The Confirmatory Factor Analysis of Enhancing the Warehouse Management Efficiency in Map Ta Phut Industrial Estate, Rayong

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Abstract: The purposes of this research were 1) to analyze the confirmatory factors of enhancing the warehouse management in Map Ta Phut Industrial Estate, Rayong Province, and 2) to verify the tests based on the consistency between the confirmatory factor structure of enhancing the warehouse management in Map Ta Phut Industrial Estate, Rayong Province and the empirical information. The sample group was 400 warehouse employees in Map Ta Phut Industrial Estate, Rayong Province with simple random sampling. The research instrument used was the questionnaire with item objective congruence (IOC) index of 0.99. The statistics used were frequency, percentage, mean, and standard deviation (S.D.), exploratory factor analysis (EFA), confirmatory factor analysis, and second-order confirmatory factor analysis. The data were analyzed by simple statistics: percentage and standard deviation.

The results of the study found that the efficiency enhancement of warehouse management in Map Ta Phut Industrial Estate, Rayong Province based on the POLC theory of Louis A. Allen. The principles of management can be distilled down to four critical functions. These functions are planning, organizing, leading, and controlling. The results of the first-order confirmatory factor analysis found that all the indexes passed the criteria. The Chi-square minimum probability (CMIN/P) was 0.108, the Chi-square minimum discrepancy per degree of freedom (CMIN/DF) was 1.137, the goodness of fit index (GFI) was 0.98, and the root mean square error of approximation (RMSEA) was of 0.02. The factor loading was between 0.90 and 0.98 at the statistical significance level of 0.01. Lastly, the factor loading ranged from the highest to the lowest as follows: organizing, planning, controlling and leading, respectively to be the guidelines for the enhancement of warehouse management efficiency in Map Ta Phut Industrial Estate, Rayong Province.

Key-words: Confirmatory Factor Analysis, Efficiency Enhancement, Warehouse Management, Industrial Estate.

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1 Introduction

Today the industrial sector realizes the significance of the cost management of logistics involved in all business and industrial activities. Thailand has a plan for logistics system development written in Thailand's 20-Year National Strategy to drive the development of the country to stability, prosperity, and sustainability. The strategy related to the business and industrial sector is the strategy of competitive efficiency enhancement to extend the successive growth with four essential factors: development of the production and service sector, development of entrepreneurs' society to create the business operators, development of supporting elements and infrastructure to enhance the competency of competition, and strong foundation to support the competency enhancement of competition under the changing contexts including the liberalization of the service business sector regarding the logistics with transportation by sea, road, rail, and air, [1], [2].

The warehouse investment in Thailand has been continuously extended for the past 4-5 years. There were 721 entrepreneurs who had warehouse registration in 2017 and 2018. There is a better signal of the overall business and more demand for space rental according to economic activities. However, there have been more warehouses than demand in some locations between 2019 and 2021 and the space rental of the warehouses tends to be settled when compared with the year 2018 according to the investment directions of the industrial sector and the demand for logistics services with the collection and distribution of goods. However, the investment in warehouse

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expansion in some places may cause excess supply, excess competitiveness, and substandard rent charges for the warehouse, [3].

Nos.	Problems found	Percentage
1	Insufficient storage areas	20
2	Picking up the wrong sizes of goods by accident	20
3	Storage of the same lot Nos. in different locations	15
4	Difficulty in finding the products/goods	13
5	Wrong number of stored items and items on the system	10
6	Delayed preparation of ready-made goods	10
7	Wrong ways of picking up the goods	5
8	Site planning of inventory storage	3
9	Carelessness of the inventory staff	2
10	Others	2
	100	

Table 1. Some problems found in the warehouses.

Source: Public Warehouse Organization, [4]

Table 1 shows the problems that are found in the warehouse because there are no proper arrangements to store the goods, no systems identifying the locations of goods, and no assigned locations of all types of goods. The only staff in the warehouse know the locations and number of the storage and it may cause a problem if the goods required cannot be found in case the staff taking care of the assigned zone are absent. Too many lavers of goods buried are also another main cause of the damage to goods. Moreover, another problem is the lack of technological system development which delays the operational processing, and the lack of immediate information to make a proper decision for urgent operations which causes some mistakes while operating. Most industries often face the problems mentioned above because some problems are difficult to be solved in the case of the space in the warehouse, investment funds, management system, and employees. If the management system of the warehouse is not effective, it highly affects the export business of Thailand because this will decrease the growth rate of the business. Therefore, the management system of the warehouse must be the most effective implementation.

Moreover, Rayong Province's industrial factories are ranked 12th in Thailand, [5] and the Eastern Economic Corridor (EEC). Therefore, there are a large number of warehouses to meet the demand for deposit and storage of goods, and the proper warehouse management and inventory control system must be the most effective implementation. And the study of guidelines for efficiency the performance competency and reduce the enhancement of the warehouse management under the management principles to constantly improve the operations is an essential way to increase operational costs of the organizations. The researcher, therefore, implemented the POLC theory of Louis A. Allen [6] to be an essential part of the study and to meet the potential enhancement of the organizations in the future. The results of the study would be beneficial for planning, warehouse management, warehouse arrangement of the industrial factories, and guidelines for the improvement and development of warehouse efficiency.

1.1 Research Objectives

- 1) To analyse the confirmatory factors of enhancing the warehouse management in Map Ta Phut Industrial Estate, Rayong Province
- 2) To verify the tests based on the consistency between the confirmatory factor structure of enhancing the warehouse management in Map Ta Phut Industrial Estate, Rayong Province, and the empirical information.

1.2 Hypothesis

The model of confirmatory factors of enhancing the warehouse management in Map Ta Phut Industrial Estate, Rayong Province was in accordance with the empirical information.

2 Literature Review

2.1 Definition of Terms

A warehouse is a facility of the supply chain to assemble goods or products in order to reduce the costs of transportation, save time and expenses of production and purchasing, and it is also a process of added value arrangement and time reduction of response, [7].

The corporations consider the warehouse as a key business operation to provide excellent customer service and enhance the advantages of competitiveness. kinds There are two of warehouses: consolidation warehouses and [8]. distribution warehouses, However, the warehouses regarding their functions in the supply chain can be divided as follows: warehouse of raw material storage, warehouse of processed products, warehouse of ready goods, distribution warehouse, warehouse of filling up goods, local warehouse of direct delivery, and warehouse of added value services, [9].

The inventory and warehouse management, warehouse management plan, and inventory management plan (IMP) are the key strategies to lead businesses to competitiveness and success. Warehouse management is the most important logistics system. Therefore, there must be several factors for warehouse management, and the complexity to meet the management need of high quality must depend upon the high-quality operating system with the technological system, modern devices, and professional workforce. These three factors must work accordingly for accurate operations, [10].

2.2 Theory of Efficiency Enhancement

[11] created the conceptual framework of factors of the organizational operations to enhance production efficiency as shown in Figure 1 below.



Fig. 1: Factors enhancing production efficiency.

Figure 1 shows the factors leading the organizations to efficient outputs. The components are as follows. 1. Factors

a. Human factors including workforce, competency, energy, passion, and expectation.

b. Non-human factors including financial capital, machinery, materials, techniques, approaches, and land.

2. Process

c. Organizing includes structural organization, potential organization of changes, analysis, objective assignment, and strategic planning.

d. Decision including decision-making process, implementation of the information technology for management, supporting system process.

e. Planning and controlling including project planning, computer-aided control system and computer-aided controlling, and cost-benefit analysis for the efficiency enhancement of personnel and assessment management.

3. Product/output including products and services, operational competency of the organizations, production volume competency, and innovation.

[12] defined the word 'efficiency' as the ration of outputs to inputs. The indicators of efficiency measurement are as follows: (1) Rate of return (2) Unit cost (3) Resource consumption rate and (4) Profit ratio of investment expenses.

Efficiency is the implementation of resource utilization and operational process with the productive outputs comparing expenses of investment and profits. If the profits are higher than the costs, it shows some higher operational efficiency. The efficiency may not show in a form of figures but in a form of reasonable and economical expenses of money, materials, and time. This also includes the implementation of strategies or techniques properly to enhance the fast and effective outputs.

The corporations' productivity provides all the stakeholders' benefits directly and indirectly and the development of workforce and performance for quality business growth enhances the economic expansion and world market competitiveness as follows: (1) The consumers can get the high quality of products and services with lower prices, variety of choices, convenience of purchasing, and security, (2) The employees will have a proper return, good benefits, security in their career and life, good experience, skills, safety at the workplace, and suitable environment, (3) The entrepreneurs or organizations can have the high turnover rates because the profits are essential for businesses to enhance production, expand branches, implement high technology, save energy, and increase the quality of products, and (4) The government of the country can earn a lot from the income taxes paid by the organizations with good income or profits, and the nation can support various kinds of projects, population well-being, and other necessities.

2.3 POLC Theory

POLC theory, [6] consists of four components as follows.

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1. Planning is an activity of setting organizational goals, creating the strategies of operations regarding the organizational goals, and implementing the strategies at the practical level. The strategies and planning at each level and in each department must be concordant to fulfill the departmental and organizational objectives.

2. Organizing is an activity of organizing the organizational structure to consider the ways how to help the organizations reach their goals, what to do, how to classify the tasks, who is responsible for each task, how to report to the supervisors, and who has the authorization to make a decision.

3. Leading is the management of showing the ways the employees how work efficiently and effectively with coordination, smooth communication, motivation in the workplace, executives' leadership, and reduction of conflict and stress.

4. Controlling is started when the organizations have clear goals and plans to set the organizational structure, recruit the employee, train the employees, and create motivation in the workplace. Therefore, to make sure that everything works well, the executives must control and pursue the employees' operational outcomes and compare the actual outcomes with the assigned goals or standards. If the outcomes are not in accordance with the assigned goals, the executives must adjust them to fulfill the objectives. Therefore, the process of performance follow-up, comparison, and correction is controlling.

From the definitions mentioned above, it was found that the warehouse is a critical factor in the supply chain. If there is effective management, it can help the entrepreneurs reduce the costs of time and money and enhance the advantages of business competition. The researcher, therefore, implemented the POLC theory as a guideline to improve and develop the quality of products.

3.2 Research Population and Sampling Group

The research population was 290,597 employees in the warehouse of the industrial factories in Rayong province Industrial Estate Authority of Thailand, [13]. The sample size was calculated through the formula of Taro Yamane at a confidence level of 95% and a margin of error of 5%, [14]. The calculation results showed a total sample size of 399.45 respondents. Therefore, the researcher implemented the 400 samples to a proper size and used the simple random sampling method to select the samples based on the sizes of the workplaces with the proportional allocation.

3.3 Instrument

The research instrument was divided into two types: qualitative research instrument and quantitative research instrument. The instrument of qualitative research was a structured in-depth interview with four dimensions, i.e., planning (P), organizing (O), leading (L), and controlling (L) according to the POLC theory of Louis A. Allen, [6]. Nine experts were selected as a sample group of the qualitative research through the purposive sampling method.

The instrument of quantitative research was a questionnaire divided into four parts. Part 1 consisted of five checklist items of the employees' personal data in Map Ta Phut Industrial Estate in Rayong Province. Part 2 consisted of 20 five-level Likert items of the employees' opinions on the warehouse administration and management of the organizations. Part 3 consisted of 12 five-level Likert items of the employees' opinions on the efficiency enhancement of the warehouse management of the organizations. Part 4 consisted of only one open-end item of the employees' opinions and suggestions if any.

3 Research Methodology

3.1 Conceptual Framework

The researcher implemented the POLC theory of Louis A. Allen, [6] to the efficiency enhancement of warehouse management in Map Ta Phut Industrial Estate, Rayong Province as shown in Figure 2 below.



Fig. 2: Conceptual Framework

The drafted questionnaire was evaluated and approved by three experts with experiences related to the field. The index of item-objective congruence (IOC) was calculated to evaluate the quality of the questionnaire and it was found that the index of the item-

objective congruence of the questionnaire was 0.60researcher 1.00. Then, the corrected the questionnaire according to the experts' evaluation. After that, the researcher distributed the questionnaire to 30 samples of a similar population for try-out to evaluate the discrimination of the questionnaire items by calculating the standard deviation (S.D.) of the items with a checklist and five-level Likert scale, and the correlation coefficient of items with the five-level Likert scale, and the reliability of the questionnaire was also evaluated by calculating the Cronbach's alpha of the items with five-level Likert scale, [11] through the SPSS. It was found that the discrimination of the questionnaire items was 0.30-0.70 and the reliability of the questionnaire was 0.99.

3.4 Data Collection

- 1) The researcher asked the executives of the organization for permission and collaboration for data collection of the warehouses in Map Ta Phut Industrial Estate in Rayong Province.
- 2) Then, the researcher distributed the questionnaire to the employees in the warehouses to fill the questionnaire. In case the employees could not meet the researcher during working hours, the researcher left the questionnaire for them to fill out and send it back later by post or other electronic media platforms.
- 3) And then, the researcher checked and corrected the questionnaire and coded the data to save the code on the computer for further data analysis.

3.5 Data Analysis

The researcher analyzed the data of the qualitative research with the in-depth interview through the content analysis and summarized the calculation of the f-frequencies. For the quantitative research, the researcher performed a factor analysis by calculating the correlation coefficient of each variable. Exploratory Factor Analysis (EFA) by Principal Component Method and Varimax Rotation. Generally, in a large sample correlation estimates are regarded as more reliable than in a small sample. Other EFA parameters crucial for the the sample size is the magnitude of the population correlations and number of factors of the estimated solution. The strongest correlations and the fewer the factors the smaller the required sample, [15]. Confirmatory Factor Analysis (CFA) and second order confirmation component analysis. Second-order Confirmatory Factor Analysis (SCFA) is placed in a hierarchy of factor analysis models, which shows how the fit of various models can be compared to examine the coherence of the structure-correlation model of the components developed with the empirical data with the use of statistical and social science software packages.

4 Results and Discussion

The results of analyzing the confirmatory factors affecting the efficiency of warehouse management in Map Ta Phut Industrial Estate in Rayong Province revealed that factors were grouped into four components. When the factor analysis with the principal component method and the oblique rotation with the varimax method were conducted and the weighting scale of each component was considered according to the assigned criteria, it was found that the eigen values of the components of 1.05-15.66 could explain the variance of the components by 3.52-52.20%. On overage, the eigen value of the four components could explain the variance of all the components by 66.20%. Component 1 had the highest percentage of variance of 52.20% and was followed by the rest of the four components as shown in Table 2 below.

cumulative percentage of each component				
Component	Eigen value	Percentage of variance	Cumulative percentage	
Organizing (O)	15.66	52.20	52.20	
Planning (P)	1.72	5.90	58.10	
Controlling (C)	1.37	4.57	62.68	
Leading (L)	1.05	3.52	66.20	

Table 2. Eigenvalues, percentage of variance, and cumulative percentage of each component

Table 2 shows the results of grouping the factors into the four components by adjusting the structures and names of the components. The factors were divided into four components when their eigen values were greater than 1.00. Each of the four components consisted of 6-11 factors and the weighting scale of the selected factors was.50-.72. Therefore, a total of 30 factors were grouped into the four components. After that, the components were properly renamed regarding the selected factors' characteristics based on the POLC theory of Louis A. Allen, [6]. The components ranked from the highest weighting scale to the lowest weighting scale were: 1) organizing (O) (15.66), 2) planning (P) (1.72), 3) controlling (C) (1.37), and 4) leading (L) (1.05), respectively.

The results of analyzing the survey data made the research findings more reliable. The results of analyzing the survey components showed a reduction of the number of factors to only the factors that could directly measure each of the four components. Therefore, a total of 30 factors were grouped into the four components regarding the eigen values according to POLC theory.

The results of testing the goodness-of-fit of the structured component model of the efficiency enhancement of warehouse management in Map Ta Phut Industrial Estate in Rayong Province with the empirical data found that the statistics of analyzing the first order confirmatory factor (before the model improvement) were the CMIN of 1669.42, CMIN/DF of 4.18, a p-value of 0.00, CFI of 0.86, GFI of 0.77, AGFI of 0.73, RMR of 0.03, SRMR of 0.05, and RMSEA of .08. It could be said that the model did not pass the empirical data. Therefore, the researcher improved the model as shown in Table 3 below.

Goodness of fit index	Criteria	Results of the first order confirmatory factor analysis	Results of consideration
CMIN	Not statistically significant	48.65	-
CMIN/DF	<2	1.28	Passed
p-value	>0.05	0.11	Passed
CFI	>0.90	0.99	Passed
GFI	>0.90	0.98	Passed
AGFI	>0.90	0.96	Passed
RMR	< 0.05	0.01	Passed
SRMR	<0.05	0.01	Passed
RMSEA	<0.05	0.02	Passed

 Table 3. Results of the first order confirmatory factor analysis

Notes: * Statistically significant level at .01

Table 3 shows the results of the first order confirmatory factor analysis (after the model improved). It was found that the CMIN was 48.65, the CMIN/DF of 1.28, the p-value of 0.11, the CFI of 0.99, the GFI of 0.98, the AGFI of 0.96, the RMR of 0.01, the SRMR of 0.01, and the RMSEA of 0.02. All the indices passed the criteria. Therefore, the model was in accordance with the empirical data of, [16].

When conserving the standardized weighting scale of the observed factors in the confirmatory factor model of the enhanced efficiency of the warehouse management in Map Ta Phut Industrial Estate in Rayong Province, it found that the standardized weighting scale of all factors was 0.77-0.88 at the statistically significant level of .01.

The standardized weighting scale of ±.5 up is generally accepted, [17]. The standardized weighting scale of component 1 (organizing) was 0.75-0.83. The standardized weighting scale of component 2 (planning) was 0.72-0.88. The standardized weighting scales of component 3 (controlling) were 0.79-0.81. The standardized weighting scale of component 4 (leading) was 0.72-0.79. Therefore, all the 30 factor items could be used to measure the confirmatory factors affecting enhancement of warehouse the efficiency management in Map Ta Phut in Rayong province. The results of the second order confirmatory factor analysis were as shown in Table 4 below.

Table 4 shows the results of the second order confirmatory factor analysis. It was found that the CMIN was 48.84, CMIN/DF of 1.22, a p-value of 0.15, CFI of 0.99, GFI of 0.98, AGFI of 0.96, RMR of 0.01, SRMR of 0.01, and RMSEA of 0.02. All the indices passed the criteria. Therefore, the model was in accordance with the empirical data.

When considering the weighting scale of each component, it was found that the weighting scale of the factors was 0.90-0.98 at the statistically significant level of .01. The weighting scale of component 1 (organizing) was of 0.98 and followed by the component 4 (leading) of 0.97, the component 2 (planning) of 0.93, the component 3 (controlling) of 0.90, respectively. The reliability (R^2) of each component was 0.72-0.88, indicating that the four components could be used to measure the enhancement of efficiency of the warehouse management in Map Ta Phut Industrial Estate in Rayong Province. Therefore, the confirmatory factor model was in accordance with the empirical data as shown in Figure 3 below.

Goodness of fit index	Criteria	Results of the second order confirmatory factor analysis	Results of consideration
CMIN	Not statistically significant	48.84	-
CMIN/DF	<2	1.22	Passed
p-value	>0.05	0.15	Passed
CFI	>0.90	0.99	Passed
GFI	>0.90	0.98	Passed
AGFI	>0.90	0.96	Passed
RMR	< 0.05	0.01	Passed
SRMR	<0.05	0.01	Passed
RMSEA	< 0.05	0.02	Passed

Table 4. Results of the second order confirmatory factor analysis

Notes: * Statistically significant level at .01



Fig. 3: Results of the second order confirmatory factor analysis

The results of factor analysis revealed that the confirmatory factor model of the enhancement of the efficiency of the warehouse management in Map Ta Phut Industrial Estate in Rayong Province was in accordance with the empirical data. The weighting scale of the first order confirmatory factors was 0.72-0.88 at the statistically significant at .01 and the weighting scale of the second order 0.90-0.98 confirmatory factors was at the statistically significant at .01. The component with the highest weighting scale was organizing (O) followed by planning (P), controlling (C), and leading (L), respectively. The indices of the goodness-of-fit between the model with the empirical data were CMIN of 48.84, CMIN/DF of 1.22, a p-value of 0.15, GFI of 0.98, and RMSEA of 0.02, indicating that the confirmatory factor model of the efficiency enhancement of the warehouse management in Map Ta Phut Industrial Estate in Rayong Province had the construct validity and the 30 factors were considered important to enhance the efficiency of the warehouse management in Map Ta Phut Industrial Estate in Rayong Province.

5 Conclusions

(1) The results of data analysis to investigate the factors of the efficiency enhancement of the warehouse management in Map Ta Phut industrial

estate found that 30 factors were analyzed and divided into four components. The factor analysis with the exploratory factor analysis and the factor oblique rotation with the varimax rotation found that the eigen values of the selected factors were higher than 1.00. Each of all components consisted of 6-11 factors and the weighting scale of each factor in the four components was 0.50-0.72. The components adjusted were renamed in association with the meanings of the selected factors according to the POLC theory. The components ranked from the highest weighting scale to the lowest weighting scale were organizing (O), planning (P), controlling (C), and leading (L), respectively.

(2) The results of testing the goodness-of-fit of the model of the efficiency enhancement of the warehouse management in Map Ta Phut Industrial Estate in Rayong Province with the empirical data revealed that the model perfectly fits the empirical data. The weighting scale e of the first order confirmatory factor was 0.72-0.88 at the statistically significant level of 0.01 and the weighting scale of the second order confirmatory factor was 0.90-0.98 at the statistically significant level of 0.01. The indices of the goodness-of-fit of the model with the empirical data were CMIN of 48.84, CMIN/DF of 1.22, a p-value of 0.15, GFI of 0.98, and RMSEA of 0.02 and it could be said that the model had the construct validity and the 30 factors were important to enhance the efficiency of the warehouse

management in Map Ta Phut Industrial Estate in Rayong Province.

6 Contributions of the Study

- (1) The organizational executives can implement the components for enhancing the efficiency of the warehouse management in Map Ta Phut industrial estate as the model of the efficiency enhancement of the warehouse management of the organizations.
- (2) The researchers or other groups who are interested in the related study can apply the research findings and conceptual framework to their future research in the warehouse management of other industrial business sectors.
- (3) The universities can apply the research findings to the warehouse management course.

7 Policy Recommendations

7.1 For Entrepreneurs

- (1) The results showed the factors affecting the efficiency enhancement of warehouse management in Map Ta Phut Industrial Estate in Rayong Province. Therefore, the organizational executives should implement the conceptual framework of this research for further factor analysis to identify the strengths and weaknesses of the development.
- (2) The organizational executives should promote the issues of the components of the efficiency enhancement of the warehouse management in Map Ta Phut Industrial Estate in Rayong Province to enhance the warehouse management efficiency of the business operators as much as possible so that the entrepreneurs can apply the information involved to manage their warehouses. This can increase the employees' competency as well.

7.2 For Government Sector/Private Sector

- (1) The organizations involved in this can implement the results of the study for warehouse management.
- (2) The government agencies and enterprises involved in supervising the warehouses of industrial factories can implement the results of the study as the guidelines for proper warehouse improvement and development.

7.3 For the Education Field

- (1) The institutes with undergraduate, graduate, or postgraduate programs can implement the knowledge of the study for the teaching and learning process in the courses related to warehouse management.
- (2) Those who are interested can implement the results of the study as the guidelines for enhancing their knowledge or effective warehouse management.

8 Recommendations for Further Study

- (1) Other theories of management should be used to study the factors development of efficiency enhancement of warehouse management.
- (2) The factor development of the efficiency enhancement of warehouse management should be studied in the other industrial estate areas in Thailand.

The results of the study "The Confirmatory Factor Analysis of Enhancing the Warehouse Management Efficiency in Map Ta Phut Industrial Estate, Rayong Province" found that

- (1) The warehouse corporations should have proper public relations and constant training in warehouse management to enhance the employees' skills and set the same operational goals.
- (2) After the work performance has been done, the assessment should be conducted to meet the corporation's goals.
- (3) Corporations should provide employees with good fringe benefits to improve employee satisfaction and get employee engagement.
- (4) The corporations should successively discuss the warehouse problem solutions that they may find during operations.
- (5) A study of customers' satisfaction with the warehouse services should be conducted.

9 Limitations

This research only studied the factor of the efficiency enhancement of warehouse management in Map Ta Phut Industrial Estate in Rayong Province.

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