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Optimization of Packaging Carton Production at PT X with the Hungarian Method and Multi Attribute Utility Theory

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ABSTRACT
Household shopping activities in Indonesia have increased by 51% percent since the pandemic period (BPS, 2022). The increase affects household ingredients in packaging. PT X produces various types of packaging for household needs with various size specifications through the make to order system has experienced an overload of production quantity resulting in a delay of 36.19%. PT X needs to conduct problem analysis and production planning to improve ontime delivery. Problem analysis is carried out by direct observation methods and management interviews. Production planning is carried out by dividing and prioritizing tasks using the Hungarian optimization method and Multi Attribute Utility Theory.
Keyword: Production, Optimization, Hungarian, Multi Attribute Utility Theory

ABSTRAK
Aktivitas belanja rumah tangga di Indonesia mengalami peningkatan sejumlah 51% persen sejak masa pandemi (BPS, 2022). Peningkatan tersebut mempengaruhi bahan kebutuhan rumah tangga dalam kemasan. PT X memproduksi berbagai jenis kemasan untuk kebutuhan rumah tangga dengan beragam spesifikasi ukuran melalui sistem *make to order* telah mengalami *overload* kuantitas produksi hingga mengakibatkan keterlambatan sebesar 36,19%. PT X perlu melakukan analisis permasalahan dan melakukan perencanaan produksi untuk meningkatkan *delivery ontime.* Analisis permasalahan dilakukan dengan metode pengamatan langsung dan *interview* pihak manajemen. Perencanaan produksi dilakukan dengan melakukan pembagian dan prioritas tugas menggunakan metode optimasi *Hungarian* dan *Multi Attribute Utility Theory*
Keyword: Produksi, Optimasi, *Hungarian, Multi Attribute Utility Theory*

1. Introduction

During the COVID-19 pandemic, household shopping activities in Indonesia increased by 51% percent (BPS, 2022). This has an effect on increasing the production of household necessities in packaging. PT X, which has been operating since 1972, produces various types of packaging for household needs with various size specifications through a make to order system. The ordering method was chosen due to the limitations of the company's technological development. Since June 2022, PT X is known to have experienced an overload in production quantity, resulting in a delay of 36.19%. Production delays result in losses both to the company and to third parties, namely distributors, up to 20%. To be able to fulfill customer orders on time, PT X needs to conduct problem analysis and conduct production planning to improve delivery on time. Problem analysis is carried out by direct observation methods and management interviews.

The results of observation methods and management interviews show that production delays most often occur at flexo machine stations. There are 9 types of machines at the flexo station. The Flexo machine consists of 6 automatic Flexo machines that can work on this type of product to the end without going through the finishing process and 3 manual Flexo machines that only reach slotters or cutting. Furthermore, production planning is carried out by dividing and prioritizing assignments using optimization methods. The optimization method used for the distribution of tasks is the Hungarian method on both types of products on the Flexo machine, namely FFG and FLS. The Hungarian method is very relevant because it aims to maximize or minimize a group of tasks to a group of objects that can do the task. After the assignment is carried out using the Hungarian method, the company needs to make decisions on the selection of tasks to be done first on the Flex machine using the Multi-Attribute Utility Theory Method. The MAUT method considers production speed, production

amount, lead time, complexity of product manufacturing, and permanent or not customers in the preparation of assignment priorities (Alinezhad and Khalili, 2019).

2. Methods

Data collection was carried out by direct observation and production supervisor interviews (Kurniawan and Amanda, 2017). The assignment of each task so that it is maximum when done on a Flexo machine uses the Hungarian method for two types of products, namely:

1. FFG is a product that is produced in the final production in the Flexo machine.
2. FLS is a product that will be worked again in the finishing section.

FFG task assignment uses the Hungarian method to divide each task. The assignment obstacle is to maximize engine speed with minimum tasks (Basuki, 2019). So the assignment of the Hungarian method is to maximize the matrix. Furthermore, the selection of alternative products that are best in production in Flexo II and III is carried out using three attributes, namely lead time, engine speed and production amount through The Multi-Attribute Utility Theory method.

3. Results and Discussion

The results of collecting data on the initial condition of the recapitulation of the FLS Task assignment to be done on the Flexo machine in the form of the nearest lead time data, paper type and quantity are as follows:

Table 1. FLS Flexo Machine Task Assignment Recapitulation Data

No	Task Name	Paper Type	Lead Time (Hari)	Total (sheet)
1	FLS001	*single wall*	8	9.270
2	FLS002	*double wall*	3	1.134
3	FLS003	*single wall*	6	6.100
4	FLS004	*Single wall*	7	8.891
5	FLS005	*double wall*	6	5.729
Total			**30**	**31.124**

The task constraint is to maximize the speed of the machine with the task at hand. So, the purpose of the assignment of the Hungarian method is to maximize the matrix. The recapitulation of flexo machine assignment using the Hungarian method is as follows:

Table 2. Recapitulation of Flexo Machine Assignment Results using the Hungarian method

Machine	Task	Lead Time (Day)	Total (sheet)	Speed (Sheet/min)	Total Time (min)
Flexo6	FLS002	3	1.134	120	9,45
Flexo8	FLS005	6	5.729	121	47,35
Flexo9	FLS003	6	6.100	187	32,62
Flexo2	FLS004	7	8.891	309	28,77
Flexo3	FLS001	8	9.270	297	31,21
Total		**30**	**31.124**	**1.034**	**149,40**

Furthermore, the prioritization of products to be produced by flexo machines using The Multi-Attribute Utility Theory method is carried out through production supervisor interviews by considering the priority level of criteria as follows:

Table 3. Criteria Weighting

Criteria	Importance	Weight	Final Weight
Lead time	sangat penting	5	0,416
Jumlah produksi	Cukup penting	3	0,25
Kecepatan produksi	penting	4	0,333

The final utility scores of the alternatives are arranged in descending order for the final ranking, and the best alternative is the highest final utility score.

Table 4. Task Alternative Ranking

Task	Lead Time (day)	Rank
FFG001	1,557	4 4
FFG005	1,827	3 3
FLS004	2,243	1 1
FLS001	1,852	2 2

Based on table 4 we can know that the FLS001 and FLS004 tasks have the highest rank among several alternatives, so these tasks will be done on flexo machines II and III. Furthermore, a recapitulation of the results of the assignment can be seen in table 5 below.

Table 5. Recapitulation of the Final Results of Flexo Machine Assignment

Machine	Task	Lead Time (day)	Total (sheet)	Speed (Sheet/min)	Total Time (min)
Flexo1	FFG004	8	9.810	245	40,04
Flexo2	FLS004	7	8.891	309	28,77
Flexo3	FLS001	8	9.270	297	31,21
Flexo4	FFG002	5	13.529	276	49,02
Flexo5	FFG003	8	1.690	167	10,12
Flexo10	FFG006	7	2.890	149	19,40
Flexo6	FLS002	3	1.134	120	9,45
Flexo8	FLS005	6	5.729	121	47,35
Flexo9	FLS003	6	6.100	187	32,62
Total		**58**	**59.043**	**1.871**	**267,98**

Comparison of current production scheduling methods in the company with the due date system. The due date system scheduling used by the company today can be seen in the table below.

Table 6. Production Scheduling with Due Date System Method

Machine	Task	Lead Time (day)	Total (sheet)	Speed (Sheet/min)	Total Time (min)
Flexo1	FFG006	7	2.890	209	13,828
Flexo2	FLS002	3	1.134	241	4,705
Flexo3	FFG002	5	13.529	247	54,773
Flexo4	FFG005	5	8.920	238	37,479
Flexo5	FFG001	4	991	167	5,934
Flexo10	FFG004	8	9.810	171	57,368
Flexo6	FLS004	7	8.891	178	49,949
Flexo8	FLS001	8	9.270	152	60,987
Flexo9	FLS003	6	6.100	187	32,620
Total		**53**	**61.535**	**1.790**	**317,645**

From the recapitulation table shows that the production speed has increased from 1790 sheets / min to 1871 sheets / min. As a result, the total production time is shorter compared to the due date system, from 317.645 minutes for the production of 61,535 units of cartons, to 290.8841 minutes for the production of 59,047 units of cartons. So the integration of Multi-Attribute Utility Theory and Hungarian Method will be able to increase the production speed of Flexo machines by 81 sheets / min (45.3%) of all Flexo machines in PT X. This result is considered to increase company productivity, but simplification is needed in the application of the Hungarian method.

4. Conclusion

PT X produces various types of packaging for household needs with various size specifications through the make to order system has experienced an overload of production quantity resulting in a delay of 36.19%. PT X needs to conduct problem analysis and production planning to improve on time delivery. The problem analysis was carried out using the integration of the Hungarian method and Multi-Attribute Utility Theory. The results of the analysis can increase production speed by up to 45.3%. In this study, it is necessary to simplify the application of the Hungarian method to make it easier for companies to carry out assignments.

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