# A decision-making model for optimum furniture production

[1]Naphaphorn Jiaphong, [2]Prapai Sridama, [3]Auemporn Dhienhirun, [4]Poramest Boonsri

[1,2,3,4] Department of Technology Management,

[1,2,3,4] Bansomdejchaopraya Rajabhat University, Bangkok, Thailand.

***Abstract：*** This research aims to study the decision-making components of furniture production operations for the best results and to find the best output function of the decision model for furniture production operations for the best results. The sample in this research consists of 12 executives and production staffs in each department of PDIS Co., Ltd., that to consist of four executives and eight production specialists. For the sample selection method, use a specific method. The results of research findings were as follows: 1) the decision-making components of PDIS Co., Ltd.'s production of best-performing furniture products has limited resources such as labor, machinery, raw materials, packaging materials. production quantity and production costs Which the decision to produce furniture is aimed at achieving maximum profit under limited resources, 2) the best outcome function of the decision-making model for operating furniture production for the best results, used the quantitative techniques in the form of linear programming that using simplex method. This method was a recalculated calculation method, which could give the optimization results and for solving problems with more than 2 production variables.

***IndexTerms* – The decision-making model for production, furniture business, optimization.**

## I. INTRODUCTION

Furniture industry situation in 2017 in the mid-upper market segment expected grow by 3-5 percent. In the second half of the year, hotels and resorts have renovated rooms to accommodate the tourist season. This situation has led to an increase in sales of ready-made furniture in the country. The furniture industry generates income for the country with an export value of approximately 37,000 million baht that growing from the previous year 3.14% or about 40,000 million baht. There is a growing trend, especially in ASEAN and in CLM countries. This growth is due to faster purchasing power and consumer purchasing decisions. In addition, it was found that the buying behaviors of consumers changed, with the new generation choosing to buy in pieces instead of buying completely. Therefore, it is necessary to have a production plan in order to receive the highest return.

The planning is divided into 3 phases, namely the long-term plan, medium-term plan and short-term plan. For manufacturing organizations, the long-term plan involves the selection of products or services, the size and location of the factory, the selection of machinery, the layout of the plant, the research and development, the new product plan, the investment plan, the capacity expansion plan. etc. Long-term forecasts help with strategic planning and capacity issues, which are responsible for top management. Executives will set policies in area such as capacity expansion, machine procurement, product research and development, and long-term investment. Medium-term planning begins after long-term capacity decisions are made. The operation managers will use medium-term forecasting to make tactical decisions in specifying the schedule, including monthly and three-month plans that must be consistent with the strategic plan. In addition, the manager must work under the resources allocated. The result of medium-term planning creates limitations for the short-term plan. Therefore, short-term planning is a decision to find alternatives to get the best results under the limitations of long-term and medium-term planning.

Short and medium-term planning can be combined into a combined production plan which involves decision making that these plans can produce products and services in the amount that is close to the needs of the customers. Therefore, the operations manager must try to make the best decision. Forecasting of products and services related to production such as improving the production rate, creating a total production plan, the labor quantity, inventory, and customer demand forecasting are required. Creating a combined production plan requires customer forecasting data. There are three forecasting techniques, which are short-term forecasting, medium-term forecasting, and long term forecasting [1-2].

Linear programming is to bring limitations, conditions, existing resources, and the desired goal to be written in the form of an equation or inequality. Then, we bring the model to solve the problem using mathematical methods to get the answer that is in line with the desired goal and the constraint conditions. Linear programming consists of 2 parts as follows: 1) objective equation and 2) constraints equation. However, the target equation is a measure or judge that between all the answers of the equation shows the scope which equation is the best answer. In addition, we try to find the target value by using existing techniques [3].

PDIS company limited operates a business of manufacturing furniture in the small and medium industrial group. The company is located in Chonburi province. The company was established in 1995. Originally, the company only produced original equipment manufacturer (OEM) for export. Later, in the year 1997, the economic crisis in the country has a great impact on exports and exports have decreased significantly. Therefore, there must be adjustment by finding a domestic market instead and develop products to have a different image and appearance from the general market. The company focuses on different designs with quality designs. Aside from being able to put into practice can also be used to decorate for beauty as well.

Production planning is therefore important for the furniture manufacturing industry. If able to plan a good production then their will help to produce and deliver furniture on time with low cost and high returns. Allowing the company to compete with other furniture manufacturing industries and creating opportunities for business. Nowadays, the company uses a holistic production planning which is based on the experience of the sole business owner which is diversified in Thailand. In addition, production planning stall are planning using personal principles. If the owner of the business is unable to manage, it may cause this business to have severs problems in the future. There is also a lot of time in the production plan each month to arrange the production plan in accordance with the needs of customers. In the past, holistic production planning was still a high cost. For this reason, there is little profit and the rate of change for high-level employees. This research is a type of R&D research in order to produce furniture to be able to produce on time and deliver products to customers on time. This research has developed a decision making model for furniture manufacturing operations for the best results and can reduce time.

## II. SCOPE OF RESEARCH

### 2.1 Content Scope

This research uses quantitative techniques to linear programming using simplex method. This technique makes the decision making of furniture manufacturing operations for the best results of PDIS company limited. This company is a furniture manufacturer in the small and medium industry group. Its business is to produce rubber wood furniture according to the company's design.

### 2.2 Demographic boundary

The population is the executives and employees of PDIS company limited, a total of 64 people, consisting of 4 executives and 60 employees working in the production department in 8 departments. Sample group used in this research is the executives and staff of production experts in the production department in each department of PDIS company limited, consisting of 12 people, consisting of 4 executives and 8 staff of production experts. The research uses the purposive sampling for selecting samples.

### 2.3 Variable Scope

The purpose function is the maximum profit [4]. The function purpose consists of the profit of each type of furniture. Conditions or limitations are time, labor, machinery, raw materials, packaging materials, production orders, production costs, and the amount of resources available for each type.

### 2.4 Conceptual framework of research

This research has the main idea to create research tools, both qualitative research and quantitative research [5-7], in order to obtain information on the components of the decision support model for the best results [8]. It is applied to the concept of decision making, which uses the method of studying the data and interviewing the production experts in order to get the right information and meet the needs. Then all the data are analyzed in the form of mathematical equations or mathematical models.
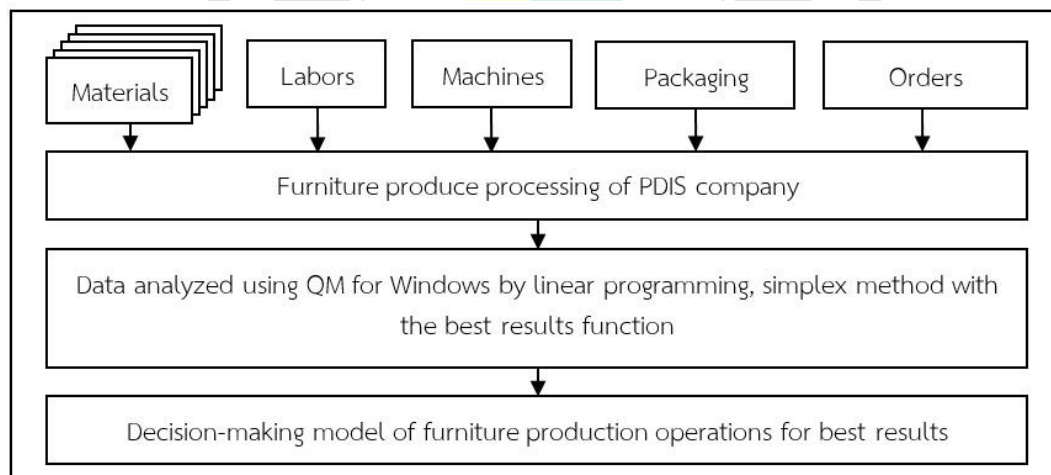


Fig 1: Research Framework

From figure 1 presents the research framework. Many input data are processed in this research that are materials, labors, machines, packaging and orders. In addition, the output in this research is made from data analyzed using QM for Windows by linear programming, simplex method with the best results function.

## III. RESEARCHED METHODOLOGY

### 3.1 Research Tools

The instrument used in this research was an interview with the production experts at the production department of PDIS company during September 2018.

**3.2 Research procedures**

There are many procedures in this research that these procedures are follows: 1) to study the concepts, theories about the decision making styles of furniture manufacturing operations for the best results from relevant work documents, 2) to collect data from the production department in all the preliminary furniture manufacturing process steps for use in the analysis of basic elements, 3) to analyze questions to create interview forms, 4) to create in-depth interviews for production experts, 5) to interview with 12 production experts in the production department of PDIS company, 6) to analyze to find components, decision styles, furniture manufacturing operations for the best results, and 7) to create mathematical models. However, in order to see the structure of each segment, the researchers summarize the details of the working process of the decision-making model of the production of furniture for the best results as in figure 2.
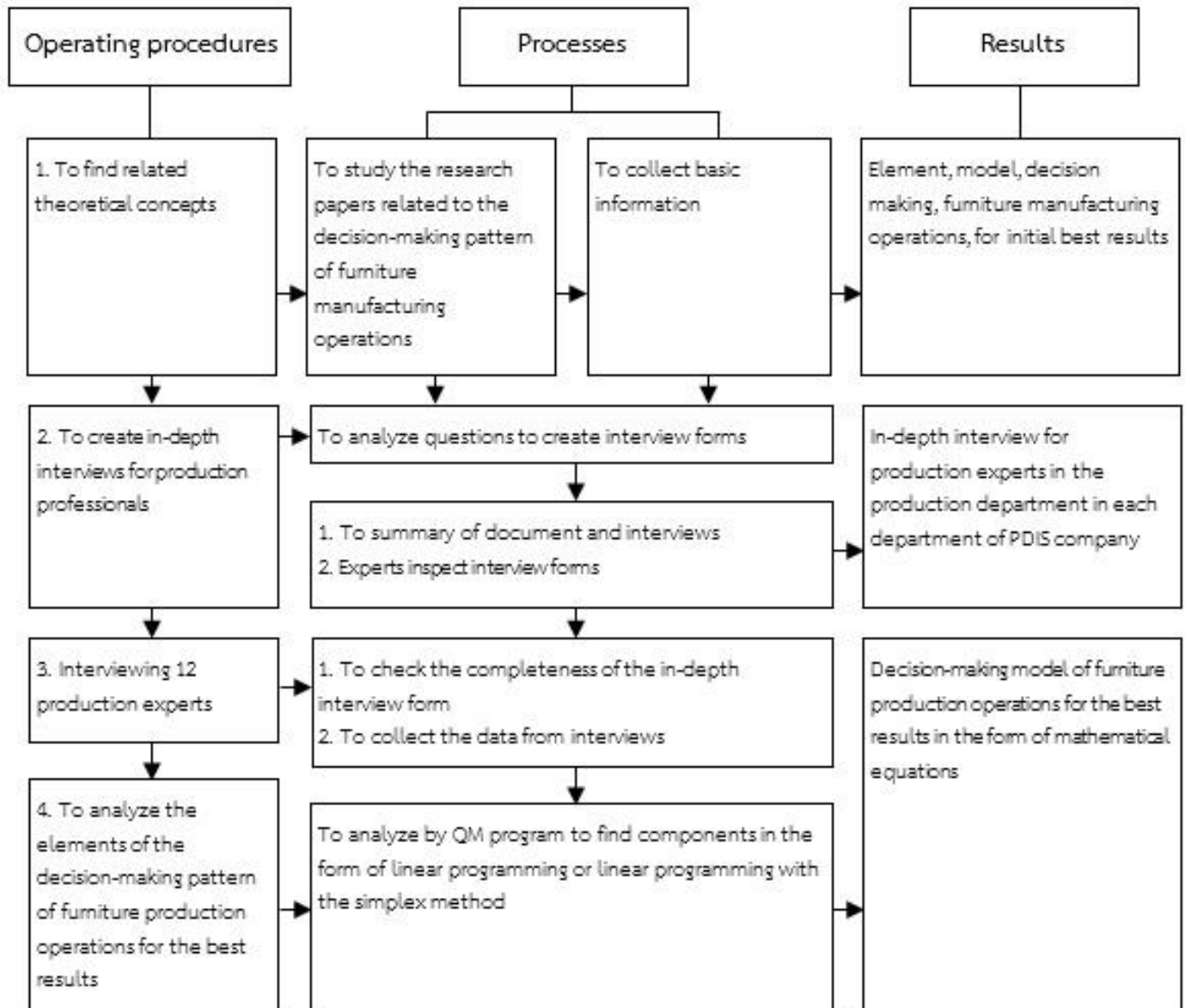


Fig. 2: Research Mapping

**IV. EXPERIMENTAL RESULTS**

The results of the study of the components of the decision-making model of furniture manufacturing operations for the best results of PDIS company. In-depth interviews show that the operational elements of rubber wood furniture production include labor, rubber wood machinery, glue, bolts, hinges, glass, primer paint, thinner, topcoat and packaging materials, production quantity, and production costs. Finding the best result function by using mathematical models with the best results function (optimization function) using the program QM for Window, which consists of labor, machinery, wood, rubber, glue, bolts, hinges, glass, primer, thinner, topcoat, packaging materials, production quantity, and the total production cost of 28 items. For the mathematical equation model are shown in equation 1-2.

Objective function:

$$\text{Maximize } Z = C_1X_1 + C_2X_2 + C_3X_3 + \ldots + C_nX_n \qquad (1)$$

The model constraints

$$
\begin{aligned}
a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + \ldots + a_{1n}X_n \quad &\leq, =, \geq \quad b_1 \\
a_{21}X_1 + a_{22}X_2 + a_{23}X_3 + \ldots + a_{2n}X_n \quad &\leq, =, \geq \quad b_2 \\
a_{31}X_1 + a_{32}X_2 + a_{33}X_3 \; \ldots + a_{3n}X_n \quad &\leq, =, \geq \quad b_3 \\
\vdots \qquad \vdots \qquad \vdots \qquad \vdots \qquad\qquad \vdots \qquad\qquad & \\
a_{m1}X_1 + a_{m2}X_2 + a_{m3}X_m + \ldots + a_{mn}X_n \quad &\leq, =, \geq \quad b_m \\
X_1, X_2, X_3, \ldots, X_n \qquad\qquad\qquad &\geq \qquad 0
\end{aligned} \tag{2}
$$

Set   Z          is the sum of the objective function.

       $X_j$          is the variable that needs to be decided on the j in objective function.

       $C_j$          is the coefficient of the variable j in the objective function, which may unit earnings or cost per unit.

       j          is 1, 2, 3, …, n

       $a_{ij}$          is resource utilization rate of variable j in condition or limitation i

       $b_i$          is amount of available resources for the condition or limitation i

       i          is 1, 2, 3, …, m

From the components involved in the production of furniture of PDIS company can be written in the form of a mathematical equation as follows:

Objective function:

$$\text{Max } Z = 3200X_1 + 2800X_2 + 2800X_3 + 3000X_4 + 2900X \tag{3}$$

Subject to:

$$880X_1 + 1060X_2 + 1060X_3 + 1030X_4 + 1060X_5 \leq 172800 \tag{4}$$
$$30X_1 + 30X_2 + 30X_3 + 30X_4 + 30X_5 \leq 11520 \tag{5}$$
$$90X_1 + 180X_2 + 180X_3 + 180X_4 + 180X_5 \leq 17280 \tag{6}$$
$$40X_1 + X40_2 + 40X_3 + 40X_4 + 40X_5 \leq 23040 \tag{7}$$
$$60X_1 + 120X_2 + 120X_3 + 120X_4 + 120X_5 \leq 8640 \tag{8}$$
$$180X_1 + 240X_2 + 120X_3 + 210X_4 + 240X_5 \leq 34560 \tag{9}$$
$$120X_1 + 120X_2 + 120X_3 + 120X_4 + 120X_5 \leq 11520 \tag{10}$$
$$3X_1 + 2X_2 + 2X_3 + 5X_4 + 2X_5 \leq 500 \tag{11}$$
$$3X_1 + 2X_2 + 2X_3 + 2X_4 + 3X_5 \leq 500 \tag{12}$$
$$16X_1 \leq 2000 \tag{13}$$
$$132X_1 + 30X_2 + 30X_3 + 64X_4 + 40X_5 \leq 5000 \tag{14}$$
$$3X_2 + 3X_3 + 6X_4 + 3X_5 \leq 300 \tag{15}$$
$$8X_4 + 15X_5 \leq 500 \tag{16}$$
$$30X_5 \leq 500 \tag{17}$$
$$5X_1 + 3X_2 + 3X_3 + 2X_4 + X_5 \leq 200 \tag{18}$$
$$15X_1 + 9X_2 + 9X_3 + 6X_4 + 3X_5 \leq 800 \tag{19}$$
$$2X_1 \; 3X_3 \leq 60 \tag{20}$$
$$X_1 + 2X_4 \leq 60 \tag{21}$$
$$X_1 \leq 60 \tag{22}$$
$$X_1 \leq 60 \tag{23}$$
$$3X_2 + X_5 \leq 60 \tag{24}$$
$$X_1 + 2X_2 + 2X_3 + 2X_4 + 2X_5 \leq 150 \tag{25}$$
$$X_1 \geq 4 \tag{26}$$
$$X_2 \geq 5 \tag{27}$$
$$X_3 \geq 5 \tag{28}$$
$$X_4 \geq 6 \tag{29}$$
$$X_5 \geq 6 \tag{30}$$
$$12800X_1 + 11200X_2 + 11200X_3 + 12000X_4 + 11600X_5 \leq 600000 \tag{31}$$

By equation 4 is labor time (minutes) in the production of furniture. Equation 5-10 are machine time (minutes) in the manufacture of furniture. Equation 11 is the amount of rubber wood (sheet) in the manufacture of furniture. Equation 12 is the amount of glue (kg.) in the manufacture of furniture. Equation 13-14 are number of screws (body) in the production of furniture. Equation 15 is number of hinges (sets) in the production of furniture. Equation 16-17 are number of glass (sheet) in the manufacture of furniture. Equation 18 is number of primers (kg.) in the manufacture of furniture. Equation 19 is number of thinner (kg.) in the production of furniture. Equation 20-24 are number of topcoats (kg.) in furniture production. Equation 25 is number of packaging materials (sets) in the production of furniture. Equation 26-30 are number of furniture (cabinets) in the production of furniture and equation 31 is the amount of production cost (baht) in the production of furniture.

## V. CONCLUSIONS

The results of the study of the decision-making component of furniture manufacturing operations for the best results of PDIS company from in-depth interviews show that the decision-making component of furniture production for the best results is the 5 types of samples (BB cabinet, PR cabinet, PW cabinet, PB cabinet, TP cabinet), namely labor, machinery, raw materials (wood, rubber, glue, bolts, hinges, glass primer thinner topcoat) packaging materials production quantity and production costs, amount 28 items. The decision to make furniture manufacturing is aimed at achieving maximum profit with limited resources that is suitable for creating as a mathematical model. This research uses mathematical models that use linear programming techniques using simplex method, which are the best result function. Moreover, the created equations can be used for other types of furniture items to adapt to this mathematical model. However, the equation created depends on the number of types of furniture and the number of conditions or restrictions.

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