A LINEAR PROGRAMMING APPROACH IN SOLVING STAFF SCHEDULING PROBLEM AT FAST FOOD RESTAURANT

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1. Introduction

Regular demand for service businesses varies throughout the day as can be seen in companies that engage in food services, retail, transport and distribution. Effective personnel scheduling has been one of the most important ways for service businesses to stay competitive by generating a single complete work schedule for the employees for an activity to meet the requirements of the company (Labidi et al., 2014). Distributing working shifts to employees over a period of time is a complicated process to complete. It is due to the presence of a variety of employee requirements on specific days or shifts in the domain of production demand (Kumar, 2016). The majority of food and beverages businesses hire hourly employees with frequently shifting schedules and specifications. Flexibility and adaptability are critical components of employee scheduling in this industry. As a result of the globalization phenomenon, numerous people's lifestyles have changed, however most people prefer fast food. The majority of families choose to dine out, particularly at fast food restaurants (Akbar & Mannan, 2015). During the last two decades people's food intake went from a traditional to a westernized diet. The fast food sector has grown significantly. In research from Wang et al. (2016) in China, the number of American fast food joints has surged. KFC has 4618 locations in the United States after 61 years, however there are 4260 outlets expanded in China in less than 30 years. ' Yum! China', the parent company of KFC, Taco Bell, and Pizza Hut, now has over 4800 KFCs and 1300 Pizza Huts in China, with a goal of opening 20,000 outlets. McDonald's is rapidly expanding in China, with roughly ten new outlets opening each week.

Staff scheduling is a combinatorial optimization problem that involves the allocation of employees to duty rosters in a broad variety of industries and circumstances (Baskaran, 2016). The optimal staff scheduling can help to minimize the effects of oversupply and undersupply of employees on the business (Castillo et al., 2009). The goal of the staff scheduling problem is to fulfil the daily employee's requirements and provide a competitive advantage to the company by minimizing the cost of doing business without violating regulations or labour agreements (Demirović et al., 2019). Several factors such as shift scheduling, the number of employees that should be allocated daily, specification of the days off and lunch break lead to difficulty in constructing employee's schedules. Having a sufficient schedule increases the work performance and the quality of food and beverage services offered to customers.

Linear Programming (LP) method is one of the mathematical methods in achieving the minimum or maximum value of linear function. LP is primarily used in management and economics as it is very useful in modelling issues involving planning, routing, scheduling and allocation. As simply stated, by using LP under specific settings and restrictions, best results can be achieved such as maximum advantage or minimal cost. At the same time, it is one of the most used methods in solving staff scheduling problem as the number of minimum employees allocated daily with maximum profit for the company can be found (Akpan & Iwok, 2016). Furthermore, LP is effective in identifying optimal solution, which is the most favourable values of the objective function among those that are possible and satisfy all constraints needed for scheduling problem (Hasan & Arefin, 2017). Hence, staff scheduling is the allocation of tasks to specify time intervals of resources to ensure there are no two tasks are assigned to the same resource at the same time or the capacity of the resource is exceeded (Özcan et al., 2018). This is the reason this study used LP method because appropriate decisions can be made whether the company needs to hire more employees or rearrange the current employee's work division. Thus, this study intends to solve the scheduling problems with an aim to figure out the variables that are used in the model and its applicability in the company.

2. Methodology

Generally, this study focuses on assigning the number of workers for each regular job assignment every shift and determining the optimal working cost of the workers at lowest possible expense. In this study, (1,0) denotes the availability of that specific worker for a specific shift, where variable '1' indicates that the particular category of worker is required for a specified task and variable '0' indicates that the particular category of worker is not necessary.

The researcher then defines the objective function to minimize the daily salary of workers as follows:

$$minimize \sum_{S=1}^{p} \sum_{d=1}^{q} \sum_{i=1}^{r} C_d X_{i,d,S}$$

when shift (S) = {1,2,…,p}, day (d) = {1,2,…,q} and type of job scope (i) = {1,2,…,r} and C_d is the daily salary of each worker. The equation (1) to (23) are the constraints that have been formed by referring to the data collection. An add-in program in Microsoft Excel which is Solver was used in this study to solve the model.

Objective function,

$$minimize \sum_{S=1}^{3} \sum_{d=1}^{7} \sum_{i=1}^{6} 40X_{i,d,S}$$

Subject to :

$$X_{1,1,S1} + X_{2,1,S1} + X_{3,1,S1} + X_{4,1,S1} + X_{5,1,S1} + X_{6,1,S1} \geq 17 \quad (1)$$
$$X_{1,1,S2} + X_{2,1,S2} + X_{3,1,S2} + X_{4,1,S2} + X_{5,1,S2} + X_{6,1,S2} \geq 20 \quad (2)$$
$$X_{1,1,S3} + X_{2,1,S3} + X_{3,1,S3} + X_{4,1,S3} + X_{5,1,S3} + X_{6,1,S3} \geq 15 \quad (3)$$
$$X_{1,2,S1} + X_{2,2,S1} + X_{3,2,S1} + X_{4,2,S1} + X_{5,2,S1} + X_{6,2,S1} \geq 14 \quad (4)$$
$$X_{1,2,S2} + X_{2,2,S2} + X_{3,2,S2} + X_{4,2,S2} + X_{5,2,S2} + X_{6,2,S2} \geq 21 \quad (5)$$
$$X_{1,2,S3} + X_{2,2,S3} + 0 + X_{4,2,S3} + 0 + 0 \geq 20 \quad (6)$$
$$X_{1,3,S1} + X_{2,3,S1} + 0 + X_{4,3,S1} + 0 + 0 \geq 14 \quad (7)$$
$$X_{1,3,S2} + X_{2,3,S2} + X_{3,3,S2} + X_{4,3,S2} + X_{5,3,S2} + X_{6,3,S2} \geq 20 \quad (8)$$
$$X_{1,3,S3} + X_{2,3,S3} + X_{3,3,S3} + X_{4,3,S3} + X_{5,3,S3} + X_{6,3,S3} \geq 20 \quad (9)$$
$$X_{1,4,S1} + X_{2,4,S1} + X_{3,4,S1} + X_{4,4,S1} + X_{54,S1} + X_{6,4,S1} \geq 16 \quad (10)$$
$$X_{1,4,S2} + X_{2,4,S2} + X_{3,4,S2} + X_{4,4,S2} + X_{5,4,S2} + X_{6,4,S2} \geq 22 \quad (11)$$
$$X_{1,4,S3} + X_{2,4,S3} + X_{3,4,S3} + X_{4,4,S3} + X_{5,4,S3} + X_{6,4,S3} \geq 18 \quad (12)$$
$$X_{1,5,S1} + X_{2,5,S1} + 0 + X_{4,5,S1} + 0 + 0 \geq 18 \quad (13)$$
$$X_{1,5,S2} + X_{2,5,S2} + 0 + X_{4,5,S2} + 0 + 0 \geq 19 \quad (14)$$
$$X_{1,5,S3} + X_{2,5,S3} + X_{3,5,S3} + X_{4,5,S3} + X_{5,5,S3} + X_{6,5,S3} \geq 18 \quad (15)$$
$$X_{1,6,S1} + X_{2,6,S1} + X_{3,6,S1} + X_{4,6,S1} + X_{5,6,S1} + X_{6,6,S1} \geq 18 \quad (16)$$
$$X_{1,6,S2} + X_{2,6,S2} + X_{3,6,S1} + X_{4,6,S2} + X_{5,6,S2} + X_{6,6,S2} \geq 24 \quad (17)$$
$$X_{1,6,S3} + X_{2,6,S3} + X_{3,6,S3} + X_{4,6,S3} + X_{5,6,S3} + X_{6,6,S3} \geq 23 \quad (18)$$
$$X_{1,7,S1} + X_{2,7,S1} + X_{3,7,S1} + X_{4,7,S1} + X_{5,7,S1} + X_{6,7,S1} \geq 19 \quad (19)$$
$$X_{1,7,S2} + X_{2,7,S2} + 0 + X_{4,7,S2} + 0 + 0 \geq 25 \quad (20)$$
$$X_{1,7,S3} + X_{2,7,S3} + 0 + X_{4,7,S3} + 0 + 0 \geq 20 \quad (21)$$
$$X_i \geq 0 \; for \; all \; i (i = 1, 2, \ldots 6) \quad (22)$$
$$X_1 \geq 7, X_2 \geq 5, X_3 \geq 3, X_4 \geq 3, X_5 \geq 3, X_6 \geq 2 \quad (23)$$

3. Results and discussion

Asserting that 25 people are required when all the different kinds of workers are used in the shift and RM 1000 is the minimum working cost of the workers per day. The summary of the number of workers for respective job scope are extracted from Excel Solver output as in Table 1.

Table 1. Number of Workers for each Type of Job Scopes

Job Scope	Role	Number of Workers Assigned by Excel Solver
Kitchen (i=1)	• Prep cooks • Grill cooks • Sous cooks • Line cooks • Vats	7
Drive thru (i=2)	• Take order • Cashier • Runner • Presenter • Expeditor	5
McDelivery (i=3)	• Take order • Runner • Presenter	3
Front counter (i=4)	• Take order • Runner	5
Lobby (i=5)	• Lobby person • Server	3
Mc Cafe (i=6)	• Barista	2

4. Conclusion

As the conclusion, both objectives of the study are achieved which is to assign the number of workers for each regular job assignment in every shift and determine the optimal working cost as much as possible, while considering all constraints in account. The usage of Solver which is an add-in program in Microsoft Excel is very helpful in this study.

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