Integer Programming Model in Handling IT Incident Workload

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ARTICLE INFO

Article history: 2019
Received: 2019
Revised: 2019
Accepted: 2020

Keywords: Integer programming, IT incident, Ticket System, Optimization, Workload distribution

ABSTRACT

A system called Incident Ticket System (ITS) uses in an organization to identify issue about service failure of IT system. The IT support personnel or team is responsible to resolve an incident associated with the ticket. The ticket has different kind of complexity which takes different time to solve and different level of expertise to close it. Therefore, allocating the optimum quantity of tickets to the right team members is vital in order to close all ticket at minimum time. Balancing the amount of ticket that each team member should get respectively with the ticket severity is important. To make even-handed workload for each team member, an approach of Integer Programming (IP) was applied in allocating the IT incident ticket. The IP model was implemented in Microsoft Excel software by using SOLVER. The computational results show that the proposed IP model was capable on solving allocation of ticket-severity problem.

I. Introduction

Making the Information Technology (IT) system reliable is crucial nowadays as many businesses are heavily depending on it. Any IT issue and problem need to be handled systematically in order to minimize IT interruption, which further impact the operation of organization. A system called Incident Ticket System (ITS) usually used in an organization to identify and capture issue about service failure of the IT system. The term ticket refers to this incident record[1]. The IT support personnel or team is responsible to resolve an incident associated with the ticket. The implementation of ITS in IT monitoring system ensures effective management of incidents and faster resolution times.

Although the ITS generates the ticket automatically, the assignment of the IT personnel for solving issue on particular ticket is done manually. As the team leader manually assigns the allocation of ticket to the IT team member, some of the team members might be overloaded due to extra tickets and some might get less workload due to fewer tickets. This imbalance of workload assignment and poor decision by the team leader not only reduces overall work performance productivity but also results dissatisfied employees[2]. Many studies consistently reported the effect of bad relationship with supervisor and co-worker was associated with high turnover[3][4]. Therefore, an objective tool that could overcome the aforementioned problems with the subjective workload assignment is utmost required.

There are several techniques available regarded to a workload allocation and staff assignment. Linear Programming (LP) and Integer Programming (IP) are among established optimization methods. The IP method was applied for solving nurse rostering schedule[5][6]. Valouxis (2016) for instance implemented a two-phase strategy of IP where a weekly nurses workload were specified in the first phase of IP model followed by specific daily shift in the second phase. The authors have developed technique called constraint integer programming to achieve balanced nurse-patient assignment[7]. Mullinax and Lawley applied a linear programming and heuristic method regarding system assignment that produced a balanced workload[8]. Pesant on the other hand has solved the integrated problem of staffing and nurse-patient assignment through constraint programming[9]. In another applications of IP, Labidi et al. have used multi objective of IP to schedule the monthly bank IT staff working shift[10]. Their approach has reduced a total of 50% of overtime cost.

There are several advantages of using IP, viz., this approach was generally guaranteed could obtain optimal solution that satisfied all constraints in many scheduling problem[11][12]. In addition, the

computational time for IP was faster than other techniques[13]. In this paper, we applied IP for solving staff assignment of ITS with the objective function to minimize the time taken to close all tickets.

II. Research Methodology

2.1. Data

Data for this study was collected from an IT company based in Cyberjaya, Malaysia. Normally, the IT helpdesk team consists of manager, team leader and IT helpdesk staff. Incident ticket was handled by the team leader and IT helpdesk staff. The daily operation starts when large quantities of IT incident tickets arrive to the team leader. The team leader will allocate the ticket to each of the IT helpdesk. Once the IT helpdesk staff receives the ticket, they will resolve the problem stated according to the tickets. The process ends after the IT helpdesk staff closes the ticket and marks the ticket status as completed. The workflow of IT helpdesk operation is illustrated in Figure 1.

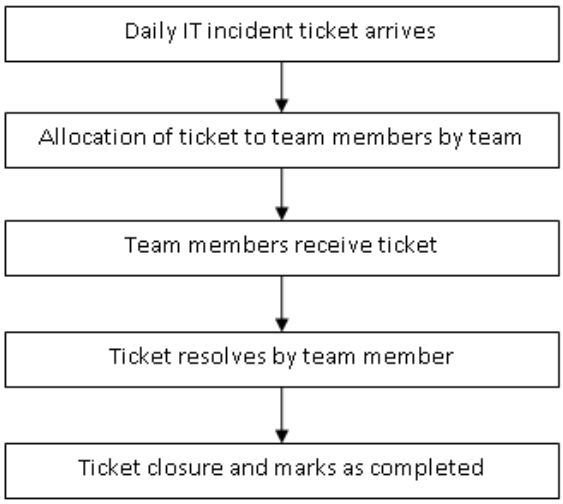

Figure 1. IT helpdesk operation workflow

IT incident tickets are crucial in defining the workload of IT helpdesk. The ticket usually has the following information:

- Incident type

  Example: software, hardware, network, backups and others
- Name of the user
- Timestamp of the ticket
- Ticket ID or ticket number
- Incident severity

There are three levels of incident severity:

- Severity 1
- Severity 2
- Severity 3

Each severity takes different time to solve and different level of expertise/skill to close the ticket. Therefore, allocating the optimum quantity of tickets to the right team members is vital in order to close all ticket at minimum time.

2.2. Integer Programming Model

2.2.1. Objective

The objective function of implementation IP in this workload assignment is to minimise the time taken to complete the tickets. We define x_{ij} to be the quantity of ticket for IT helpdesk *i (i=1,2,3,…,n)* and *j* represents the ticket severity (*j*= 1, 2 and 3). The ITS records the time taken of each IT helpdesk staff to close ticket. Hence, the values obtained in Table 1 based on the historical data recorded in the ITS. The time taken to close IT incident ticket was varied between the staff. The difference was due to the staff working experience, skill level and expertise.

The mathematical model for IP is defined in the following form:

$$\text{Max } Z = \Sigma\, c_j x_j \text{ for } i=1, 2, 3,\ldots,n \text{ and } j=1, 2 \text{ and } 3 \quad (1)$$

where c_{ij} is the time taken for staff *i* to solve incident ticket severity *j* and x_{ij} is the total number of tickets based on severity *j* assigned to the staff *i*.

2.2.2. Constraints

As stated earlier in 2.1, this IP approach was implemented on the problem where large volume of tickets arrives at the start of every workday. Therefore, a maximum quantity of ticket per each IT helpdesk was calculated by using equation (2).

(i) Maximum quantity of ticket per person = (Daily total quantity of ticket)/(quantity of team member including team leader) (2)

(ii) Quantity of ticket according to severity

As stated earlier, a daily IT incident ticket consists of Severity 1, Severity 2 and Severity 3 tickets. Severity 1 ticket is the hardest issue/problem to solve and require the longest time to close. Severity 2 ticket is the medium issue/problem to solve and require medium time to close. Severity 3 ticket is the simplest issue/problem to solve and require less time in comparison to Severity 1 and 2.

Table 1. Average value of time taken (in minutes) to close the ticket for various ticket severity.

Staff ID	Severity 1	Severity 2	Severity 3
Team leader	18	16	12
IT helpdesk 1	19	18	11
IT helpdesk 2	20	19	13
IT helpdesk 3	21	15	12

2.3. Implementation Process flow

IP model for ITS staff assignment problem was implemented on a daily basis as the total amount of tickets change from day to day. The workflow on how the team leader applies IP to allocate tickets to team members is shown in Figure 2.

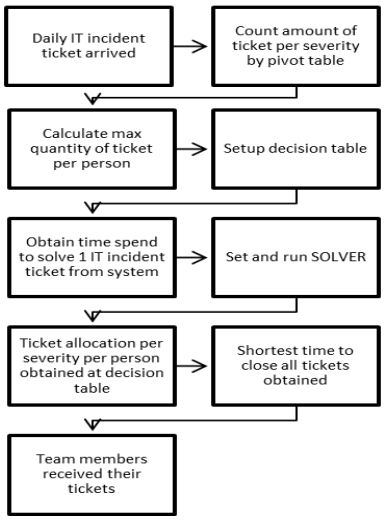

Figure 2. The IP model workflow for ITS staff assignment.

2.4. Software

IP model for this ITS problem was modeled by using the Microsoft Excel Solver. Excel Solver uses Simplex method of LP in solving optimization problem. Excel Solver requires user to define three parameters of the model namely the objective function, decision variables and finally the problem constraints.

III. RESULTS AND DISCUSSION

This present work was conducted solely as a pilot study to show how a simple IP model could be implemented to solve imbalanced workload assignment in IT company. The IP model was tested during a normal working day in the company where the total incident ticket was recorded at 64 and the total IT helpdesk staff on duty was 4 persons. The maximum quantity of ticket per person was calculated by using equation (2) and gave the maximum value of 16. The total amount of tickets categorized to the Severity level of 1, 2 and 3 was recorded at the value of 9, 20 and 35 respectively. The result of the IP model for ITS staff assignment problem is shown in Table 2. The optimal time taken to close all the ticket was 907 minutes. The team leader received the maximum number of tickets but all was for Severity 3. The total utilization time of the team leader to solve ITS problem was 192 minutes. In comparison, the IT helpdesk staff 1, 2 and 3 used 243, 235 and 237 minutes respectively to solve the tickets assigned to them. The result from IP model among the IT helpdesk staff was comparable and provides a balanced workload assignment. The limitations of this study are this IP model requires fixed number of IT tickets in order to calculate the maximum quantity of ticket per person at a time and it could not cater a condition where new ticket arrives during the day. In addition, this model does not include cost minimization in the objective function, which directly benefits organization. Other modern method of IP such as mixed integer and multi-objective approach could be implemented to improve this model[14][15].

Table 2. Integer Programming ITS staff assignment result.

Staff ID	Severity 1	Severity 2	Severity 3
Team leader	-	-	16
IT helpdesk 1	5	7	2
IT helpdesk 2	3	1	12
IT helpdesk 3	1	12	3
Minimum total time taken (in minutes)	907		

IV. CONCLUSION

In this study, an optimization model based on IP was adapted to solve staff assignment in the ITS problem. The outcome from SOLVER would help the team to achieve the optimum value in term of shortest time to close all ticket and a balanced quantity of the ticket for each IT helpdesk staff. We believe this work on IP contributes to the improvement of the managerial decision in the company.

ACKNOWLEDGEMENTS

This research was funded under Research University Grant (Vot No. 03K24) from Universiti Teknologi Malaysia. The authors would like to thank the Research Management Centre of UTM and the Malaysian Ministry of Education for their financial support.

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