EVALUATION OF A METHODOLOGY FOR IMPROVING THE WAREHOUSING OF ANIMAL FEED

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ABSTRACT

This study aimed to evaluate a project for improving warehousing for animal feed. The concept was the reduction of animal feed pick up time and distance within the warehouse. Storage efficiency was also improved. The project invested in shelves and an electric forklift. It started PDCA on QCC steps. ABC analysis was done to compare the design of the old and new animal feed plan using a fixed positioning system. The shelf was used as a device to help arrangement and control of products based on a first in first out system. Working devices were added: an electric forklift and mobile ladders. The payback period (PB) was not over 1 year, which is in line with the criterion that the payback period would not exceed 3 years. The net present value (NPV) was 167,817THB. The internal rate of return (IRR) was 7%. This was higher than the loan interest rate (K) of 6.25%, which was in line with the criterion that the internal rate of return should be more than the loan interest rate.

KEYWORDS :NPV, IRR, PB, ABC analysis, Flow process chart.

1. Introduction

A warehouse is an important part of a supply chain management system for merchandise. A warehouse serves to store goods and work in progress (WIP) between different points in the shipping process. The problem in the warehouse is quantity imprecision of stock, goods damage, surplus/ out of stock goods, searching for goods in store for a long time, arranging to ship goods for a long time and other things which affect the inventory. The company has to bear the cost of goods. Application of a toolkit to improve the productivity of a warehouse has costs and key factors concerning success. The evaluation methodology is a complex process, with NPV, IRR, PB criteria and industrial engineering.

To allocate investment budget for the application of toolkits is an important decision for the right reasons. Current research has produced many different methods defined as decision measures. Some of these indicators are the 3 payback period method, net present value method and the internal rate of return method [1-4]. They are essential factors in making a decision about the growth and profitability of a company [5, 6]. Ordoobadi [7] applied the Analytic Network Process (ANP) methodology to satisfy these requirements by considering interdependencies among all the factors, and by allowing a transformation of qualitative judgments into quantitative values for decision analysis. The Analytic Hierarchy Process is an aggressive analytical tactic to make decisions using a scale rate based on the comparison of the other party for each element in the hierarchy process, and finding the best selection of criteria for deciding the other from the judgment. This is inferential statistics to study group information. Key characteristics of the study sample are then taken. Similarly Petković, Dalibor et al. [8] analyzed NPV for a wind farm investment project to see whether it increases or decreases for different numbers of turbines installed in the wind farm, using the adaptive neuro-fuzzy approach. Finally any project will have to choose only one NPV method for the project, over others, in an effective way. If you have a project that is independent, the IRR is a very effective method. The basis of the project indicates that the company could make much profit. Kharitonov and Kosterin [9] analyzed relationships between the investment performance criteria and basic engineering and economic parameters of nuclear reactors. Durham, Bouma and Goddik [10] addressed artisan cheese makers who lacked access to valid economic data to help them evaluate business opportunities and make important business decisions, such as determining a cheese pricing structure. The model was also used to determine the minimum retail price necessary to ensure positive NPV for 5 different cheese types produced at 4 different production volumes. Milk type, cheese yield and aging time all affected variable costs. This decision must be considered in conjunction with other decisions.

All the summaries of past research indicate that there are no applied industrial engineering tools to help industrial decision making from empirical reasoning through observation and experiment. Therefore, the objective of this research is to evaluate the project for improving the warehouse for the animal feed.

2. Case study

ABC warehouse is located in Khon Kaen province, central Northeast Thailand. They are a deliverer company for beverage, rice and animal feed in the province and also throughout the Northeast. Warehouses are specific elements that help manufacturers, distributors, and retailers monitor inventory and store it safely. The functions of a warehouse are receiving, storing, picking, packing, shipping, and checking. An overview of basic elements includes: shelving and rack systems, inventory control, forklifts, pallet jacks, bins, conveyor belts and others.

3. Methodology

This research presents the project evaluation guidelines to improve productivity both in terms of economics and industrial engineering. The economic analysis consists of NPV, IRR and Pay back (PB.) ratio analysis when the project finishes. The use of industrial engineering tools provides empirical evaluations which support the reasons for the decision made by the executives with confidence, as shown in Figure 1.

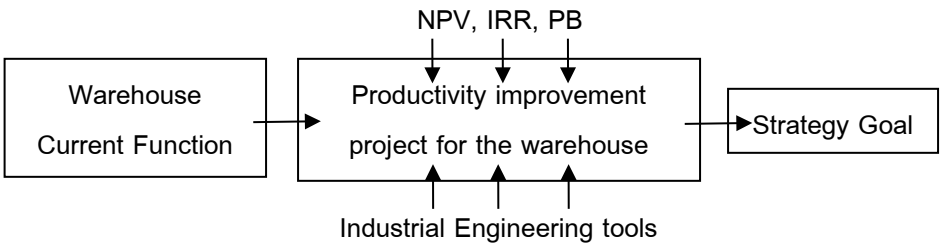

Figure 1 Evaluation methodology concept

The methodology begins with PDCA, implemented on QCC steps, as in Table 1.

Table 1 PDCA implemented on QCC steps

PDCA	QCC steps	Productivity Implementation
P is plan	1. Select improvement opportunity.	The problems were goods piled up, which occurred for 760 units, uncertain placing of 270 units, goods prepared sluggishly for 70 units and others for 50 units.
	2. Analyse current situation.	The current situation picking time must be reduced by more than 10%, the distance of goods flow by more than 20% and the storage efficiency increased by more than 50%,
	3. Identify root causes.	1. Picking taking a long time is caused by having no classification of goods type. 2. The long distance for goods flow is caused by an unsuitable layout. 3. The root cause of inefficient storage was having no shelves to stack goods.
	4. Select and plan solution.	1. Classify goods type by ABC analysis. 2. Reduce long distance for goods flow by changing layout. 3. Increase storage efficiency by installing shelves.
D is do.	5. Implement pilot solutions.	They focus on 2 parts: 1. Industrial engineering tools ABC analysis and re-layout with 3 plans. 2. Considering shelf type from 3 types, buy new forklift and new ladders.
C is check.	6. Monitor results and evaluate solutions.	Item No.1 on D phase evaluated by flow process chart and No. 2 on D phase evaluated by economic analysis consists of NPV, IRR and Pay back (PB) ratio analysis
A is action.	7. Standardize.	Decide about the project.

Three indicators (NPV, IRR, and PB) are recognized [2, 11]. The performance of the security of the sample project is similar to Biezma and Cristobal [12], to determine whether to reject or accept the project production of mechanical or electrical energy and heat. They used the results of a calculation from three formulae to decide about the new project productivity.

$$NPV = -C_0 + \sum_{=t0}^{n} \frac{CF_t}{(1-r)^t} \quad (1)$$

$$IRR = \sum_{=t0}^{n} \frac{CF_t}{(1-k)^t} \quad (2)$$

$$PB = \frac{\text{The cost of initial investment}}{\text{Net benefit on average per year}} \quad (3)$$

Given that CF_t = Account flow, C_0 = Initial investment, t = each period, k = opportunity cost of capital and r = rate. The goals of the organization are based on "strategic goals", that is the primary target of 30%-time reduction in 2017/2018 that will be used in communications across the warehouse.

4. Research results and discussion

The information about the distribution and storage of goods was obtained from the past approach, so the warehouse performance was as accurate as possible. Analysis of volume and type products to identify appropriate storage type and area required within the warehouse is shown in Table 2.

Table 2 ABC analysis of animal feed goods.

Group	No. of goods (Items)	Percentage	Moving
A	127	60	Annual consumption value is the highest.
B	69	30	Medium consumption value
C	29	10	Lowest consumption value
Total	225	100	

Table 2 classifies goods by the ABC analysis method, and next was problem solving to reduce long distances for goods flow by re-layout. The pilot solution involved the re-layout of 3 plans as in Figures 3-5, compared to the original in Figure 2, and then evaluating the result by a flow process chart.

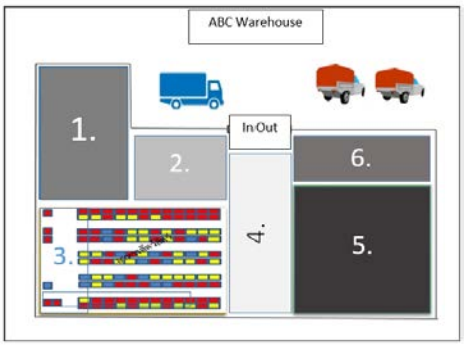

Figure 2 Original layout

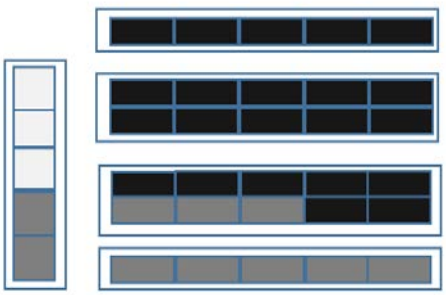

Figure 3 Layout no.1

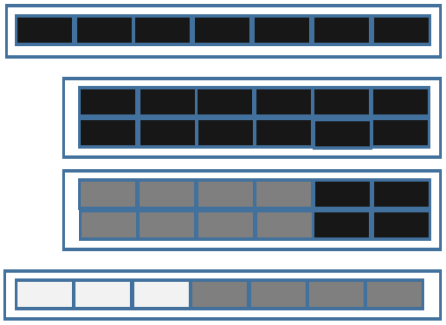

Figure 4 Layout no.2

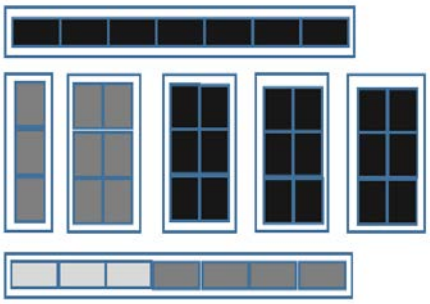

Figure 5 Layout no.3

Figure 2 visualizes the area of the warehouse. No.1 is the office. No.2 is the rice mill area. No.3 is the animal feed area. No.4 is the animal feed preparation area. No.5 is the beverage area. No.6 is the beverage preparation area. Figures 3-5 show only re-arranging the layout within the animal feed area from the result of ABC analysis. Black was group A. Gray was group B. Light gray was group C. The results are shown in Table 3.

There were 5 steps to implement a warehouse procedure for evaluating the distance of goods flow and picking time as follows: 1. Receiving the order from the office, 2. Walking to animal feed goods, 3. Picking goods, 4. Placing and checking goods quantity and 5. Moving the goods to the truck.

Table 3 illustrates the distance of goods flow and picking time for delivery in each layout, when compared to the original layout. Layout no. 1 had a distance of goods flow reduction of 29.36% and picking time reduction of 7.4%. Layout no. 2 had a distance of goods flow reduced by 12% and -21.8% picking time reduction. Layout no. 3 had goods flow reduced

by 18.25% and picking time reduced by -17.5%. Therefore, they need to reduce distance of goods flow and picking time by considering the most appropriate warehouse layout for finding the distance along the axis XY.

Table 3 Distance of goods flow and picking time reduction.

Items	Distance of goods flow (meters)	Reduction (meters)	Picking Time (minutes)	Reduction (minutes)
Original layout	1,066.15	-	82.6	-
Layout no.1	753.15	reduced 313	76.4	6.1
Layout no.2	942.95	reduced 123	100.6	- 18.0
Layout no.3	871.55	reduced 194	97.1	- 14.5

Next, they invested in one of the 3 shelf types and a new ladder. They can now store 210 pallets or 9,030 boxes with layout no. 1. The number of pallets was increased by 64% when compared with the original. The layout no. 2 was a vertical warehouse and could store 228 pallets or 9,804 boxes. The number of pallets was increased by 78% when compared to the original. The layout no. 3 could now store 246 pallets or 10,578 boxes. It could increase the number of pallets by 92% when compared to the original as shown in Table 4.

Table 4 Warehouse utilization.

Item	Pallet quantity	Package quantity
Original layout	128	5,504
Layout no.1	210	9,030
Layout no.2	228	9,804
Layout no.3	246	10,578

Therefore, they must evaluate the economic index NPV as in equation 1, IRR as in equation 2, and PB and equation 3 as shown in Table 5 below. They had a net profit for

plan no. 1 of 986,189 baht, no.2 made 983,292 baht and no.3 made 978,801 baht which is shown in Table 6.

Table 5 Cost of equipment for warehouse.

Description	Price (Baht)	Lifetime	Scrap value (Baht)	Depreciation (Baht)
Plan no.1 (Made to order)	278,636	5 Years	22,291	51,269
Plan no.2 (Used shelf)	297,032	5 Years	23,763	54,654
Plan no.3 (New shelf)	329,576	5 Years	26,366	60,642
Forklift (Electric Reach)	600,000	10 Years	66,000	53,400
Ladder	2,600	5 Years	208	478

Table 5 shows the initial investment on equipment that consists of shelves, forklift and ladder. The shelves are separated into made to order shelves, used shelves, and new shelves. These are plans numbers 1, 2, and 3.

Table 6 NPV and IRR calculation

Description	Initial investment	Net cash flow for 5 years	Inflation in year 2016	NPV	IRR
Shelf type 1	-฿881,236.00	฿986,189.00	1.01%	฿167,817	7%
Shelf type 2	-฿899,632.00	฿983,292.00	1.01%	฿55,018	3%
Shelf type 3	-฿932,176.00	฿978,801.00	1.01%	฿19,308	2%

Payback period (PB) was calculated as follows

Plan no. 1, PB = 881,236 / 986,189 = 0.893 year

Plan no. 2, PB = 899,632 / 983,292 = 0.914 year

Plan no. 3, PB = 932,176 / 978,801 = 0.952 year

Finally, the last phase is the action that decided on layout no. 1. The current situation picking time must be reduced to a picking time of 7.4% which is less than 10%. It did not meet the strategy goal. The distance of goods flow reduced 29% which is more than 20% and increased the storage efficiency by 64%, which is more than 50%. The initial investments were 881,236 baht, 899,632 baht, and 932,176 baht respectively. The projects have NPVs greater than 0 and the percentage of the IRR was greater than the present value so investment will be accepted. Table 6 shows that the project had a calculated payback period for layout no. 1 of 0.893 years or 1 year, which accords with the criterion for the decision that the payback period should be no more than 3 years, and the net present value of the investment project had a positive value equal to 167,817 baht. The internal rate of return on the investment project was 7%, greater than the interest rate for a loan (K) of 6.25%. This research had an IRR less than that in Mattar, Cristina and Ibarra [13] who calculated the IRR for a techno-economic assessment of offshore wind energy in Chile of 10%/year, but according to the criteria for the decision that the payback period should be more than the internal rate of return of the project which was 6.25%. The results of Jia et al. [14] who performed an energy analysis and techno-economic assessment of a co-gasification of woody biomass and animal manure, solid oxide fuel cells and micro gas turbine hybrid system had an IRR of 15.2% and a payback period 7.41 years. Bailera et al. [15] who addressed power in the gas-electrochemical industry hybrid systems had an IRR of 11% and a payback period of 7.3 years, while Laoha and Sukto [16] had a PB of 5 years.

5. Conclusion

The objective of this research was to evaluate a project for improving the warehouse for animal feed. We began with tools from Industrial Engineering, consisting of ABC analysis, warehouse layout and flow process chart. However, the company did not decide immediately, as they needed to consider investment in facilities and equipment. NPV, IRR and PB are the key indicators to make a decision on this project. The result of selecting the best layout is a format for the warehouse which is appropriate for the work, and provides the best economic results. Future research should consider simulation software, such as the Arena simulation to explore a simulation against time. The distance function is one way to compare the data in a more detailed way.

Acknowledgement

The researchers would like to thank ABC distribution Co. Ltd., Khon Kaen, Thailand for the data used in the project.

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