

# A Model for Factors Affecting the Performance of Warehouse Management to Increase the Competitiveness of the Ceramic Industry in Thailand

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## ABSTRACT

*This research aimed 1) to study the effects of the factors influencing the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand; 2) to study the development of a model for factors affecting the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand; and 3) to study the guideline and development of the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand. The study employed the quantitative research methodology and the statistical devices of percentage and Structural Equation Modeling (SEM). The population and sample group comprised executives in the ceramic industry in Thailand. The findings revealed the following: 1) The factors concerning knowledge of information technology, warehouse management and digital systems positively affected the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand at the statistically significant levels of  $\beta = 0.324$ ,  $0.163$  and  $0.271$  respectively. The antecedent variables which had Direct Effect (DE) and Total Effect (TE) on the latent variable of the performance of warehouse management to increase the competitiveness were 1. knowledge of information technology (DE = 0.324, and TE = 0.324), 2. warehouse management (DE = 0.271, and TE = 0.271), and 3. digital system (DE = 0.163, and TE = 0.163) respectively; 2) The results of the study of the guideline and development of a model for factors affecting the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand revealed that the factors concerning knowledge of information technology, warehouse management and digital system were well-fitted with the empirical data at statistically significant levels; and 3) The factors concerning knowledge of information technology, warehouse management and digital system contributed to the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand in terms of speed, time and customer service.*

**KEYWORDS:** Warehouse management; Competitiveness; Ceramic industry.

## 1. Introduction

Ceramic industry has an important role in Thailand in terms of employment and income distribution. Compared with other ASEAN countries, the output of Thailand's ceramic industry is relatively robust. This has resulted in a sizable export expansion of each product category in the ceramic industry in Thailand. Most exported ceramic products are shipped to

Japan, ASEAN countries, the U.S.A., Hong Kong, Germany, China and Denmark. The U.S.A. is Thailand's main market for this type of export [21]. Thailand had the second biggest market share of ceramic products in 2019, with 10 percent of market share following Japan that had 40 percent of market share. In 2020 the export of construction materials was contracting whereas the import of construction materials, especially of ceramic tiles from China, was slightly expanding [3]. It is estimated that Thailand's ceramic industry will project an expansion trend following the increase of domestic demands propelled by the government's economic stimulus measures in

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the real estate sector and the entrepreneurs' sales promotions to boost the market as well as the production volumes for the export markets in the U.S.A., China and Japan, particularly the export of sanitary ware to the U.S.A. and the export of ceramic floor and wall tiles to China and Japan. The ceramic industry produces a variety of ceramic products. Examples of important traditional ceramic products are floor tiles, wall tiles, sanitary ware, souvenirs, jewelry, tableware and insulators. Examples of new types of ceramic products are those used in electricity and electronics industry, automotive industry and medicine industry. These new types of ceramic products constitute a very low amount of output in Thailand. Most of the ceramic production in the country caters for the traditional products. The ceramic industry, therefore, is a fundamental industry that plays a role in income distribution in rural areas and in facilitating numerous continuous industries. The industry has been important to the economy since the old days because it mostly employs raw materials available in the country. Most of the factories are located in provincial areas, and the products aptly reflect their respective local identities.

Nevertheless, the ceramic industry is facing domestic economic contraction and the decrease of global demands due to consumers' lower purchasing power. In addition, the industry is impacted by the competition from other nations which can be classified into two levels, namely the low-end market which offers products from China that has the largest production capacity and is able to manufacture goods of various standards, forms and price ranges, and the high-end market which offers products from countries in the European Union such as Spain, Italy and Germany.

The challenges mentioned above require the ceramic industry to urgently figure out ways to adjust and increase its competitiveness. In the free market economy that features high competition in goods and service investment as well as economic and social risks from all aspects, the efficiency of business administration requires knowledge of information technology, digital system, warehouse management capacity, entrepreneurs' market access capability, capital sources and a higher level of self-reliance [1]. This can be perceived as marketing opportunities for the ceramic industry to develop. This research study, therefore, aimed to investigate the effects of factors contributing

to the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand, the development of a model for factors affecting the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand and the guideline and development of the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand. The study could help the entrepreneurs in the ceramic industry to heighten the performance of warehouse management in their industry and improve their operational process. Related organizations could make use of the empirical data to set operation policies in collaboration with entrepreneurs in the ceramic industry so that they could help one another enhance their work capabilities.

### **1.1. Research objectives**

1. To study the effects of the factors influencing the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand.
2. To study the development of a model for factors affecting the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand.
3. To study the guideline and development of the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand.

## **2. Literature Review**

An organization's resources include items such as its entire assets, work capability, operational process, attitude, data and knowledge that can be controlled within the organization and can enhance the organization's competitiveness [15]. Moreover, [6] define performance results as the outcome reflected by the decision to run an organization. [7] states that a company must produce high-quality goods to positively affect its competitiveness. This involves using resources to provide customers with efficiency in terms of time, speed, customer service or values related to the desired outcome. Efficient warehouse management sharpens an organization's competitive edge because warehouse serves to store raw materials to meet the production and sales demands and to deliver goods in a timely manner [19]. This study reviewed the literature related to the study of

the guideline and development of a model for factors affecting the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand, the results of which are presented as follows.

Knowledge of information technology refers to the development of knowledge, the accessibility of knowledge of information technology and the use of knowledge of information technology in tandem with knowledge of science and operation arts in order to solve operational problems and to create new knowledge of information technology to facilitate the operation [20]. This is in agreement with [12] who found that the continuous development of ceramics to increase their implementation potentiality and diversity involved the use of modern technologies and innovations in the production and the application of knowledge of information technology to reduce waste, which created positive effects on the operation.

Digital system refers to the system's readiness, connection capability, automatic operational quality and various types of electronic equipment used to process signals to enable the desired operational characteristics. This is in agreement with Willmott (2013) who found that business components in the digital age must include connectivity, innovation-based business development, automatic system adjustment and data-driven decision making.

Warehouse management refers to the quality of warehouse administration and operation using technological system and modern equipment. This is in agreement with [24] who found that efficient warehouse management could increase the performance of a warehouse by reducing the time of storage process, storage cost and storage space as well as displaying real-time product status.

**2.1. Research hypotheses**

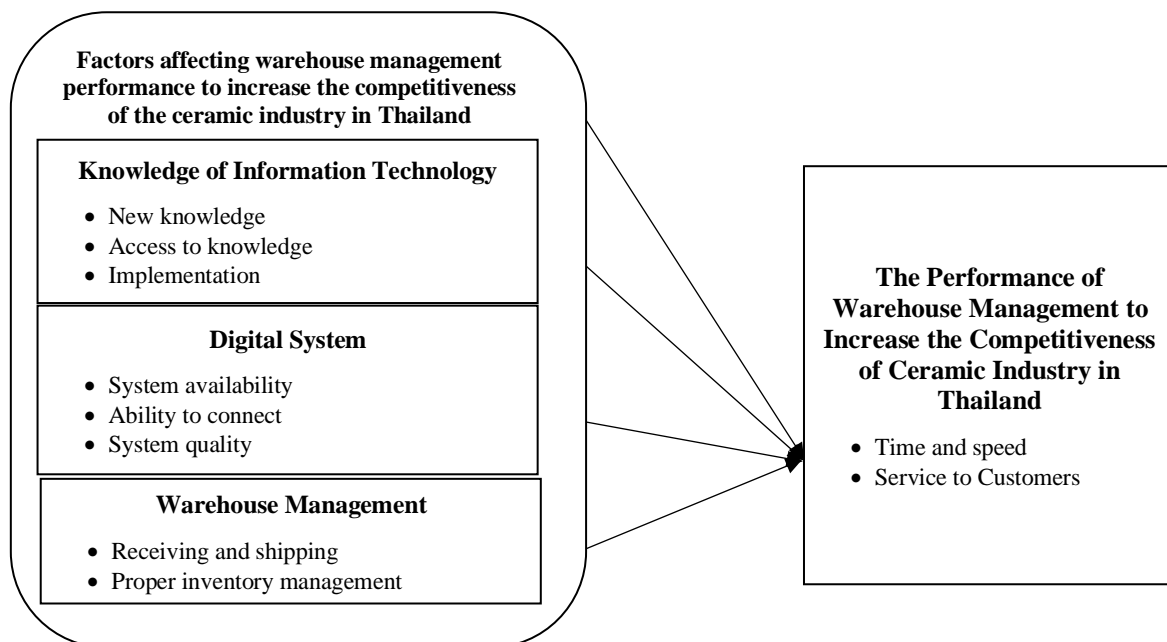
Hypothesis 1: The factors concerning knowledge of information technology affect the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand.

Hypothesis 2: The factors concerning digital system affect the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand.

Hypothesis 3: The factors concerning warehouse management affect the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand.

**2.2. Conceptual framework**

A Study of the Guideline and Development of a Model for Factors Affecting the Performance of Warehouse Management to Increase the Competitiveness of the Ceramic Industry in Thailand.



**Fig. 1. Conceptual framework for a study of the guideline and development of a model for factors affecting the performance of warehouse management to increase the competitiveness of the ceramic industry in thailand**

### 3. Methods

Research Methodology This study followed the methodology of qualitative and survey research.

The population and sample group comprised executives in the ceramic industry according to the existing databases and Creative Industrial Material Research and Development Center (Creative Industrial Material Research and Development Center, 2021; Department of Industrial Works, 2021).

The data collection consisted of 2 parts as follows:

1. The secondary data were derived from reviewing related literature, research studies and research articles in order to study theories, concepts and information relevant to the data analysis.
2. The primary data were collected using a questionnaire.

The validity and reliability of the research instrument were tested as follows:

1. Validity: The questionnaire was checked by 3 experts to verify the congruence and content validity.
2. Reliability: The questionnaire was piloted with 30 organizations that were not included in the sample group.

The statistics used for the data analysis included percentage and Structural Equation Modeling: SEM.

To analyze the relationships of measurable statistical variables, the researcher sent the questionnaire to 400 executives, each in the position of unit head or higher, in the ceramic

industry and 300 executives (75 %) returned the completed questionnaire. This number corresponded to [5] who suggest that a sample size of 300 is a good size.

To measure the validity of the questionnaire, 3 experts conducted an initial check of the quality of the revised questionnaire. The results were between 0.60 and 1.00. The reliability of the 300 returned questionnaires was 0.948.

The goodness of fit was tested with the data for factor analysis using KMO and found to be at 0.837.

### 4. Results

The study of the guideline and development of the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand revealed that most of the questionnaire respondents were male (51.70 %), aged between 41 and 50 years (35 %) and graduated with a Master's degree (47.30 %).

The goodness of fit of the data to be used for factor analysis was tested using KMO and Bartlett's Test. The results revealed the variables' KMO value of 0.837, which suggested that the data were well-fitted to be studied using the factor analysis technique. The value passed the criterion for model analysis and agreed with the theoretical framework which stipulated that the value of the goodness of fit should not be lower than 0.50 [22]. The Bartlett's Test based on the statistical distribution of Chi-Square had the result of 3818.069 and p- value < 0.001, meaning that the variables in the analysis were correlated.

**Table 1. The item reliability of the questionnaire**

Latent Variable	Observed Variable	Corrected Correlation	Item-Total	Cronbach's alpha
Factors Affecting the Performance of Warehouse Management to Increase the Competitiveness of the Ceramic Industry in Thailand				
Knowledge of Information Technology				
	KIT <sup>1</sup>	0.707		0.797
	KIT <sup>2</sup>	0.478		
	KIT <sup>3</sup>	0.027		
	KIT <sup>4</sup>	790		
Digital Business				
	Digi <sup>8</sup>	0.347		0.700
	Digi <sup>9</sup>	0.534		
	Digi <sup>10</sup>	0.449		
	Digi <sup>11</sup>	0.544		
Warehouse Management				
	WH <sup>12</sup>	0.398		0.754
	WH <sup>13</sup>	0.635		
	WH <sup>14</sup>	0.590		
	WH <sup>15</sup>	.408		

Latent Variable	Observed Variable	Corrected Correlation	Item-Total	Cronbach's alpha
The Performance of Warehouse Management to Increase Competitiveness	WH16	.435		.867
	WH17	0.526		
	Quali1	0.431		
	Quali2	0.680		
	Quali3	0.658		
	Quali4	0.292		
	Time5	0.563		
	Time6	0.578		
	Time7	0.643		
	Time8	0.506		
	Ser9	0.490		
	Ser10	0.456		
Ser11	0.596			
Ser12	0.636			

Table 1 shows the reliability results from 300 questionnaire respondents. The Cronbach's alpha values were found to be between 0.700 and 0.867 According to the Corrected Item Total Correlation, the discrimination and

reliability values should not be lower than 0.30 and the Cronbach's alpha coefficients should not be lower than 0.70. The results were, therefore, in agreement with the criteria.

**Tab. 2. A summary of statistical results after model adjustment**

Index	Criterion	Value	Interpretation
P-value	> 0.05	0.684	PASS
CMIN/DF	< 3.00	0.881	PASS
GFI	> 0.90	0.982	PASS
RMSEA	< 0.08	0.000	PASS

**Source :**The criteria were adapted from Arbuckle (2011)

From the table summarizing the statistical results after the model adjustment, it could be seen that all the statistical values passed the standard criteria and correlated with the empirical data according to the suggestion of [2]. The results from the theory-driven analysis confirmed that the structural equation model fitted the empirical data. The results of the statistical analysis of the correlation between the hypothetical model and the empirical statistical data after the model adjustment revealed that the P-value was  $0.684$  and the CMIN/DF value was  $0.881$ , which passed the criterion that requires the value to be lower than 3. The Goodness of Fit Index (GFI) was at 0.982, which passed the criterion that requires the GFI value to be higher than 0.90. In this instance, the GFI value was 0.982, which made it pass the criterion of 0.90. Finally, the Root Mean Square Error of Approximation (RMSEA) value was 0.000, which passed the criterion that requires the value to be lower than 0.08.

**4.1. The results of hypothesis testing**

The model analysis employed key statistical values to check the model's goodness of fit based on the construct and empirical data as follows:

Hypothesis 1 Factors concerning knowledge of information technology affected the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand at the statistically significant level of 0.001, with the path coefficient value of  $\beta = 0.324$ ,  $t = (0.909)$ .

Hypothesis 2 Factors concerning digital system affected the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand at the statistically significant level of 0.01, with the path coefficient value of  $\beta = 0.163$ ,  $t = (3.020)$ .

Hypothesis 3 Factors concerning warehouse management affected the performance of warehouse management to increase the competitiveness of the ceramic industry in

Thailand at the statistically significant level of 0.001, with the path coefficient value of  $\beta = 0.271$ ,  $t = (2.387)$ .

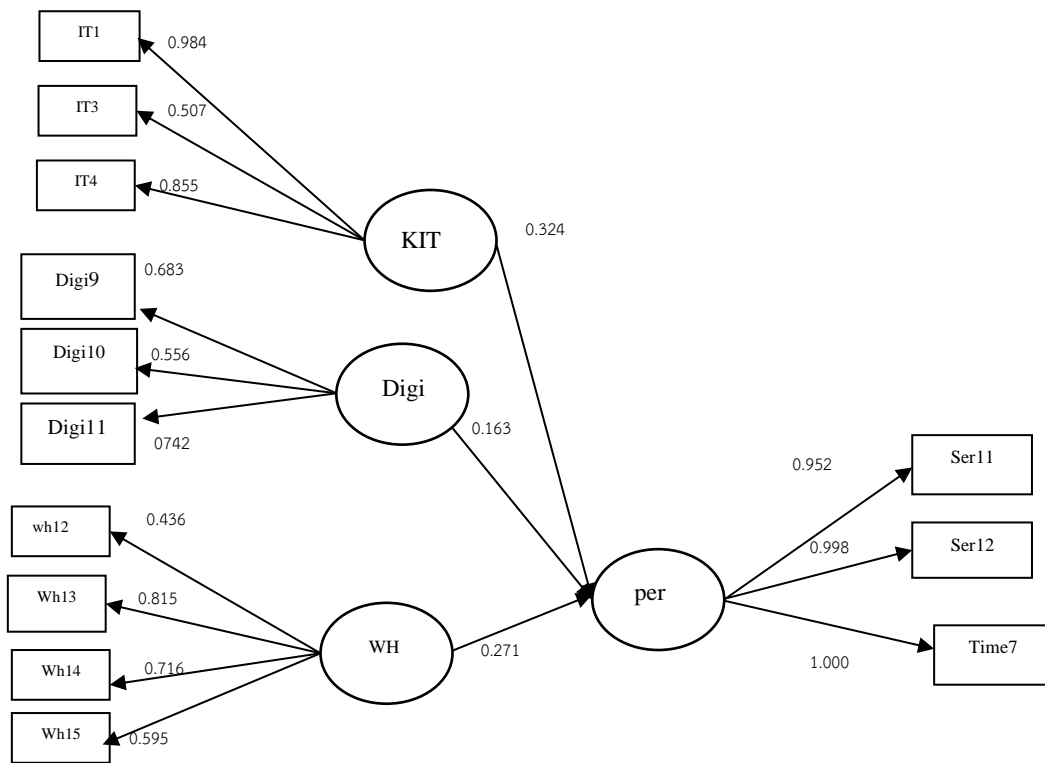
The analysis of the effects of antecedent variables revealed the following:

**Tab. 3. Effects of antecedent variables**

Latent Variable	Effect	Effects of Antecedent Variables		
		Knowledge of Information Technology	Digital System	Warehouse Management
The performance of warehouse management to increase the competitiveness	DE	0.324	0.163	0.271
	IE	0.000	0.000	0.000
	TE	0.324	0.163	0.271

The effects of the antecedent variables on the latent variable of the performance of warehouse management to increase the competitiveness were as follows: Factors whose Direct Effect (DE) and Total Effect (TE) positively affected the performance of warehouse management to

increase the competitiveness at the highest level were 1) Knowledge of Information Technology (DE = 0.324, and TE = 0.324), Warehouse Management (DE = 0.271, and TE = 0.271), and Digital System (DE = 0.163 and TE = 0.163 respectively).



**Fig. 2. Structural equation model for the study of guideline and development of a model for factors affecting the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand**

Figure 2 shows the structural equation model for the study of guideline and development of a model for factors affecting the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand. The model indicates the following: 1) Factors concerning knowledge of information technology include perception of the significance of developing up-to-date IT

knowledge that can be implemented in the operation, employees' ability and agility to implement and access IT knowledge, and regular trainings in IT knowledge provided by the organization; 2) Factors concerning digital system include system readiness for data accessibility, connectivity network for digital operation, and quality system or quality product inspection system; and 3) Factors concerning

warehouse management include appropriate volume of products in the warehouse, appropriate process and system of incoming goods inspection, appropriate system of returned goods inspection, and appropriate management of inventory and orderly storage. These factors positively affected the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand with statistically significant values and with the path coefficients of 0.324, 0.163 and 0.271 respectively.

### 5. Conclusion and Discussion

This research studied the guideline and development of the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand. The findings are discussed according to the study's objectives and hypotheses as follows:

From Objective 1: To study the effects of the factors influencing the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand, it was found that the factors concerning knowledge of information technology, warehouse management and digital system positively affected the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand at statistically significant levels. The factors concerning knowledge of information technology had the highest effect on the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand. This was in accordance with [11] who state that infrastructure-related information technology that can be implemented systematically could sharpen an organization's competitive edge. Moreover, this agreed with [7] who states that high quality production generates the quality of competitiveness by making the best use of resources for the benefits of customers. Better performance is the result of accurate, speedy and timely operation as well as of making the best use of resources to satisfy the service receivers [24].

From Objective 2: To study the development of a model for factors affecting the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand, it was found that all the variables in the three categories of factors, namely knowledge of information technology, warehouse management and digital system, in

the SEM test were well-fitted with the empirical data. Therefore, the structural equation model was found to correspond to the criteria for evaluating the fit of model [2], as can be explained based on the research hypotheses as follows:

Hypothesis 1: Factors concerning knowledge of information technology affected the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand at the statistically significant level of 0.001, with the path coefficient value of 0.324. This corresponded to [12] who found that executives and entrepreneurs continuously developed ceramic products in order to increase the potentiality of their usage and that they employed knowledge of modern technology and innovation in the production to reduce costs and to turn wastes into new applications. Knowledge of information technology positively affected the performance of warehouse management at a statistically significant level. Entrepreneurs could implement technology to reduce the process, cost and time of production, to increase the volume of production and to maintain their market share. In addition, [11] project that businesses equipped with information technology could make use of the knowledge to efficiently manage their investment information in SME businesses and implement strategies that would enable them to compete with their rivals [23].

In short, the factors concerning knowledge of information technology affected the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand, with emphasis on perception of the significance of developing up-to-date IT knowledge that could be implemented in the operation, employees' ability and agility to implement and access IT knowledge, and regular trainings in IT knowledge provided by the organization.

Hypothesis 2: Factors concerning digital system affected the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand at the statistically significant level of 0.01, with the path coefficient value of 0.163. This corresponded to [13] who state that marketing in the digital era is required to present goods that match customers' tastes and to do it correctly, timely and quickly. Most significantly, goods and services must be developed to serve multiple purposes in

multiple forms. This has created new marketing tools that can present goods and services to their target groups in a timely manner and in ways that satisfy their customers. Likewise, [9] found that innovation and digital marketing affected the operation of SMEs because accessibility to communication channels and efficient, fast, low-cost and accurate interactions with customers could respond well to customer behaviors in terms of product access and selection in the digital age. Since digital system is a good tool for various forms of knowledge management, it plays an important role in the lives of individuals in a learning society, particularly in the context of ceramic industries from the past [10] and are now in digital manufacturing ecosystems [17]. This accords with [8] who states that digital system has an important role for both individuals and the society in a learning society. In short, the factors concerning digital system affected the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand because it is a tool for various forms of management based on systematic techniques, system analysis and design, and IT development for practical applications and efficient management.

Hypothesis 3: Factors concerning warehouse management affected the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand at the statistically significant level of 0.001, with the path coefficient value of 0.271. This corresponded to [24] who found that automatic warehouse system could help reduce product cost by 72.63 %, could help reduce storage space by 72.63 %, and could help reduce storage processing time by 100 %. This efficiency affected the storage time, cost and real-time display of product status respectively. It agreed with [4] who found that the management of inventory positively correlated with the efficiency of inventory management at a high level. The management included goods receipt, returned goods inspection, efficient storage space management, proper storage temperature, movement of goods via the shortest distance, movement of goods using standard equipment, and punctual shipment of goods. In addition, [14] found that warehouse management correlated with performance enhancement in terms of operational speed, reduced problems related to goods picking and enabled efficient system management in the operation.

In short, aspects related to the management of inventory that all organizations should consider include appropriate volume of stored goods, appropriate process and system for incoming goods inspection, appropriate system for returned goods inspection, appropriate inventory management, orderly storage and goods picking that provides sufficient goods that are ready to be used.

From Objective 3: To study the guideline and development of the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand, it was found that the factors concerning knowledge of information technology, warehouse management and digital system positively affected the performance of warehouse management to increase the competitiveness of the ceramic industry in terms of customer service which included after-service customer satisfaction and operational improvement based on after-service information, in terms of time and speed which included launching goods in the market before other business rivals. These factors could increase the performance of warehouse management in the ceramic industry, which corresponded to [7] who states that high-quality operation sharpens an organization's competitive edge in terms of time, speed and customer service, and agreed with [14] who found that good warehouse management created efficiency in terms of operational speed at the highest level and led to services that met the customers' satisfaction and the ability to increase competitiveness in the future.

From the study of the guideline and development of the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand, it could be concluded that factors concerning knowledge of information technology, warehouse management and digital system influenced the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand. As a result, related organizations could manage their resources efficiently and implement systematic development.

### **5.1. Suggestions from the present study**

1. Knowledge of information technology is necessary for the performance of warehouse management to increase the competitiveness of the ceramic industry in Thailand because it keeps the



operation on a par with currents of changes. Industrial workers should be kept updated on the development of new forms and knowledge of modern technology so that they can learn about technology, have an awareness of its significance as well as an ability to apply it at work in a sustainable manner.

2. The results from this study indicate that entrepreneurs in the ceramic industry should focus on keeping up with and exploiting knowledge of information technology as well as on operating businesses using digital and warehouse management systems in order for the ceramic industry to gain competitiveness in the market.

## 5.2. Recommendations for future studies

In-depth qualitative studies focusing on each contributing factor are recommended. The results from these studies will lead to further development of the industry's performance and business competitiveness in the future.

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