A shift sequence for job scheduling by using Linear programming problem

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Abstract

The job scheduling problem (JSP) of this paper is to study and analyses the scheduling process in practice and the job shop scheduling problem is a well known combinatorial optimization problem. In this paper to minimize the fairness of the schedule the solution can be represented in several ways with different constraints and evaluation function. This paper illustrates how the linear programming problem solve the job scheduling problem and how it has been effectively used in BISMI Trades company. A linear programming model for company is developed for job scheduling optimization. A numerical illustration example of employee scheduling for four hours shift is presented and the optimum solution is solved by Excel solver. Finally, some conclusive observation have drawn recommendations have been suggested.

Keywords:*job (employee) scheduling, linear programming problem (LPP), constraints, objective function, Excel solver.*

1. Introduction

Job scheduling is the series of action of constructing a single whole work timetables for its employee so that an activity can satisfy the requirement for its worships. The deed of transferring the working shifts to employee over a period for many days is a hard for utilizing the task. In the domain of production demand, this is particularly challenging because of the presence of a range of different employee requirement on different days and shifts. Finally, use Microsoft Excel solver to generate scheduling problem to solve is the determination of day schedules for employee.

Linear programming or linear optimization, is a mathematical method to achieve the minimum or maximum value of a linear function. To put simply, one can achieve the best outcome (e.g. maximum profit or minimum cost) by using linear programming under specific settings and constraints. While linear programming is mainly used in management and economics. Linear programming uses a mathematical model to describe the problem of concern. Linear programming is a set of techniques and method inferred from mathematics and other sciences which can play anefficient role in improving the management decision.

Linear programming can be used in various fields of study. Linear programming is mainly used in commercial and economic situation. In addition, it is useful in modeling issues of planning, routing, scheduling, allocation and design. An evaluation of 500 largest companies in the world showed that 85% of them have used linear programming (chasten 2001).

The Mason and smith introduced work stretch cost and work stretch transition in an integer programming model to decide the cost of the day–on within and between the work stretches. Column generation was employed to decided on the content of the work stretch and to link them in constructing the schedules concerning other costs related to shifts. Where a concept called stint is introduced to define a feasible sequence of shifts on consecutive days. Schedules for employee can then be constructed either cyclic or non cyclic rosters.

In this work, the purpose this article is suitable method for linear programming to solve an instance of the employed scheduling problem met in BISMI industry, while seeking for the schedule that guarantees a high level of fairness between the employees.

In section 2, we present the statement of the problem. The application area is described in section 3 and literature review in section 4. Section 5 shows the format of LPP. Finally, we implementation of employee scheduling model and Excel solver are given and the conclusion in section 6 & 7 respectively.

2. Statement of the problem

Since the optimization model that will be developed is expected to be applicable to different instances, this section starts with depicting the scope of the problem which is followed by an extended description of the problem through a case provided by the company.

In mathematics, linear programming issues include optimization linear objective function that should established a series of limitations in form of linear equality and unequal. Informally, goal of linear programming is using mathematical model to get the best output linear (e.g. maximum profit, minimum working).

The standard form of linear programming follows as

$$\text{Maximize } z = c^T x \quad (1)$$

$$\text{Subject to } Ax \leq b$$

$$x \geq 0$$

The objective in this paper is to create a roistering tool, which is practically and which complies with the requirements of realistic settings in a company. Several literatures reviews have addressed the lack of broadly applicable approaches.

From these we are describe general roster characteristics as; Fixed planning period, Fixed number of shifts, Time norm each employee, Maximum number of days on in a week / on-stretch, some combinations of on /off days prohibited, A minimum rest period after a shift is required, specific shifts transitions are not allowed, single days-on / days-off are undesirable., Each employee has individual preferences, May have shift assignments which are fixed in advance.

We, at the same time, find a number of individual rules and agreements which are very specific and only apply to few of the problems. We must be able to cater for these individual rules by several literatures as;

On all days: at least one of the employee was also there the day before, A employee cannot work two consecutive weekends, Minimize the number of different shifts in a stretch, one week with 60 hours allows only 16 hours the following week, If workings nights shifts, at least to constructive nights shifts must be scheduled, If a set of days on ends with a night shifts, then the following on-stretch must not begin early, unless there is a 'long' off-stretch in-between, some nurses have a weekly off day called a zero-days are always on the same day of the week. A special shift type must be covered by the same employee for a whole week.

3. Applications

Linear programming has several applications in military, government, industry and civil engineering. In addition, it is often used as part of a calculated plan, solving nonlinear programming problem, discrete programming problems, optimal control problems and contingency. Linear programming is an important optimization for several reasons: Many practical and also a number of other algorithm of optimization problems by linear programming work as sub-problem. Historically, ideas of linear programming inspire many basic concepts of optimization theory such duality. Decomposition and importance of convexity and its generalizations.

Linear programming mainly is used in macroeconomics, business management, maximizing revenue and minimizing the cost of production. For example, inventory management, asset and stock management, human and non-human resources allocation, planning and advertising tours (chacharsooghi and Jafari, 2007).

Many companies and government agencies have saved millions of dollars in successful application of linear programming. The following are some of these achievements.

4.Literature Review

Literature on employee rostering and scheduling is extensive. Several studies have employed optimization methods to solve the JSP, like linear, integer or mixed integer programming, goal programming or constraint programming. Many of more recent paper tackle the JSP with met heuristic methods such as genertic algorithms,tab search or simulation. We believe the resolution techniques involving the use of solvers are more easily transferable to

industry-services.other approaches, is focused on the linear programming problem, which seeks the demand coverage while minimizing the salary cost and maximizing the employs preferences as well as team balance.

Different objectives are studied in this literature are to decrease manual scheduling, to increase demand covering in terms of workforce size but also according to required skills, to obtain equality between the schedules.

5.Format of Linear Programming model

The general format of the Linear Programming model essentially consists of three components.

i). The activities (variables) and their relationships.
ii). The objective function and
iii). The constraints

The activities are represented by $x_1 , x_2 x_3 , \ldots . x_n$.
There are known as Decision variables.

The objective function of an LPP is a mathematical representation of the objective in terms a measurable quantity such as profit, cost revenue,etc

Optimize (maximize or minimize) z = $c_1 x_1 + c_2 x_2 + c_3 x_3 + \cdots c_n x_{n.}$.
Where z is the measure of performance variable?
$c_1 x_1 + c_2 x_2 + c_3 x_3 + \cdots c_n x_{n.}$are the decision variables. And $c_1 , c_2 c_3 , \ldots . c_n$ are the parameters that give contribution to decision variables. The constraints these are the set of linear inequalities which impose restriction of the limited resources.

5.1 Assumptions of linear programming

Certainty

In all LP models it is assumed that, all the model parameters such as availability of resources, profit(or cost) constructing of a unit of decision variable and consumption of resources, by a unit of decision variable must be known and constant.

Divisibility (continuity)

The solution values of decision variables and resources are assumed to have either whole numbers (integers) or mixed numbers (integer or fractional). However, if only integer variables are desired, then integer programming method may be employed.

Additivity

The value of the objective function for the given value of decision variables and the total sum of resources used, must be equal to the sum of the contributions (profit or cost) earned from each decision variable of the resources used by each decision variable respectively./ The objective function is the direct sum of the individual contributions of the different variables.

Linearity

All relationships in the LP model (i.e. in both objective function and constraints) must be linear.

5.2 General Mathematical Model of an LPP

Optimize (Maximize or Minimize) z = $c_1 x_1 + c_2 x_2 + c_3 x_3 + \cdots c_n x_{n.}$. (2)

Subject to constraints,

$$a_{11} x_1 + a_{12} x_2 + \cdots \ldots \ldots \ldots . + a_{1n} x_n \, (<, =, >) \, b_1$$
$$a_{21} x_1 + a_{22} x_2 + \cdots \ldots \ldots \ldots . + a_{2n} x_n \, (<, =, >) \, b_2$$
$$a_{31} x_1 + a_{32} x_2 + \cdots \ldots \ldots \ldots . + a_{3n} x_n \, (<, =, >) \, b_3$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$a_{m1} x_1 + a_{m2} x_2 + \cdots \ldots \ldots \ldots . + a_{mn} x_n \, (<, =, >) \, b_m$$

And $x_1, x_2, \ldots . x_n > 0$

5.3 Guidelines for formulating linear programming model

i). Identify and define the decision variable of the problem
ii). Define the objective function
iii). State the constraints to which the objective function should be optimized (i.e. Maximization or Minimization)
iv). Add the non-negative constraints from the consideration that the negative values of the decision variables do not have any valid physical interpretation.

6. Job Scheduling problems Modeling

Job scheduling is a known problem, Improving self-scheduling are of the familiar. Some of them will be describe in the technical way. The practical examples will be studied, modeled, and different ways of enlighten the present process will be published. In industry the clerk goes through the pursuing steps to create a schedule:

i) Gather preference
ii) Block out the schedule
iii) Revise the schedule
iv) Display the schedule
v) Accommodate the schedule

Job schedule aim is to minimize changes to be original schedule while minimizing costs , rebuilding the schedule with current staff is usually be simple way ,by changing the schedule will alter other job schedule as well. One of the BISMI traders company has the following minimal daily requirements for job.

Table 1. Job scheduling

Shift(period)	Clock time(24hours day)	Minimum number of employee required
1	6.00 a.m – 10.00 a.m	50
2	10.00a.m - 2.00 p.m	100
3	2.00 p.m - 6.00p.m	150
4	6.00p.m - 10.00p.m	64
5	10.00p.m - 2.00 p.m	25
6	2.00p.m - 6.00p.m	36

Employee report at the company at the beginning of each period and work for 6 consecutive hours. The company wants to determine the minimal number of employees to be employed so that there will be a sufficient number employees available for each period.

Formulate this as a linear programming problem by setting up appropriate constraints and objective function

Minimize $z = x_1 + x_2 + x_3 + x_4 + x_5 + x_6$

Subject to constraint

$$x_1 + x_2 \geq 50$$
$$x_2 + x_3 \geq 100$$
$$x_3 + x_4 \geq 150$$
$$x_4 + x_5 \geq 64$$
$$x_5 + x_6 \geq 25$$

$x_6 + x_1 \geq 36$; $x_1, x_2, x_3, x_4, x_5, x_6 \geq 0$.

Since the model has six variables by using the Excel solver to solve LPP, the feasible solution is 225.The solution found by the linear programming algorithm. (Excel –shown below) uses the minimum number of 225 employees to meet the scheduled.

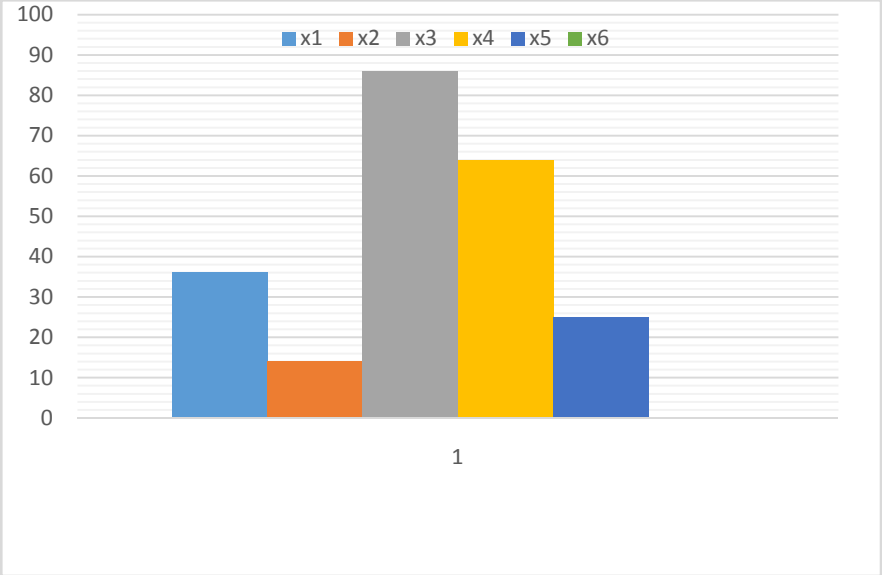

Fig 6.1 Bar diagram- shift sequence of job scheduling

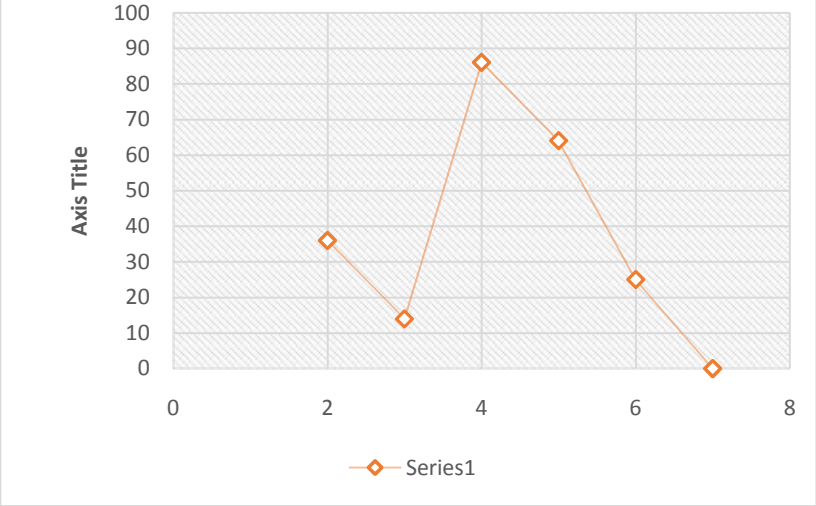

Fig 6.2. X Y (scatter) of employed scheduling

A1 variables

	A	B	C	D	E
1	variables				
2	x1	36			
3	x2	14			
4	x3	86			
5	x4	64			
6	x5	25			
7	x6	0			
8	objective				
9					
10	minimize	225			
11					
12	constraints		inequality	RHS	
13	1	50	>=	50	
14	2	100	>=	100	
15	3	150	>=	150	
16	4	89	>=	64	
17	5	25	>=	25	
18	6	36	>=	36	
19					
20					

7. Conculsion

In this paper solve the optimization of job scheduling problem the seeks the minimum number of employees can handle the company needs. The job scheduling problem could be solved by the Excel solver to minimum the number employees to meet at the schedule. And also to draw a job scheduling of bar diagram. This is one of the best way of optimization problem.

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