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Optimization in Personnel Scheduling for Local Content Verification

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Abstract

Optimization of personnel scheduling is necessary to acquire labor schedules precisely and efficiently and finally it can directly reduce the cost of the project. The purpose of this research is to produce an optimal personnel scheduling in verification activities in order to reduce delays in project completion and determination of the optimal labor with a case study of verification activities in upstream oil and gas sector. Mathematical model approach is used to obtain optimal labor schedule. The result is confimed that mathematical model can be used to perform the optimization of personnel scheduling to minimize delay in the completion of work and analyze personnel requirements for each period of time either weekly or monthly.

Keywords
Optimization, Personnel Scheduling, Mathematic Model, Local Content Verification

1. Introduction

Manpower Planning is a two-phased process because manpower planning not only analyses the current human resources but also makes manpower forecasts and thereby draw employment programmes (Makwana et al. 2012). Manpower Planning is advantageous to firm in following manner (Makwana et al. 2012): (1) shortages and surpluses can be identified so that quick action can be taken wherever required; (2) all the recruitment and selection programmes are based on manpower planning; (3) it also helps to reduce the labour cost as excess staff can be identified and thereby overstaffing can be avoided; (4) it also helps to identify the available talents in a concern and accordingly training programmes can be chalked out to develop those talents; (5) it helps in growth and diversification of business. Through manpower planning, human resources can be readily available and they can be utilized in best manner; (6) it helps the organization to realize the importance of manpower management.

Based on solution method used, personnel scheduling can be classified into severall types. The Personnel scheduling solution methods is classified in two categories (Bergh et al. 2013): (1) linear programming; (2) construction based. Gonzalves et al. (2004) made classification from different approach where the solution of personnel scheduling is divided into five groups: (a) Demand modeling; (b) Artificial Intelligence Approach (fuzzy set theory, searchand expert systems); (c) Constraint programming; (d) Metaheuristics; and (e) mathematical Programming Approach. In the last few decades, personnel scheduling problems have been studied widely. The increase in research attention could be motivated by economic considerations. For many companies, labor cost is the major direct cost component. Cutting this cost by only a few percent by implementing a new personnel schedule could therefore prove very beneficial (Bergh et al. 2013). Bergh et al. (2013) conducted a research by reviewing and analyzing ± 300 research related to man power. The study is indentified those researches from various perspectives then analyzed them. In his research, it also classified those personnel schedulling researches into some categories based on *Personnel* *characteristics*, *decision delineation*, *shifts definitions*, *constraints*, *performance measures*, *flexibility*, *solution method*, *uncertainty* incorporation, *application area,* and *applicability of research*. Furthermore, the aim of the research is to facilitate the search of research in the field of personnel scheduling to be relevant and interesting, and to identify trends and areas of future researchs.

2. Methods

As case study, the national survey company has selected through the project of verification of the use of domestic products in the upstream oil and gas sector conducted by the Business Unit of Industry and Facilities. According to the Regulation of the Indonesia Minister of Industry No. 16 / M-IND / PER / 2/2011 local content can be defined as the amount of domestic component of a product in the form of goods, services or a combination of goods and services (eg building projects, construction of roads and construction of production facilities). Simply put DCL can be interpreted as a percentage value that indicates the amount of the use of domestic products in a process of making goods, services or in a work process of combined goods and services. The higher the Local Content value of goods / services / combined goods and services, it means the greater use of local products in the manufacturing process.

Local content verification can be defined as an activity to verify the achievements of local content stated by domestic manufacturers and/or the goods and/or services providers with data taken or collected from business activities of domestic manufacturer and/or goods and/or services providers. In facts, local content verification activities always starts with the work order from the employer. Based on the type of contract and work order, local content verification can be classified into: (1) Lumpsum Contract. Local Content verification activities based on a lump-sum contract within a specified period (1 to 3 years), so that scheduling of verification can be planned from the beginning of the year; (2) Periodic contract. on this contract local content verification activities is performed periodically (monthly, quarterly, semiannually, annually) with the start and the end of the verification activities can be mostly predictable; (3) On Call Contract. In this contract, local content verification is conducted once the work order is received while the issuance of the work order depends on the need of employer; (4) Retail Contract. This contract is generally between PTSI and goods and/or service provider who needs Local Content verification service. This type of contract has generally smaller contract value but many in number and local content verification time is 'impromptu'. General constraints in Local Content verification are: (1) Frequent delays in the completion of local content verification; (2) Workloads among the labors are uneven.

Therefore the optimization of the existing workforce scheduling is necessary so that both constraints that exist can be solved or minimized. By doing optimizing of labor scheduling, it is expected that the optimal amount of labor (based on the number of existing contracts) to verify DCL can be known.
This study was used mathematical model approach to solve the problem. Assumptions and model limitation, mathemaical model, completion the model and verification model was developed. The assumptions and model limitation consist of: (1) local content verification activity for each contract is free from each other and shares the human resources available; (2) starting time of local content verification activities for each contract is known. One worked on that day: (a) If the labor is available, the project is immediately executed according to the schedule stated in the contract (WK_i), (b) if the labor is unavailable, the project is executed once the labor is available (WM_i); (3) The number of personnel is known. In the table 3.2 for the contract with Mobil Cepu Ltd (EPC1-Banyu Urip) and Mobil Cepu Ltd (EPC2-Banyu Urip) Local Content verification is conducted monthly thus 2 personnel are already assigned for the project. Therefore the number of available personnel is 18 persons; (4) The number of personnel used in used for the project are known and depends on the complexity of the project; (5) The labor can be directly used if needed and available; (6) It is not permitted for the time delay in each stage of the verification; (7) The mathematical model that was made aims to create personnel scheduling for a certain period (weekly or monthly).

Based on the case, mathematical model was developed as presented below:

Index
i : project index, i = 1, 2,…., I
j : working days index,k = 1, 2,…, J
k: labor index ,j = 1, 2,….,K K = 18

Parameters

WK_i = project contract period i (the soonest time of commencement of project i)
W_i = implementation time (duration) of project i
WP_i = delivery time (*due dates*) of project i
TKP_i = Total labor needs for the project i
TKS_j = The amount of labor available on the day j

Variables
WM_i = start time of project i
WS_i = finish time of project i
C_i = the number of excess working days of project i from due dates
l_i = number of days of delay in project i from dari due dates

$$Y_{ijk}\begin{cases}1 : project\ i\ is\ conducted\ on\ the\ day\ j\ by\ labor\ k\\ 0 : no\end{cases}$$

$$X_{ijk}\begin{cases}1 : project\ i\ starts\ on\ the\ day\ j\ by\ labor\ k\\ 0 : no\end{cases}$$ where j = WM_i

Constraints
A project is started on the jth day, thus on the jth, X_{ij}=1 and WM_i value will be in accordance with j.

$$WM_i = \sum_j J \times X_{ijk} \qquad \forall i \tag{2.1}$$

A project only starts once thus it has X_{ij} only 1 (one).

$$\sum_j X_{ijk} = 1 \qquad \forall i \tag{2.2}$$

Labor needed to start a project is in accordance with the needs of labor for the project.

$$\sum_k X_{ijk} \le TKP_i \quad \forall i \ \ \forall j \tag{2.3}$$

In 1 day the number of doable project is in accordance with the number or available labor.

$$\sum_i \sum_k X_{ijk} \times TKP_i \le TKS_j \quad \forall j \tag{2.4}$$

The relationship between actual starting time of project i (WM_i) with the scheduled starting time of project i (WK_i).

$$WM_i \ge WK_i \qquad \forall i \tag{2.5}$$

Relationship between starting time of project i and finished time of project i.

$$WS_i = WM_i + (W_i - 1)\sum_j X_{ijk} \qquad \forall i \tag{2.6}$$

Relationship between finishing time of project and its due dates..

$$WS_i + C_i - l_i = WP_i \tag{2.7}$$

Relationship between X_{ijk} and Y_{ijk}

$$X_{ijk} \le Y_{ijk} \qquad \forall i \quad \forall X_{ijk} \tag{2.8}$$

A project conducted for W_i working days.

$$\sum_j \sum_k Y_{ijk} = W_i \times TKP_i \quad \forall i \tag{2.9}$$

$$Y_{ijk} \le Y_{ij+1k}$$
$$\forall i \ \ \forall k \ \forall_{j \ge WMi \ and \ j \le WMi+Wi-2} \tag{2.10}$$

In 1 day the number of doable project is in accordance with the number or available labor.

$$\sum_i \sum_k Y_{ijk} \times TKP_i \leq TKS_j \qquad \forall j$$

(2.11)

For each project i and each working day j, the number of labor working on the project i is in accordance with the needs of labor for the project

$\sum_k Y_{ijk} \leq TKP_i \qquad \forall i \quad \forall j$ (2.12)

Constraints for variable WM_i, WS_i, C_i, l_i

$WM_i \geq 0$ (2.13)

$WS_i \geq 0$ (2.14)

$C_i \geq 0$ (2.15)

$l_i \geq 0$ (2.16)

WM_i, WS_i, C_i, l_i is integer
Constraints for variable $Y_{ijk}\ dan\ X_{ij}$

$Y_{ijk}\ and\ X_{ij}$ are binary number (2.17)

Software Lingo is used to aid completing the the issue of personnel scheduling. Mathematical model is incorporated into the software Lingo. After the mathematical model is incorporated into the software Lingo, then the data needed for personnel scheduling is input (parameter data) as follow: (a) Starting time of contractWK_i; (b) Implementation time (duration) of project W_i; (c) *Due dates* of project WP_i; (d) The number of labor needed for each project TKP_i; (e) The number of available labor; (f) Then the *software* Lingo is run to complete the problem of personnel scheduling.

Before it is used to complete the actual problem, the mathematical model formulated and input in the *software* Lingo needs to be verified and validated. Verification and validation aims to test mathematical models and ensure that the mathematical models already accommodate the purpose of the research and constraints that exist in the completion of personnel scheduling in the field of verification. Verification and validation is conducted by running mathematical model in the program Lingo 10 by using *dummy* data. If the data input in Lingo program produces a scheduling results that are in accordance with the existing objectives and constraints, then the mathematical model has been verified and validated. Once the mathematical model is verified and validated, the mathematical model and Lingo software can be used for data processing.

3. Result and Discussion

In this stage mathematical model is used to do personnel scheduling on the local content verification activity period of July to December. The result of data processing showing the number of days of delays in project completion from July to December is shown in Table 1.

Table 1. Comparison of the number of days of delays each month

No	Month	Number of Running Project	The Number Of Days Of Delays	New Project Addition **
1	July	21	24	0
2	August	11	24*	3
3	September	27	0	0
4	October	32	44	0
5	November	16	44*	4
6	December	8	0	0

Note:
*delay caused by the lateness of the work in the previous month keterlambatan

** addition of new project caused by the project is worked late in the previous month

Based on the data processing and mathematical models, optimal amount of personnel for local content verification activities from July to December can be known. Total optimal personnel number for local content verification activities from July to December are shown in Table 2.

Table 2. Comparison of Data Processing Result of The Number of Personnel

No	**Month**	**Initial Condition**			**Optimal Initial Condition**			**Deviation of Personnel**
		Number of Personnel (person)	**Number of days of delay (Working Days)**	**Number of Personnel *Idle* days (Working Days)**	**Number of Personnel (person)**	**Number of days of delay (Working Days)**	**Number of Personnel *Idle* days (Working Days)**	
1	July	18	24	35	18	24	35	-
2	August	18	24*	190	11	0	60	-7
3	September	18	0	52	17	0	30	-1
4	October	18	44	18	20	18	31	+2
5	November	18	44*	130	13	0	64	-5
6	December	18	0	258	8	0	38	-10

Table 2 shows that the minimum optimal number of personnel needed to conduct verification is 8 persons (December), while the maximum optimal number of personnel is 20 persons, meanwhile the largest number of optimal personnel is 20 people (October). Based on the data above and it can be concluded that for the verification activity period of July to December the minimum number of personnel needed to work on project is 8 persons, while the maximum number of personnel needed is 20 persons. This minimum number of personnel can be a reference on determining how many personnel needed to conduct local content verification. Based on the data above, the number of permanent personnel who can be hired to work on the project is 8 people. While the personnel requirements for other months can use contract labor. Another factor to be considered in the recruitment of personnel is educating of the personnel because recruited personnel are not always directly ready and able to carry out verification activities technically and scientifically.

4. Conclusion

Personnel scheduling optimization by using approach of mathematical model is capable of providing optimal personnel scheduling, reduces the amount of manpower delays and can be used to analyze the needs of labor based on the number of existing projects. Analysis of optimal personnel needs is performed by taking into account the trend of the number of verification projects and average speed factor of the educating time of each personnel.

Mathematical model resulted can be further developed by considering the cost of contract personnel recruitment and penalty cost due to delay in project finishing. The delay in completing the verification work is not only caused by the lack of personnel number or poor personnel scheduling but also is influenced by other factors such as late submission of documents by the subject of verification. Therefore, these factors should be minimized by creating a standard procedure regulating the procedures for verification, and verification stages and implementation time for each stage of verification.

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Biographies

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Amar Rachman is senior lecturer in operation research in the Industrial Engineering Departmen, Universitas Indonesia, Depok, Indonesia. He was graduated from Mechanical Engineering, Universitas Indonesia. Then, he obtain her Master Degree from KuLeuven, Belgia. Mr Amar is really concern about the implementation of optimization approach in order to solve industrial problems. Its expertise make her activities always correlated with optimization field. He had run several courses, including linear programming, operation research, machine element and plant facilities.