TR3	**.656**	.197	.375	-.001	.205	.202	-.220	.146
TR4	**.659**	.303	.289	-.174	.264	-.146	.046	.253
TR5	**.528**	.250	.104	-.035	.275	-.022	-.028	.352
SR1	.155	-.005	.198	**.809**	.063	.111	.033	-.036
SR2	.235	.094	.276	**.801**	-.029	.098	.208	-.065
SR3	.277	.086	.053	**.839**	.111	-.020	.050	.027
SR4	.177	.197	.171	**.835**	.058	.063	-.016	.073
GS1	.148	.136	.044	.124	**.802**	.054	.168	-.061
GS2	.113	.245	.210	.049	**.712**	.039	.164	.062
GS3	.328	.137	.022	.084	**.806**	.051	.048	-.073
GS4	.333	.098	.002	.137	**.808.**	.069	.112	.125
IBP1	.126	.233	.284	.031	.271	.073	**.745**	.136
IBP2	.138	.177	.322	.242	.114	.145	**.750**	.163
IBP3	.028	-.072	.084	.033	.022	.063	**.827**	.166
EFE1	.279	.240	.067	.092	.003	**.695**	-.071	.152
EFE2	.271	.183	.040	.082	.129	**.744**	.111	.035
EFE3	-.013	.246	-.033	.199	.081	**.706**	.201	.030
EFE4	.046	.127	.041	.163	.012	**.855**	.005	.024
SPC1	.077	.168	.279	.183	.286	.266	.056	**.667**
SPC2	-.111	.187	.116	.123	.221	.167	.036	**.757**
SPC3	.009	.152	.154	.213	.022	.119	.032	**.839**
SPC4	.053	.171	.028	.181	.080	-.080	.173	**.804**
SPC5	-.020	.104	.279	.099	-.054	.136	.044	**.757**
SPC6	.002	.010	.227	.156	.190	.133	.031	**.818**
Total	8.247	4.911	3.527	3.426	2.712	2.181	1.638	1.392
%Var	21.704	12.924	9.282	9.015	7.137	5.739	4.311	3.663
Cum%	21.704	34.628	43.910	52.925	60.062	65.801	70.113	73.775

of goodness-of -fit indices demonstrated that the model provided a good data. In order to improve the applicability of the model, the WM8, WM7, GS1, GS2 and IBP3 metrics with a standard loading value equal to or less than 0.6 have been deleted.

For models with goodness of fit to data: CMIN=613.678, CMIN/df=1.408, CFI=.951, TLI=.941, IFI=.952, NFI=.852, GFI=.808, AGFI=.753 RMR=.028, RMSEA=.055. According to the analysis, CR values were found to be 0.7(0.838~0.904) and AVE values over 0.5(0.549~0.723) for all variables. Therefore, the analysis could be reflected to have reliability and convergent validity.

Correlation Analysis

The correlations among the variables were analyzed. The comparison of AVE square root and correlation are presented as shown in Table 6. As a result of comparing the correlation of all two variables and the square root value of AVE, the correlation value is lower than the square root value of all AVE. Also, no pair of measures found with a correlation that exceeds 0.9, indicating no multi-co linearity exists among the construct.

Path Analysis

To test the hypothesis established in this study, covariance structural analysis was conducted, and the results are shown in Table 7. For models with goodness of fit to data: CMIN=586.634, CMIN/df=1.349, CFI=.958, TLI=.949, =.95T9, NFI=.858, GFI=.819, AGFI=.766 RMR=.026, RMSEA=.051. The majority of indices show that they are above the baseline. The hypothesis test results are as follows.

Leadership of top management has no significant effect on

Table 5. Confirmatory factor analysis

	Estimate	S.E.	t-value	p-value	C.R	AVE
WM6	.782				0.875	0.621
WM5	.819	.095	10.297	***		
WM4	.817	.098	10.268	***		
WM3	.791	.100	9.863	***		
WM2	.744	.105	9.159	***		
WM1	.775	.110	9.622	***		
OD4	.784				0.904	0.703
OD3	.895	.095	11.651	***		
OD2	.873	.093	11.309	***		
OD1	.797	.093	10.075	***		
TR5	.762				0.859	0.549
TR4	.712	.115	8.322	***		
TR3	.714	.097	7.823	***		
TR2	.768	.101	8.387	***		
TR1	.750	.112	8.197	***		
SR4	.847				0.907	0.709
SR3	.848	.079	12.222	***		
SR2	.896	.089	13.265	***		
SR1	.775	.100	10.634	***		
GS4	.928				0.865	0.763
GS3	.816	.103	8.200	***		
IBP2	.898				0.838	0.723
IBP1	.800	.105	8.607	***		
EFE4	.845				0.868	0.622
EFE3	.729	.085	9.934	***		
EFE2	.811	.069	11.682	***		
EFE1	.767	.079	10.701	***		
SPI6	.874				0.891	0.696
SPC5	.788	.080	11.819	***		
SPC4	.800	.090	12.133	***		
SPC3	.900	.068	15.290	***		
SPC2	.821	.073	12.709	***		
SPC1	.818	.073	12.629	***		
CMIN=613.678, CMIN/df=1.408, CFI=.951, TLI=.941, IFI=.952, NFI=.852, GFI=.808, AGFI=.753 RMR=.028, RMSEA=.055						

Table 6. Correlation analysis

	WM	OD	TR	SR	GS	IBP	EFE	SPC
WM	**.621**							
OD	.341	**.703**						
TR	.357	.311	**.549**					
SR	.263	.190	.404	**.709**				
GS	.123	.098	.318	.201	**.763**			
IBP	.056	.226	.056	.103	.099	**.723**		
EFE	.253	.605	.162	.122	.209	.336	**.622**	
SPC	.236	.691	.248	.164	.256	.263	.619	**.696**

expectation for competitiveness enhancement. The H1a is rejected (Estimate=.021, p=.807). Competency development of organizational members has significant positive effect on expectation for competitiveness enhancement. The H1b is accepted (Estimate=-.138, p=.036).

Technology relevance has significant positive effect on expectation for competitiveness enhancement. The H2a is accepted (Estimate=.729, p=.000). Safety and risk taking has no significant positive effect on expectation for competitiveness enhancement. The H2b is rejected (Estimate=-.044, p=.191).

Government support has significant positive effect on expectation for competitiveness enhancement. The H3a is accepted (Estimate=.159, p=.000).

Table 7. Path analysis

	Estimate	S.E.	C.R.	P	Results
H1a	.021	.073	.244	.807	Rejected
H1b	-.138	.065	2.094	.036	Supported
H2a	.729	.121	6.104	***	Supported
H2b	-.044	.079	-1.308	.191	Rejected
H3a	.159	.064	3.777	***	Supported
H3b	-.303	.060	-.502	.615	Rejected
H4	.973	.098	9.758	***	Supported
CMIN=586.634, CMIN/df=1.349, CFI=.958, TLI=.949, IFI=.959, NFI=.858, GFI=.819, AGFI=.766 RMR=.026, RMSEA=.051					

Influence of business partners positively no significant effect on expectation for competitiveness enhancement. The H3b is rejected (Estimate=-.303, p=.615).

Expectation for competitiveness enhancement has significant positive effect on smart plant construction. The H4 is accepted (Estimate=.973, p=.000).

Conclusion

This study aimed to identify the antecedents of smart plant construction mediating the expectation of competitiveness enhancement. The findings and implications are as follows.

First, it is possible to address the limitations of previous research on technology by positively looking at organizational factors, technical factors, and environmental factors that have a significant impact on the company's expectations for competitiveness. Furthermore, we can observe from the results that the expectation for competitiveness enhancement has a significant effect on the smart plant construction, the result that the company's competitiveness is the highest when organizational factors, environmental factors, and technical factors are all considered is emphasized in this study.

On the other hand, the results of these empirical studies are significant in that they reconfirmed their importance by empirically verifying existing prior studies (DIN and DKE, 2016; C.R. Rad et al., 2015; A. Radziwon et al., 2014) that emphasized social and technological systems such as the 4th industrial revolution and smart factories. In addition, the existing qualitative and quantitative studies conducted in this study show that the introduction of smart plants in the rapidly changing modern business environment is a contemporary task for the survival of companies.

Second, among the key success factors of smart plants, the importance of the development of the impact of organization members is also emphasized. Therefore, to strengthen corporate competitiveness, it is necessary to establish a clear vision, strategy, and plan for the smart plant based on the development of the influence of members of the organization, and to join and lead the change to the organization members by the introduction of new systems and technologies.

Third, the purpose of this technical factor is to secure data and the acquisition and processing of this data are major for business feasibility and engineering, equipment manufacturing and supply, construction, operation, management and operation, and is the basis of the plant industry. Vulnerability to common core technologies such as value-added equipment, package equipment, management, and operation system, maintenance, and repair can be improved in more and more areas through securing and processing a lot of data, which is very much in the anticipation of strengthening corporate competitiveness. It will develop into an important factor.

Finally, the expectation of enhancing corporate competitiveness has a positive impact on the willingness to build smart factories. As discussed, the organizational factors, technical factors, and environmental factors set as the preceding variables in this study stimulate positive expectations for Smart Plant Construction, and it is confirmed that this affects the willingness to build smart plants.

The limitations of the study are as follows. First, the sample size is small. The size of the sample is one of the key factors that have a great influence on the results of the study. However, since the empirical research related to smart plants is still in its infancy, there are many limitations in securing data at the individual level. In future research, efforts will be made to secure a large number of samples to derive conclusive results. Second, there are a large number of technologies related to smart factories, but all could not be studied. Inclusion of all different technologies related to the smart factory need to be focused in future research in this field.

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