Universiti Teknologi MARA
Cawangan Perlis
Jurnal Intelek

Volume 13 Issue 2 (2018)

Optimization of Workforce Scheduling using Integer Goal Programming Approach

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ABSTRACT

Crisis of large number of workers suffered from stress at workplace is a real global world issue either in local or international country. This is due to the long working hours, inappropriate rest or leisure times and imbalance wages. Thus, appropriate worker scheduling should be well organize in order to have job satisfaction among all workers. Scheduling is defined as the allocation of resources to task over time in such a way that a limited performance measure is optimized. This research proposed a model of Integer Goal Programming which intends to optimize the staff scheduling that are related to the staff requirements by the company and staff preferences. Three main constraints encountered in the model are hard constraints, soft constraints and logical constraints. The objective function is to allocate staff in order to have balance work schedule at the optimal work hours and at the mean time to ensure the employee satisfaction and efficiency of workloads. Lastly, the pattern of scheduling will be rotated efficiently among the staff and each staff will be working according to each schedule pattern. The result from this study gives optimum solution in which are supported by software LINGO and Excel are presented and discussed based on the optimal staff schedule. Lastly, the pattern of scheduling will be rotated efficiently among the staff and each staff will be working according to each schedule pattern. With this cyclical scheduling, it gives staff more control over their work life because they know the type of shift schedule in future should have positive effect on their job satisfaction.
Keywords: *integer goal programming; optimization; workforce scheduling; constraint.*

1. Introduction

1.1. Background of the Study

Nowadays, in global workplace issues, many workers have suffered from stress in the workplace. According to Sobri (2015), it has been proposed that 70 percent of Malaysian workers have developed work stress due to high competition of global economy. Sobri (2015) also stated that 48 percent of Malaysians faced a rise in stress levels, and 42 percent reported of having less sleeping hours. Meanwhile, 33 percent of the respondents lost their jobs while another 32 percent felt less confident about their work sector. The Employment Act 1955 provided that working hours for employees should not exceed 5 consecutive hours excluding leisure period of no less than 30 minutes, should not be more than 8 hours per day, should not be more than 48 hours in a week. Besides, workers' overtime is paid at a rate of no less than one and half time his or her hourly rate of pay. Each worker should have at least a full one-day rest per week.

Scheduling is a large issue for the management of a company. Some companies face a problem in allocating manpower to meet fluctuating hours and demands of the day. The study shows that local country (Malaysia) having a workforce problem as the workers are mostly involved in extended working hours and they spend less time on personal activities. Poor organization by managers may lead to distress of the company. In order to solve the scheduling problems, the proposed model is based on the integer goal programming formulation for workforce problem as an effort to rearrange the schedule to become more efficient at the right cost while achieving high level of employee job satisfaction.

ISSN: 2231-7716

1.2. Past Studies

According to Mohamad and Said (2013), some managers or facilities are not able to estimate the problems of allocating manpower planning and meet the fluctuating hour requirements of the day. The focus in this paper is to define and minimize the labor cost and the corresponding schedule to satisfy the worker requirements related to working hours and days. Kim et al. (2014) described that scheduling problem is the assignment of the organization over the time and with respect to the different set of constraints such as capacity constraints, capabilities and priority constraints which are the resources that are needed for the assignment. Kumar et al. (2014) proposed a variety of problems in the health care system such as in deciding suitable qualified nurses to cover the arising patient demands in the wards while at the same time having the need to focus on work regulations, to distinguish between full-time and part-time workers to fair assign night and weekend shifts among staff, availability of days off and leave, and to considering staff preferences. The 24-hour hospital service brought a lot of workloads in which the staff needs to consider both the patients and work. Labidi et al. (2014) has proposed two good ways to adapt the scheduling conflicts or conflict constraints which reviewed the full schedule during and after making adjustments and placed one person in charge of the schedule. The first step is important to avoid new conflicts being generated or detected while the second step reduces the risk of mistakes that made by the workers due to people working on the same schedule. The authors really emphasized this solution for managers to avoid and minimize the workforce issues in companies.

Workforce scheduling is classified into three types which are shift scheduling, days-off scheduling and tour scheduling. Shift scheduling (time-off-days) describes each employee's work and break hours per day. Days-off (days-off-week) scheduling describes each employee's work days and off per week or multiple-week work cycle. Tour scheduling is a combination of both shift and days-off scheduling (Hapsari et al, 2015). Shift scheduling is divided into two types which are single and multiple shifts. Seçkiner et al. (2007) conducted an alternative shifts or multiple shifts days by which workers can work during the course of a week. This alternative shifts described in the model is used to achieve optimal productivity by using compressed workweeks. In the meantime, meeting worker's requirements is also one of the aims of companies in terms of difference in shift works, number of off-days, and daily activities of workers as they are the factors for the company to achieve their objectives. Therefore, due to the cost consideration in the shift types and number of off-days of workers each week, they will be able to avoid unequal wages among workers. Similar to the research conducted by Özgüzen and Sungur (2013), they developed two models (B1 and B2) that were used sequentially by removing a fault in the system of previous published models (Seckiner's and Billionet's model) under the assumption of divisibility which is considered as multiple shifts approach. However, a model A developed by Özgüzen and Sungur (2013) was used under the assumption of indivisibility or single shift which means it gives unpaid reasonable off-days instead of keeping the workers idle the whole day .

Labidi et al. (2014) has proposed two good ways to adapt the scheduling conflicts or conflict constraints which reviewed the full schedule during and after making adjustments and placed one person in charge of the schedule. The first step is important to avoid new conflicts being generated or detected while the second step reduces the risk of mistakes that made by the workers due to people working on the same schedule. The authors really emphasized this solution for managers to avoid and minimize the workforce issues in companies.

Integer linear programming (ILP) is widely used by researchers to solve the optimization problem to maximize profit or to minimize cost. In general, integer linear programming functioning normally is a set of single objective. ILP is used as the basic phase for solving a branch of multi-objective optimization of integer goal programming (IGP) optimization problem. Kumar et al. (2014) introduced integer linear programming to solve nurse scheduling problem by estimating the minimal number of nurses to handle the hospital facility, maximize the nurses' preferences as well as team fairness and minimize the salary cost with respect to the constraints. However, Lim et al. (2012) stated that nurse scheduling problem can be formulated by using multi-objective binary integer programming models where substitution of nurse shift preferences for job satisfaction (e.g., if the nurse is able to work for shift of interest, then job satisfaction will increase) and substitution of patient workload for patient dissatisfaction are considered in the models (e.g., the increase in patient workload is the increase in the patients' dissatisfaction). The approaches used by the authors are different in deciding the number of nurses required for the hospital.

Other than that, Perriere et al. (2012) made a decision that integer linear programming is the best approach in solving real-time pump scheduling problem for its velocity performance even in the presence of many variables in a water distribution system. The author applied the integer linear programming in hydraulic system scheduling because it is more efficient and accurate to be used rather than other related techniques such as ant colony optimization, non-linear programming and genetic algorithm. However, Perriere et al. (2012) found the difficulties at the early stage of research. The system of hydraulic system constraints need to be expressed in linear form and to deal with large sizes of linear programming models as well as to stay within the limited computation time (CPU). There is a solution where the researchers found that linearizing the hydraulic constrains is able to achievable by writing down the constraints into linear equations. Fırat et al. (2016) emphasized the Branch-and-Price with hierarchical skill levels approach which takes into consideration the pricing problem by replacing technician job-pair with another one technician from current team base to find a stable workforce assignment. The stability in technician workforce describes how happy the technicians in enjoying work with their teams.

2. Methodology

In this study, integer goal programming is used to solve the scheduling problem. The integer programming can be divided into two categories, which are general integer variables and 0-1 (binary) integer variables. Therefore, the study used 0-1 goal programming to analyze the scheduling problem. The illustration of this method is illustrated as in Figure 1 below.

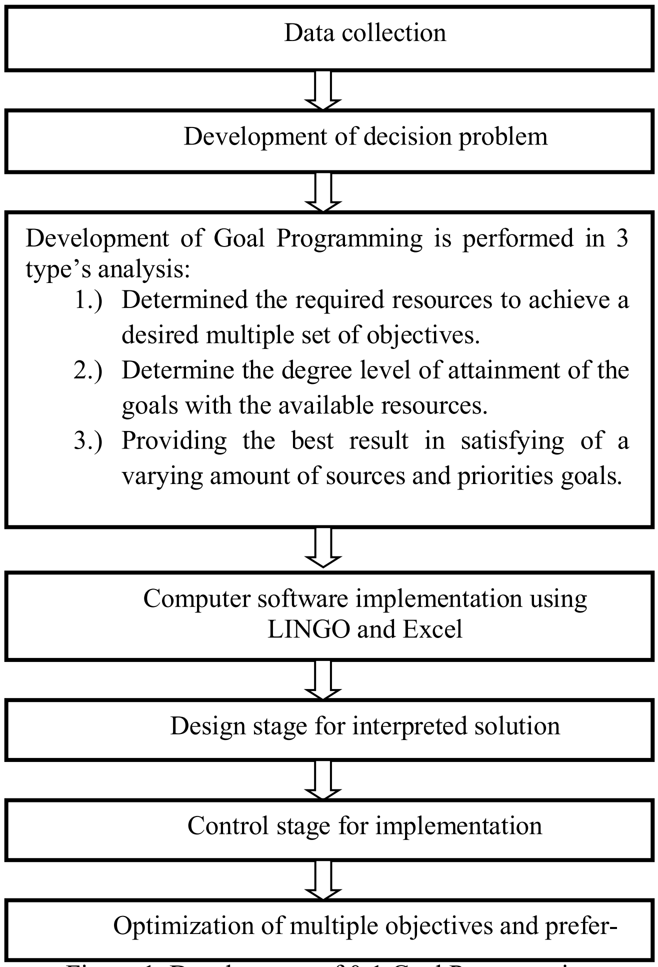

Figure 1. Development of 0-1 Goal Programming

2.1. Data Collection

Weekly scheduling data from 1st August 2017 until 28th August 2017 from an electronic industrial company, Flextronic in Penang, Malaysia are used for solving the scheduling problem.

2.2. Development of Decision Problem

The development of workforce scheduling model in this study is based on the industry's objective and the workforce's preference where the industry's objective are described as follows:

- The unit is covered by two shifts with 12 hours morning shift (7 am – 7pm) and 12 hours night shift (7 pm – 7 am) for a durations 24-hour a day and 7 days a week.
- Minimum staff level requirements must be satisfied.
- Each staff is required to work only one shift per day (morning or night shift).
- Any isolated days on are avoided (off-on-off).

- A staff who works the night shift for 4 consecutive days must have off day for the next 2 consecutive days.
- The regular working days are between 16 to 22 days per schedule in 4 weeks.
- No staff can work for more than 6 consecutive working days.
- Request on days off should be considered.
- A staff who works a night shift is not allowed to work the morning shift or the evening shift of the following day.

Meanwhile the workforce's preference are defined as follows:
- All staff members should have the same amount of working days which are 19 days per schedule.
- Morning shift should exceed night shift for each staff in the schedule.
- Avoid morning shift followed by night shift of the following day.
- Avoid night shift followed by morning shift.

This scheduling problem contains 31 sets of constraints. Since the feasible solution may not be obtained in order to satisfy all sets of constraints, therefore these sets are divided into two groups; hard constraints and soft constraints. The hard constraints represent the industry's preference while the soft constraints represent the workforce's preference in order to have an efficient and optimum solution.

2.3. Formulations

2.3.1. Notations

The following notations are used to specify the model:

n = number of days in the schedule (n = 28)
m = number of workforce available for the units of interest (m=18)
j = index for days, $j = 1,..,n$
k = index for workforces, $k = 1,...,m$
X_i = staff requirements for morning shift for day i, $i = 1,..,n$
Y_i = staff requirements for night shift for day i, $i = 1,..,n$

2.3.2. Decision Variables

The decision variables are explained as follows:

$$P_{j,k} = \begin{cases} 1 \text{ if staff } k \text{ is assigned a morning shift for day } j \\ 0 \text{ otherwise} \end{cases}$$

$$M_{j,k} = \begin{cases} 1 \text{ if staff } k \text{ is assigned a night shift for day } j \\ 0 \text{ otherwise} \end{cases}$$

$$C_{j,k} = \begin{cases} 1 \text{ if staff } k \text{ is assigned a day off shift for day } j \\ 0 \text{ otherwise} \end{cases}$$

2.3.3. Hard Constraints

The formulations of hard constraints are defined as follows:

Set 1: Minimum workforce level requirement for weekday's morning and night shifts must be satisfied:

$$\sum_{k=1}^{m} P_{j,k} \geq X_j, j = 1,2,...,n \tag{1}$$

$$\sum_{k=1}^{m} M_{j,k} \geq Y_j, j = 1,2,...,n \tag{2}$$

Set 2: Each staff works only one shift per day:

$$P_{j,k} + M_{j,k} + C_{j,k} = 1, j = 1,2,...,n \text{ and } k = 1,2,...,m \tag{3}$$

Set 3: Any isolated days pattern of "off-on-off" is avoided:

$$C_{j,k} + P_{j+1,k} + M_{j+1,k} + C_{j+2,k} \leq 2, j = 1,2,...,n-2 \text{ and } k = 1,2,...,m \quad (4)$$

Set 4: Each staff has works for 4 consecutive days of night shift and followed by 2 days off days as follows:

$$M_{1,k} + M_{2,k} + M_{3,k} + M_{4,k} + C_{5,k} + C_{6,k} + P_{7,k} = 7, k = 1,8,15 \quad (5)$$

$$M_{5,k} + M_{6,k} + M_{7,k} + M_{8,k} + C_{9,k} + C_{10,k} + P_{11,k} = 7, k = 2,9,16 \quad (6)$$

$$M_{9,k} + M_{10,k} + M_{11,k} + M_{12,k} + C_{13,k} + C_{14,k} + P_{15,k} = 7, k = 3,10,17 \quad (7)$$

$$M_{13,k} + M_{14,k} + M_{15,k} + M_{16,k} + C_{17,k} + C_{18,k} + P_{19,k} = 7, k = 4,11,18 \quad (8)$$

$$M_{17,k} + M_{18,k} + M_{19,k} + M_{20,k} + C_{21,k} + C_{22,k} + P_{23,k} = 7, k = 5,12 \quad (9)$$

$$M_{21,k} + M_{22,k} + M_{23,k} + M_{24,k} + C_{25,k} + C_{26,k} + P_{27,k} = 7, k = 6,13 \quad (10)$$

$$M_{25,k} + M_{26,k} + M_{27,k} + M_{28,k} = 4, k = 7, K = 7,14 \quad (11)$$

Set 5: Each staff has works between 16 to 22 days per schedule:

$$\sum_{j=1}^{n} \left(P_{j,k} + M_{j,k} \right) \geq 16, k = 1,2,...,m \quad (12)$$

$$\sum_{j=1}^{n} \left(P_{j,k} + M_{j,k} \right) \leq 22, k = 1,2,...,m \quad (13)$$

Set 6: Each staff has works not more than 6 consecutive days:

$$C_{j,k} + C_{j+1,k} + C_{j+2,k} + C_{j+3,k} + C_{j+4,k} + C_{j+5,k} + C_{j+6,k} \geq 1, j = 1,2,...,n-4 \text{ and } k = 1,2,...,m \quad (14)$$

Set 7: Morning shift constitutes at least 26.32% of total workload:

$$\sum_{j=1}^{n} P_{j,k} \geq 5 \quad (15)$$

2.3.4. Soft Constraints

The formulation of soft constraints are expressed as follows:

Set 1: Working in a night shift followed by a morning shift on the next day is avoided:

$$M_{j,k} + P_{j+1,k} \leq 1, j = 1,2,...,n-1 \text{ and } k = 1,2,...,m \quad (16)$$

$$M_{n,k} + P_{1,k+1} \leq 1, k = 1,2,...,m-1 \quad (17)$$

$$M_{n,m} + P_{1,1} \leq 1 \quad (18)$$

Set 2: Working in a morning shift followed by a night shift on the next day is avoided:

$$P_{j,k} + M_{j+1,k} \leq 1, j = 1,2,...,n-1 \text{ and } k = 1,2,...,m \quad (19)$$

$$P_{n,k} + M_{1,k+1} \leq 1, k = 1,2,...,m-1 \quad (20)$$

$$P_{n,m} + M_{1,1} \leq 1 \quad (21)$$

Set 3: Each staff has at least 4 weekend off:

$$C_{1,k} + C_{7,k} + C_{8,k} + C_{14,k} + C_{15,k} + C_{21,k} + C_{22,k} + C_{28,k} \geq 4, k = 1,2,...,m \quad (22)$$

Set 4: All staff members have the same amount of total workload. One of the hard constraints explained that the total workload of the staff should be between 16 and 22 days. Based on the staff member's preferences, each staff should have a workload of 19 days:

$$\sum_{j=1}^{n}\left(P_{j,k}+M_{j,k}\right)=19, k=1,2,...,m \tag{23}$$

2.3.5. Goals

Soft constraints are formed as the ideal goals in the model. The goals are formulated as follows:
Goal 1: It ensures that all staff members are scheduled to have 19 work days possible in a 4-week schedule. Here, $\eta 1_k (ST1)$ is the amount of negative deviation respectively to $\rho 1_k (PO1)$ which is the amount of positive deviation from goal 1 for staff k. Both the negative and positive deviations are penalized.

$$\sum_{j=1}^{n}\left(P_{j,k}+M_{j,k}\right)+\eta 1_k-\rho 1_k=19, k=1,2,...,m \tag{24}$$

Goal 2: It avoids assigning a staff to have a morning shift the next day. Here $\eta 2_k (ST2)$ (amount of negative deviation) with respect to $\rho 2_k (PO2)$ is the amount of positive deviation) from goal 2 for staff k. Only positive deviations are penalized.

$$M_{j,k}+P_{j+1,k}+\eta 2_k-\rho 2_k \le 1, j=1,2,...,n-1 \;\; k=1,2,...,m \tag{25}$$

$$M_{n,k}+P_{1,k+1}+\eta 2_{n,k}-\rho 2_{n,k} \le 1, k=1,2,...,m-1 \tag{26}$$

$$M_{n,m}+P_{1,1}+\eta 2_{n,m}-\rho 2_{n,m} \le 1 \tag{27}$$

Goal 3: It avoids assigning a staff members to have a night shift the next day. Here $\eta 3_k (ST3)$ is the amount of negative deviation with respect to $\rho 3_k (PO3)$ which is the amount of positive deviation from goal 3 for staff k. Only positive deviations are penalized.

$$P_{j,k}+M_{j+1,k}+\eta 3_{j,k}-\rho 3_{j,k} \le 1, j=1,2,...,n-1 \quad k=1,2,...,m \tag{28}$$

$$P_{n,k}+M_{1,k+1}+\eta 3_{n,k}-\rho 3_{n,k} \le 1, k=1,2,...,m-1 \tag{29}$$

$$P_{n,m}+M_{1,1}+\eta 3_{n.m}-\rho 3_{n,m} \le 1 \tag{30}$$

Goal 4: It ensures that each staff member has at least 4 days off during weekend in a 4-week schedule. Here, $\eta 4_k (ST4)$ is the amount of negative deviation respect to $\rho 4_k (PO4)$ which is the amount of positive deviation from goal 4 for staff k. Only negative deviations are penalized.

$$C_{1,k}+C_{7,k}+C_{8,k}+C_{14,k}+C_{15,k}+C_{21,k}+C_{22,k}+C_{28,k}+\eta 4_k-\rho 4_k \ge 4, k=1,2,...,m \tag{31}$$

Thus, the preemptive goal programming for this model is defined as follows:

$$\text{Minimize: } \left(\sum_{k=1}^{m}(\eta 1_k+\rho 1_k), \sum_{j=1}^{n}\sum_{k=1}^{m}\rho 2_{j,k}, \sum_{j=1}^{n}\sum_{k=1}^{m}\rho 3_{j,k}, \sum_{k=1}^{m}\eta 4\right) \tag{32}$$

Subject to:
Equations (1)-(15);
Equations (16)-(31);

where, $P=0$ or 1, $M=0$ or 1, C = 0 or 1, and $\eta 1, \rho 1, \eta 2, \rho 2, \eta 3, \rho 3, \eta 4, \rho 4 \ge 0$.

3. Results and Discussion

The 0-1 goal programming was selected and implemented in a technical department that has 18 technicians with the number of minimum requirement for morning and night shifts. Besides, the company also needs to consider the off days needed by the technicians. The problem is solved by using the preemptive method because the priority order used is T1>T2>T3>T4. The model is optimized using one goal at a time such that the optimum value of a higher priority is never degraded by a lower priority. Before running the model using LINGO, a computer code has been developed. A few models have been developed and adjusted in order to get the best solution.

Table 1 shows the result of the shift patterns of working and day-off for 4 weeks (28 days) planning period. Both goals 2 and 3 are satisfied in which there is no morning shift followed by night shift on the next day and also there is no night shift followed by morning shift on the next day assigned to each schedule's pattern.

Table 1. The Schedule Pattern using 0-1 Goal Programming Model

	Schedule's Pattern																	
	Number of staff																	
Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	M			P				M				P			M	P		M
2	M	P	P	P	P	P	M	M	P	P	P	P		P	M		P	
3	M	P	P		P	P	M	M	P	P	P		P	P	M		P	P
4	M		P	M	P	P		M		P	P	P	P	P	M		P	P
5		M	P	M	P	P	P		M	P	P	P	P	P		M	P	P
6		M	P	M	P	P	P		M	P	P	P	P	P		M	P	P
7	P	M		M				P	M						P	M		
8	P	M	M					P	M						P	M		
9			M	P	P	P	P			M	M	P	P	P			M	P
10	P		M	P	P	P	P	P		M	M	P	P	P	P		M	P
11	P	P	M		P	P		P	P	M	M	P	P		P	P	M	P
12	P	P			P	P	P	P	P	M		P	P	M	P	P	M	
13	P	P		M	P	P	P	P	P		M	P	P	M	P	P		M
14			P	M							M	P	P	M	P			M
15		M	P	M						P	M						P	M
16		M	P	M		P	P	P	P	P	M		P	P	P	P	P	M
17	M	M			M	P	P	P	P			M	P	P	P	P		
18	M	M	P		M	P	P	P	P	P		M	P	P	P	P	P	
19	M		P	P	M		P	P	P	P	P	M		P		P	P	P
20	M		P	P	M		P	P	P	P	P	M		P	M	P	P	P
21		M				M		P		P			M		M		P	
22		M				M	P		M				M			P	P	
23	P	M		P	P	M	P	P	M	P	P	P	M		P	P		P
24	P	M		P	P	M		P	M	P	P	P	M		P	P	P	P
25	P		M	P	P		M	P	M	P	P			M	P	P	P	P
26	P		M	P	P		M			P	P	M		M		P	P	P
27	P	P	M	P	P	P	M				P	M	P	M		P		P
28		P	M			P	M		M				P	M				

(P=Morning, M=Night)

Meanwhile, Table 2 shows a summary for the number of shifts and weekend off for each schedule pattern. Goal 4 is achieved such that almost all staff members in each schedule pattern must have at least 4 weekends off in 28 days except for staff of number 2 which has 2 days off and staff of number 15 which has 3 days off.

Table 2. Summary of the Staff's Weekends off for Each Schedule's

Number of Staff	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Weekend's Off	5	2	5	5	8	5	6	4	4	6	7	6	5	6	3	5	5	7

As the result in Figure 2 and 3 showed the 0-1 goal programming scheduling (preemptive method) produced a balance shift distribution compared to the previous schedule which is generated manually. There are differences in terms of the total number of working days in 4-week period between staff scheduled and staff schedule with 0-1 goal programming approach (preemptive method). For manual schedule, the number of working days which should be between 16 to 22 days (based on company policy) is not satisfied. This is because there are one staff member code number 3, had to work at maximum days for 22 days and staff with code number 14, the working days are less than 19 days (16 days). This has created inequality in terms of the number of working days in the staff schedule throughout the period of 4 weeks. Meanwhile, the schedule for staff which is based on 0-1 linear goal programming (preemptive method) is much more balanced as each staff has a total of 19 work days which is in the range of 16 to 22. It is clearly shown that the distribution of the shifts for the schedule generated using 0-1 goal programming is almost equally distributed compared to the schedule which is manually generated. Hence, it certainly creates a sense of satisfaction among staff members as there is fairness in the distribution of the number of working days between them. As a result, staff members will be more diligent and happy in performing their duties. Since the LINGO result for the first soft constraint was able to get the best minimum value as shown in Figure 3 (the global optimum is 0 and the objective bound near to 0), thus the objective of the soft constraint has been successfully met. This explains why is each staff manages to get the same total working days for the 4-week period (28 days) using the 0-1 linear goal programming approach.

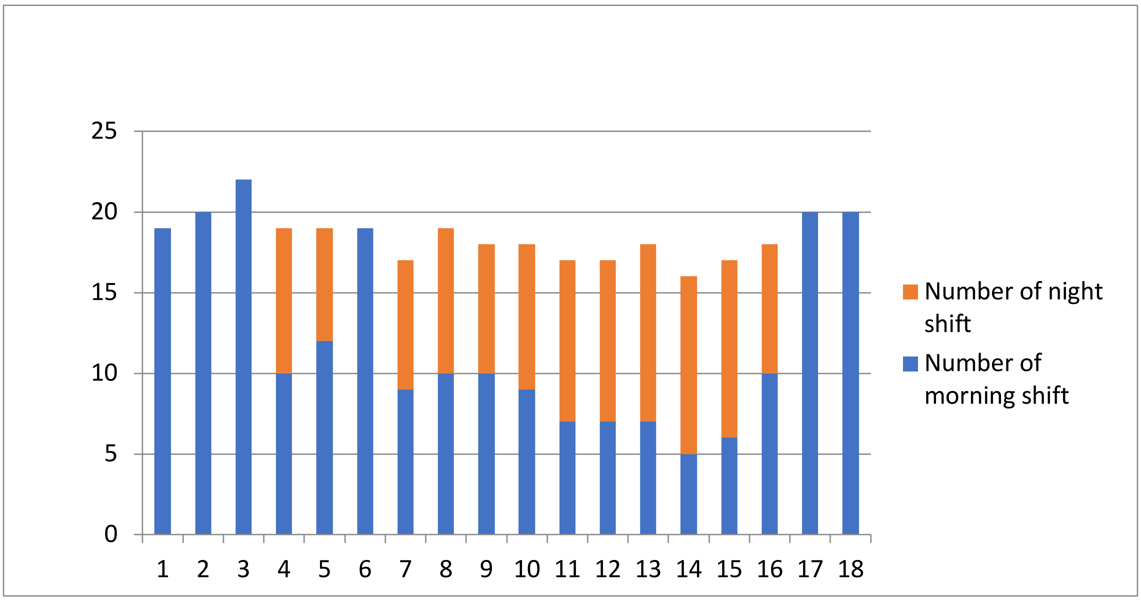

Figure 2. Previous Number of Day's Distribution for Staff (Manually Generated)

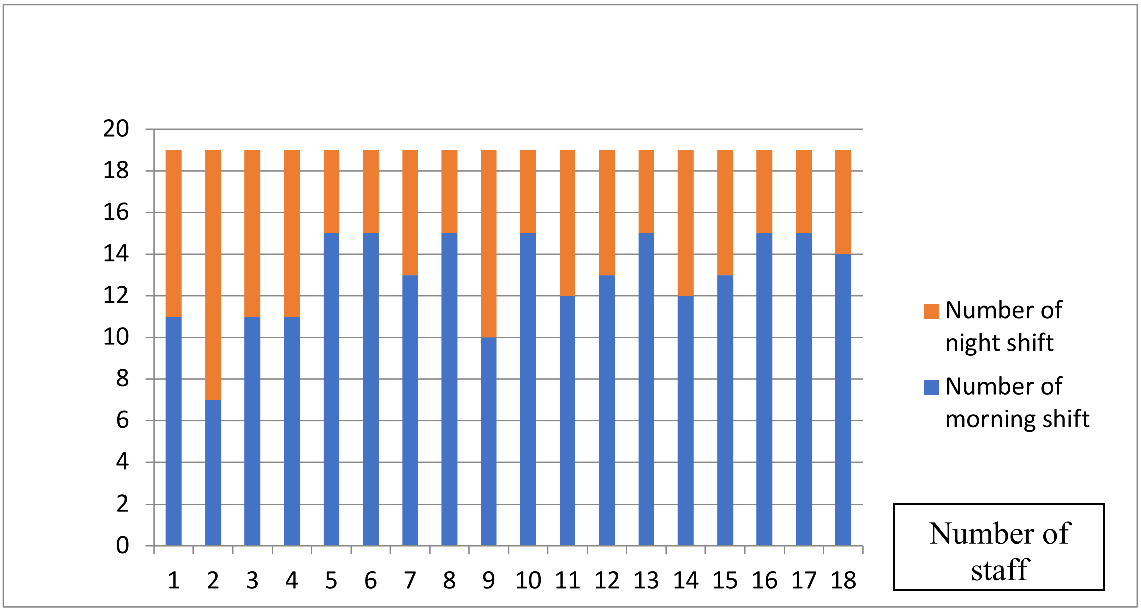

Figure 3. Number of Day's Distribution for Staff (0-1 Linear Programming Approach)

4. Conclusion

In conclusion, in order to solve an optimization problem, various techniques and approaches can be used. A problem in this study which is optimizing the workforce scheduling was modeled using integer goal programming. The workers' schedule should be set in order to have job satisfaction among all workers. Goal programming is known as a branch of multi-criteria decision analysis (MCDA) which means it can be thought of as an extension of linear programming to handle multiple conflicting objective measures. The deviations which are divided into positive and negative deviations in between goals and what can be achieved within the given set of constraints are minimized. Thus, the objective function becomes minimized based on the priorities assigned to them.

The objective function in the study is to distribute or divide shifts for each staff for each day thereby generating an efficient schedule of working days and days off for each staff in a work place. In addition, the number of total working hours per week does not exceed the limit set by the standard Employment Act 1955 which is 48 hours in a week. Thus, the objective of the study was successfully achieved in obtaining the optimal solution of the same total work hours, respecting multiple work constraints and costs, balancing workloads, and controlling idle days among all technical staff members. The schedule will be rotated and the schedule pattern will be used in the future. In this study, it can be concluded that the optimal solution leads to maximum satisfaction, fairness of workload distribution among workers, and quality of services provided by the staff to the company. The result of this study which is presented by LINGO and Excel (as data embedding) helps users in solving the problems systematically. With this cyclical scheduling, it gives staff members more control over their work life because they know the type of shift schedule in the future. This would give positive effect on their job performances.

Since goal programming is a powerful and interactive tool, which is effective in solving linear and nonlinear problems and also provides a simultaneous solution to a complex system of competing objectives, it is highly recommended by experts and decision makers in handling the complexity of decision making problems. There are other goal programming (GP) algorithms and methodologies in the GP models such as Interval GP, Fractional GP, Duality solution, and Fuzzy GP to use along with linear GP, integer GP and non-linear GP to solve various multiple decision making problems. Therefore, for further study, the result obtained will be compare with other GP algorithms or methodologies in the GP models to determine the efficiency of the result.

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