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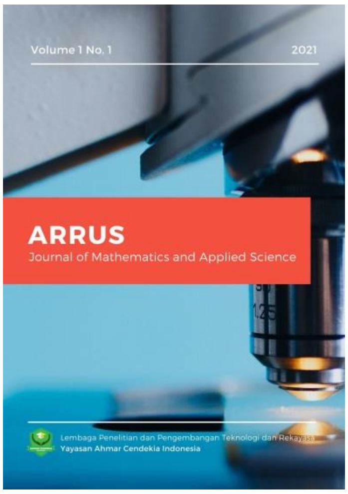

RESEARCH ARTICLE

Production Scheduling Mathematical Model in Garment Industry

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Abstract: In this paper, the author introduces about building the support system of production schedule, based on the linear programming model, exploiting effectively Branch and Bound (BnB) algorithms in Lingo software. In addition, the result of the study is the software that supports production schedule based on the C# programming language, friendly interface makes the operator easy to use. After the implementation and final test, the research model is applied to the case of the garment company to support the production schedule, reduces the number of orders delayed, shorten the production time to increase profits for the company.

Keywords: production schedule, planning production, system engineering.

1. INTRODUCTION

In recent years, the garment industry has ceaselessly developed and has played an important role in the country's industry. However, the biggest constraint of the garment industry is that most of the export orders are processed in the form of outsourcing so that the added value of the products is low.

In the garment industry, efficient use of limited resources to meet the needs of customers always fluctuate by month, season and especially shorting the delivery time is not easy. Therefore, outsourcing products have many codes, various types of outsourcing and systematic replenishment of new orders cause difficulties in the process of production scheduling regulation leading to late delivery, increase production costs, affect the prestige of the company. Therefore, production scheduling regulation is becoming more and more important in production management in the companies and enterprises. However, to build a model schedule of effect it is not easy because the process of understanding and building mode is relatively complex and requires a proper approach, tailored to each company.

2. Literature Review

A flowshop scheduling problem has been one of classical problems in production scheduling since Johnson (1954) proposed the well-known Johnson's rule in the two-stage flowshop makespan scheduling problem. Yoshida and Hitomi (1979) further considered the problem with setup times. Yang and Chern (2000) extended the problem to a two-machine flowshop group scheduling problem. Maggu and Dass (1981) introduced the concept of equivalent job for a job-block when the situations of giving priority of one job over another arise. Kim, et al (1997) considered a batch scheduling problem for a two-stage flowshop with identical parallel machines at each stage. Brah and Loo (1999) studied a flow shop scheduling problem with multiple processors. Futatsuishi, et al. (2002) further studied a multi-stage flowshop scheduling problem with alternative operation assignments.

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Lomnicki (1965) introduced the concept of flow shop scheduling with the help of branch and bound method. Further the work was developed by Ignall and Schrage (1965), and Brown (1966) in the branch and bound technique to the machine scheduling problem by introducing different parameters.

3. Methodology

The process of constructing the production support system is described on figure 1.

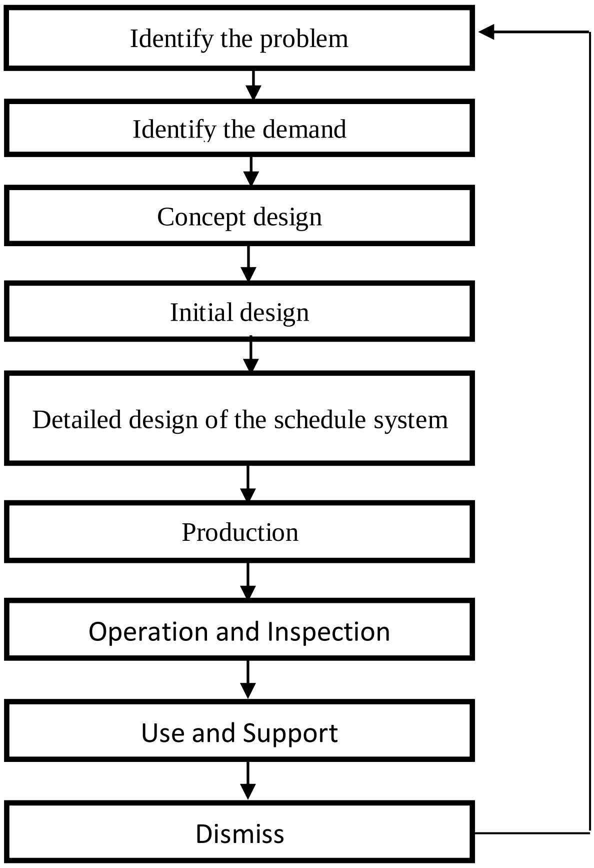

Figure 1: Methodology diagram

4. Introduction to Research Objectives

To concentrate on researching the process of production schedule at the garment workshop for the company specialized in wearing apparels such as shirts, sport pants, protective gear.

The object of study is a garment factory, specializing in processing trousers and shirts for export. The company has 15 sewing lines. Currently, the company manages the production based on the experience of planning department staff in principle “Order form comes first done first and adjust handmade if it is late”. This leads to 87% order have to be adjusted, due to regularly production planning and goods delayed the result of which reduced production efficiency and business impact on the prestige of the company. The problem is to set up a production support system.

5. Linear Model

The linear programming problem is an optimization problem with the objective function and the constraints are linear expressions with variables.

- Symbols used in the mathematical model:

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X_{ij} - the output of the code j processed on the i line
P_{ij} - Productivity of the i line when producing code j
L - Production line
N - Number of product codes

- Objective function

  A mathematical model was developed to calculate and allocate the number of codes in the production lines to minimize the total production time, as shown in the formula:

$$\text{Min}\left(\sum_{i=1}^{L}\sum_{j=1}^{N}\frac{X_{ij}}{P_{ij}}\right) \quad (1)$$

- Subject to:

  The total output of a given product code for production lines is equal to the total ordered output, as shown in the formula:

$$\sum_{i=1}^{L} X_{ij} = G_j \quad (2)$$

  - G_j is the total ordered output of the rowing code j. j = (1... N)

- The daily workload turnover is greater than the corresponding quota revenue over the corresponding period of time, expressed in the formula:

$$\sum_{i=1}^{L} RT_{ij}D_i \leq \sum_{j=1}^{N} X_{ij}K_j \quad (3)$$

  - K_j is the unit price of item number j
  - D_i is the normalized turnover of i, i = (1, 2, ..., L);
  - RT_{ij}: Number of days of actual production of code j on line i;
  - X_{ij} is the output of the code j processed on the i line;

- The total time from the passing of each line plus the cumulative production time of each item code shall be less than the corresponding finish time of the corresponding item code, expressed in the formula:

$$\sum_{i=1}^{L}\frac{x_j}{p_j} \leq d_j \quad (4)$$

  - d_j: time garment of item code j must finish;

Constraint of the required processing time of each pass

  - The total production time of each batch is equal to the total processing time of the quantity of goods items allocated less than the prescribed maximum time (40 days/batch).
  - The total production time of each batch is equal to the total processing time. The number of goods items allocated is greater than the minimum prescribed time (24 days/batch).

- The number assigned to the passes must be an integer and greater than or equal to zero expressed in the formula:

$$x_{ij} \geq 0; x \in Z \quad (5)$$

6. System Design

This section describes the features of the system that support the production schedule for the company. Research focuses on gathering data based on system goals. Data types are used based on the functions of each department that support the production moderation. In this paper, the main functions of the system are presented in the following diagram of figure 2 and table 1.

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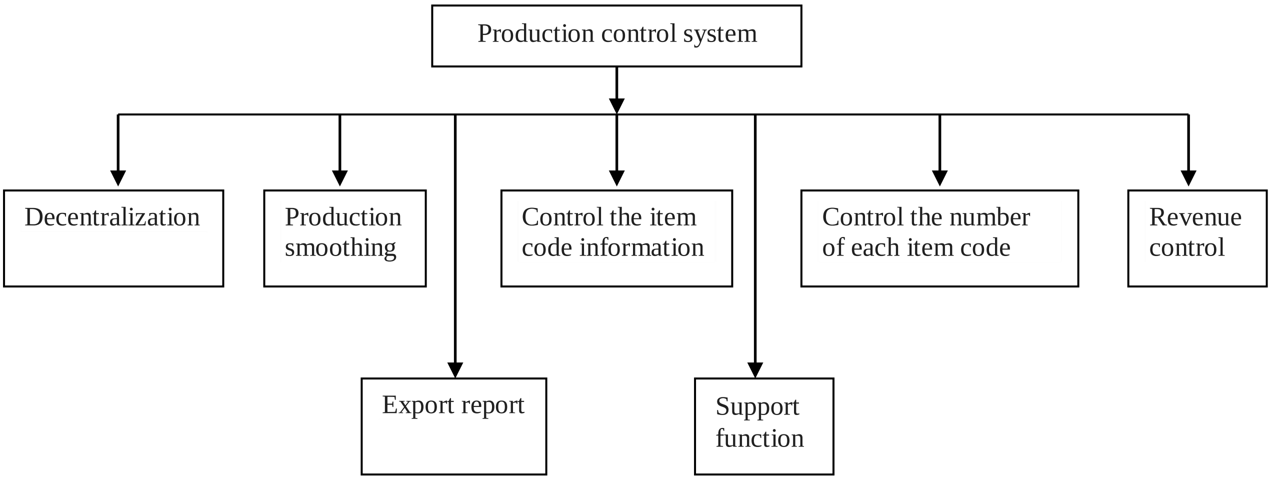

Figure 2: Tree function of the system

Table 1: Significance of system functions

Numerical order	Function	Meaning
1	Decentralization	✓ Check account information; ✓ Limit the access to the Stake-holder's moderation system
2	Regulating production	✓ Regulate the goods codes; ✓ Allocate the number of goods codes into the lines; ✓ Track the implementation progress of the goods;
3	Controlling of item code information	✓ Number of item codes; ✓ Order / Delivery Date, ...
4	Controlling the number of products	✓ Control the number of outsourced / outsourced goods and preparation for processing; ✓ Expected delivery time; ✓ Serial number of the delivery delay.
5	Controlling revenue	✓ Control the processing cost of each product; ✓ Control revenue per pass.
6	Checking out report	✓ Report from functional departments; ✓ Report production schedule;
7	Support functions	✓ Support printing; ✓ Support to rename account; ✓ Support to change login password; ✓ Warning codes are close to the delivery date.

The overall features of the proposed system include three main categories: modularity, utility and user with 10 main functions: scheduling, line balancing, moderation, reminder delivery, current production status, configuration, business, information and account.

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This system is built and the access is limited based on the management of accounts. Based on the user's account upon when logging in, the system will display separate groups of tools for the user's login account (Figure 3).

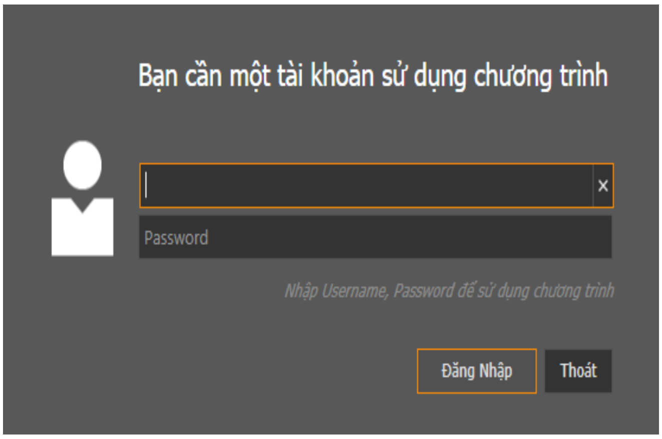

Figure 3: Logon is required to interact to the system

After the user fill in the account information and click on login, the system will be based on the account information and the access that led to the windows (Figure 4).

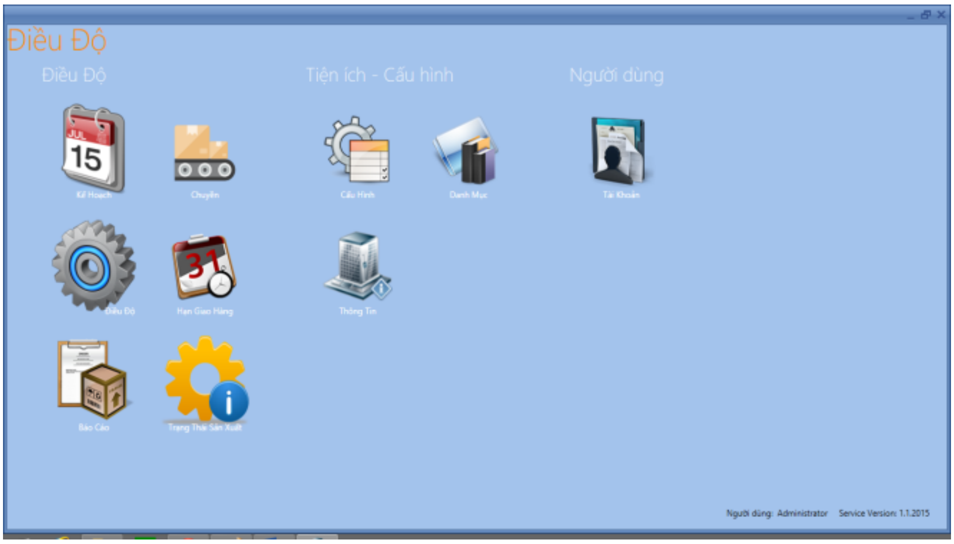

Figure 4: The interface of the system user

7. Building application software

After designing the system interface, we built a production support system through the C # programming language integrated with Lingo software - an application software that helps find the optimal solution through Use Branch and Bound algorithms to find the optimal solution. Friendly, easy-to-use interface exploits BnB algorithms in Lingo.

System after construction form the main interfaces (Figure 5). Result of the optimal solution as shown in Figure 6 and Figure 7:

- Build models to support effective production regulation to minimize production time;
- Set up a system to support the production schedule, especially application software, friendly user interface;
- Allocate orders to the right streams, thereby improving the efficiency of the garment factory.

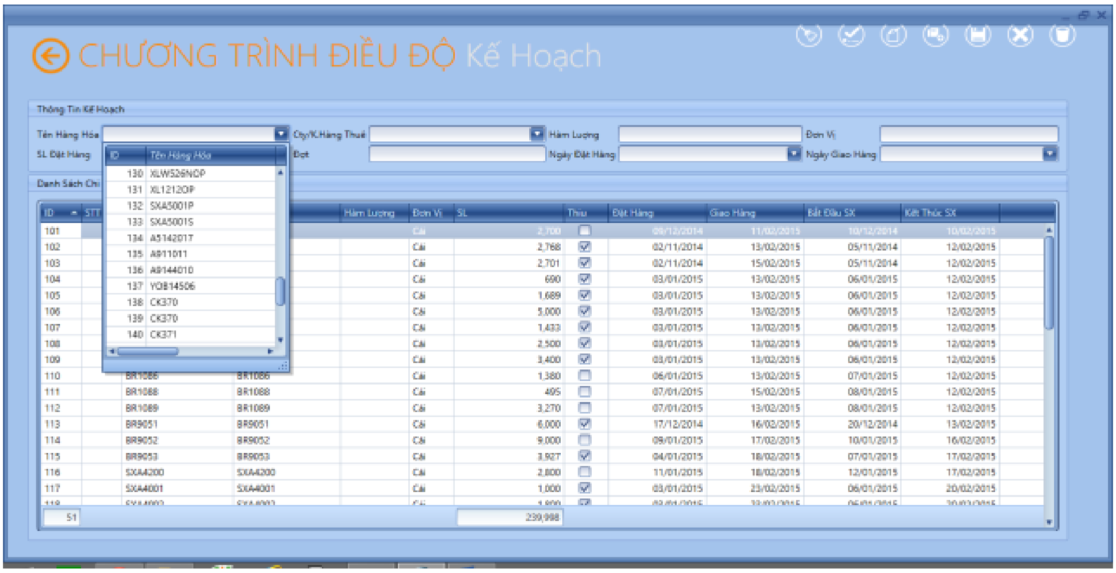

Figure 5: Commodity code interface

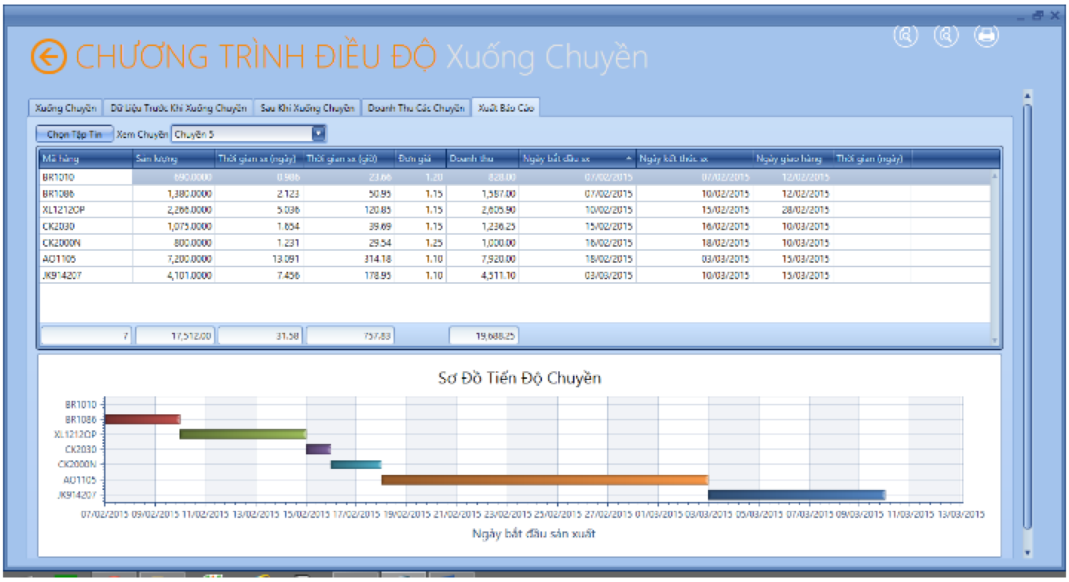

Figure 6: The interface of the optimal line schedule

8. Conclusion

The study have studied about the model into designing a suitable model for the production scheduling model in the garment industry. However, the study has not considered the human factors, machine downtime, and lack of raw materials that could heavily affect the model. There are also additional random factors that affects the constructed modus operandi. Finally, there are also some inventory factors that affect the production process. In conclusion, a system to support production in professional programming languages in information technology should be developed.

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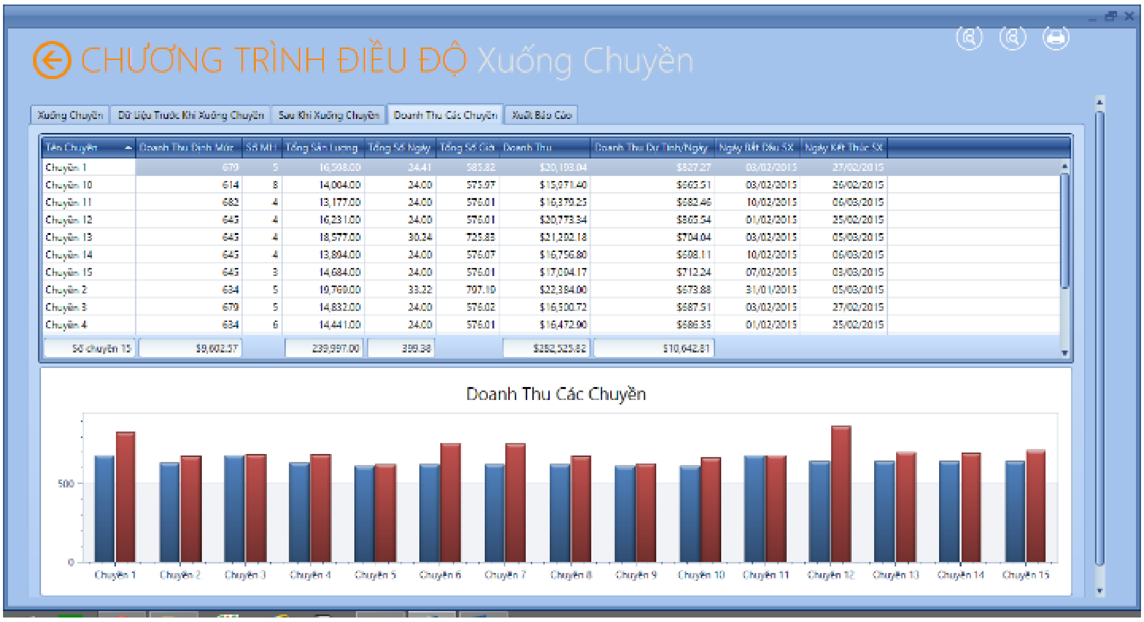

Figure 7: Income value of all line

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