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Application of Operation Research in Library Management

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***Abstract*—In view of such difficulties in library management as the number of orders and heavy tasks, the Management Operation Research method is introduced hereinto. Firstly, the normal situation of library daily works is presented in three pictures, wherein sights of library service are clear at a glance, and the task of optimal model is given. Then, the linear programming method is used to solve the model, and the results are directly applicated to guide the schedule of library staff. And the service quality of circulation desks is evaluated comprehensively by using the queuing theory model, the optimal number of library workers are obtained by model solution. The two examples illustrate the significance of these methods in the planning of library work arrangement, and by using the introduced methods, the efficiency of library weekly works is heightened greatly. In addition, the optimal model can be used in other similar mission planning problems.**

Keywords—Library Management; Management Operation Research; Linear Programming and Queuing Theory

I. INTRODUCTION

With the rapid development of science and technology, the knowledge created by human beings tends to grow explosively. And as the carrier for knowledge dissemination, books are also increasing at a very high speed in type and quantity. And library is the organization that gathers, collates and collects books and materials to provide information service. How to carry out library management scientifically and efficiently, improve library work and service quality, give full play to library functions, promote the development of library cause, and make library exert the maximum efficiency is a very valuable subject. The science that studies library management activity and its rule is called science of library management. It is an important branch of modern library science formed upon the application of management science in library management. Library management[1-5] is an activity to effectively manage the library's document information, human resources, financial resources and material resources through a series of processes such as planning and decision-making, organization, leadership, control and coordination. In this paper, the method of Management Operation Research[6] is introduced to arrange library work scientifically.

II. INTRODUCTION TO THE MANAGEMENT OPERATION RESEARCH

Operation Research[7] is an applied science making overall arrangement of human resources, material resources, financial resources and other resources in the economic management system by methods of analysis, experiment and quantification to provide decision makers with the optimal scheme based on evidence, so as to achieve the most effective management. Management Operation Research is the application of Operation Research in human resources, material equipment and production management.

III. APPLICATION EXAMPLE OF MANAGEMENT OPERATION RESEARCH METHODS

A. Human resource management

For libraries of common colleges and universities, in order to make many departments run normally, it needs a considerable number of staff, the daily work scene is displayed in figure 1-figure 3.

Fig. 1 Picture of modern library

Fig. 2 Picture of readers searching books

Fig. 3 Sight of library workers serving readers one by one

This raises a question for library managers, that is, how to determine the number of staff required and the schedule of work and rest to not only meet the requirement on normal operation of the work, but also enable each staff member to have two consecutive days off every week, of course, from practical considerations, the total number of staff shall also be minimized.

Analysis: When determining the total number of staff required, as each person has two consecutive days off, the total number of staff needed can be figured out as long as the total number of people who have two consecutive days off is calculated. According to their rest time, they can be divided into 7 categories, and the analysis is shown in Table 1.

Table I consists Number of workers required and people who take a rest every day.

TABLE I. TABLE STYLES

Category	Time to take a rest	Number of people who take a rest	Workers required
I	Monday	X1	M1
II	Tuesday	X2	M2
III	Wednesday	X3	M3
IV	Thursday	X4	M4
V	Friday	X5	M5
VI	Saturday	X6	M6
VII	Sunday	X7	M7

Then, set out the constraints in terms of the number of workers required each day, for example, the number of people needed on Monday is M_1, so everyone should go to work except those who begin to take a break on Sunday and those who begin to take a break on Monday. According to the above analysis, the following mathematical model can be established:

The targets are to Minimize the total number of staff required. That is, $X_1+X_2+X_3+X_4+X_5+X_6+X_7$ is the minimum

The actual constraints are:

(1) At least M1 people work on Monday (composed of those who begin to take a rest from Tuesday, Wednesday, Thursday, Friday or Saturday).

(2) At least M2 people work on Tuesday (composed of those who begin to take a rest from Wednesday, Thursday, Friday, Saturday or Sunday).

(3) At least M3 people work on Wednesday (composed of those who begin to take a rest from Monday, Thursday, Friday, Saturday or Sunday).

(4) At least M4 people work on Thursday (composed of those who begin to take a rest from Monday, Tuesday, Friday, Saturday or Sunday).

(5) At least M5 people work on Friday (composed of those who begin to take a rest from Monday, Tuesday, Wednesday, Saturday or Sunday).

(6) At least M6 people work on Saturday (composed of those who begin to take a rest from Monday, Tuesday, Wednesday, Thursday or Sunday).

(7) At least M7 people work on Sunday (composed of those who begin to take a rest from Monday, Tuesday, Wednesday, Thursday or Friday).

M_1 can be obtained from long-term statistic survey. According to the idea of linear planning in Operation Research[8-10], the above models can be transformed into mathematical formula:

$$\min X_1+X_2+X_3+X_4+X_5+X_6+X_7$$

$$\text{s.t. } X_1+X_3+X_4+X_5+X_6 \geqslant M_1$$

$$X_3+X_4+X_5+X_6+X_7 \geqslant M_2$$

$$X_1+X_4+X_5+X_6+X_7 \geqslant M_3$$

$$X_1+X_2+X_5+X_6+X_7 \geqslant M_4$$

$$X_1+X_2+X_3+X_6+X_7 \geqslant M_5$$

$$X_1+X_2+X_3+X_4+X_7 \geqslant M_6$$

$$X_1+X_2+X_3+X_4+X_5 \geqslant M_7$$

Substitute specific values hereinto. And the optimal solution of the above problems can be obtained by linear programming and solving method [8].

B. Circulation desk service quality evaluation

A very important part of the daily work in library is to provide services for the vast number of book borrowers. As far as libraries of colleges and universities are concerned, the borrow time is random, and the probability of a reader arriving has nothing to do with time t, but is related to the length of time, that is, the probability of a reader arriving is very big in a long period of time, and the probability of a reader arriving in time interval △t is proportional to the length of △t.The above features satisfy the three conditions of Poisson distribution [5] exactly, that is to say, the arrival process of borrowers at the circulation desk forms Poisson flow.

Suppose a circulation desk can serve 3 persons every minute, 2 borrowers arrive at the desk on average a minute, that is, a queuing theory model can be established for the service system of this desk: average arrival rate in unit time , and average service rate in unit time .

The following index parameters can be figured out in accordance with the idea of queuing theory:

(1) Possibility of no borrower at the desk:

$$P_0 = 1-\frac{\lambda}{\mu} = \frac{1}{3}$$

(2) Average number of borrowers in line:

$$L_q = \frac{\lambda^2}{\mu(\mu-\lambda)} = \frac{4}{3}$$

(3) Average number of borrowers at the desk:

$$L_s = L_q + \frac{\lambda}{\mu} = 2$$

(4) Average queuing time spent by a borrower:

$$W_q = \frac{L_q}{\lambda} = \frac{2}{3}$$

(5) Average lingering time a borrower at the desk:

$$W_S = W_q + \frac{1}{\mu} = 1$$

(6) The possibility that borrowers must queue:

$$P_w = \frac{\lambda}{\mu} = \frac{2}{3}$$

Upon the analysis of above parameters, and combination with the actual situation, service system of the desk is relatively satisfactory as a whole. However, when the average number of people in front of the desk reaches 2, a person needs to wait for 0.7 minute on average. These two service parameters should be reduced, that is to say, the waiting time of borrowers should be shortened as much as possible, and the queue length should be shortened. The above parameters can be reduced by increasing the average service rate per unit of time, thus achieving the effect of improving service quality.

IV. CONCLUSION

In this paper, the idea of Management Operation Research is introduced into library management with examples, providing scientific reference basis for library work arrangement. However, library management shoulders a heavy task and is complicated. In addition to the two examples in this paper, many work arrangements can be analyzed by using related methods in Management Operation Research, so as to enable managers to make scientific decisions and finally achieve the goal of improving service quality, reducing operation cost and efficiently operating each department.

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