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Mug Up Of Library Management Using Operations Research Technique

Dr.Roshli Aniyeri

Assistant Professor,

Dept: of Mathematics,

Mahatma Gandhi Government Arts College Mahe,

Affiliated to Pondicherry Central University,Pondicherry ,India

Abstract

Libraries play a vital role in providing people with reliable content. They encourage and promote the process of learning and grasping knowledge. The book worms can get loads of books to read from and enhance their knowledge. Quality of library and its services is the key to the success of learning program. Information on research, teaching and learning is the major role of a public library in present scenario. The heart of the public is provides the information for learning and teaching. Public libraries are at present facing their supreme challenge due to the universal electronic revolution. The public libraries started badly to evaluate how healthy they are in meeting, delighting, and anticipating the user group. Operations research (OR) is a branch of applied mathematics that can be used to analyze libraries and information organizations. OR can help library managers use resources effectively, and make better decisions. the linear programming method is used to solve the model, The method illustrate the significance in the planning of library work arrangement, the efficiency of library weekly works is heightened greatly.

Keywords: Linear programming problem, library Management, Python

Introduction

Libraries and information organizations, like any other organization require competent management. The present day libraries are complex systems and require sophisticated management. Operations research is an important management tool which can aid the library managers in effectively using all available resources. OR, having a set of analytical tools enables researchers to understand library and information activities and services in a better manner.

Operations research is a branch of applied mathematics that helps in making better decisions in given resource constraints. This field first emerged during World War II and has evolved to encompass numerous analytical techniques. Areas that lend themselves to OR techniques besides the library and information organizations are manufacturing, logistics (especially airlines), health care and materials transportation. The right technique when applied to real-life problems can deliver significant values and insights to planners and policy makers who have to make decisions. The objective of Operational Researchers

is to work with users to find practical and pragmatic solutions to operational or strategic problems. In short, libraries are a great place to gain knowledge. They serve each person differently. They are a great source of learning and promoting the progress of knowledge. One can enjoy their free time in libraries by reading and researching. As the world has become digitized, it is now easier to browse through library and get what you are looking for. Libraries also provide employment opportunities to people with fair pay and incredible working conditions. The application of operations research methods in libraries started in the early 1960s. Philip M. Morse at the Massachusetts Institute of Technology (MIT) was first one to develop interest in libraries. He used the library of MIT as a convenient laboratory for student projects in the operations research program.

The National Science Foundation was one of the first foundations that supported much of the early work in the United States and was the major factor in influencing operations researchers to address the problems of libraries. The early efforts focused on traditional areas of library operations, particularly those that required a minimum understanding of library science. The work at Purdue began in 1962 with an internally funded operations research study of the university's libraries. Later, the work received funding from the National Science Foundation. An important feature of the Purdue work was the extensive involvement of the librarians. The work done by the Leimkuhler group at Purdue was probably the most significant, both in terms of impact, size and duration. The Industrial Engineering School at Purdue had a good working relation- ship with the Purdue University Libraries. Definition of Operations Research (OR) in the context of library and information organisations is that it is an analytical method of problem-solving and decision-making that is useful in the management of organizations. In operations research, problems are broken down into basic components and then solved in defined steps by mathematical analysis.

Due to rising costs, shrinking budgets and available technologies, the modern libraries want to make the best use of available resources. The modern computer and communication technologies have increased need for information requirements and the present day library users expect high-quality library products and services whenever and wherever they need them. Library organizations, whether public or private, need to provide these products and services as effectively and efficiently as possible. This requires careful planning and analysis, in other words, the hallmarks of good operations research (OR). This is usually based on process modelling, analysis of options or mathematical modeling.

OR has been successfully applied to the library and information science field. It is due to the fact that it is a problem-solving activity which is capable of developing new techniques as and when a situation demands, OR is applicable not only to the routine problems but also to strategic and operational planning and problems of design in organisations. Although considered to be one of the best decision-making and monitoring techniques of management, it is a constraint, that is, it can be applied to situations where it is possible to construct mathematical models.

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,

Methodology

Linear programming is a mathematical concept that is used to find the optimal solution of the linear function. **(LPP)** involve optimizing a linear function to find the optimal value solution for the function. The optimal value can be either the maximum value or the minimum value.. Linear Programming has a huge real-world application and it is used to solve various types of problems. **Linear Programming Problems** In LPP, the linear functions are called **objective functions.** An objective function can have multiple variables, which are subjected to conditions and have to satisfy the **linear constraints**.

A linear programming problem consists of,

- Decision variables
- Objective function
- Constraints
- Non-Negative restrictions

Decision variables are the variables x, and y, which decide the output of the linear programming problem and represent the final solution.
The **objective function**, generally represented by Z, is the linear function that needs to be optimized according to the given condition to get the final solution.
The **restrictions** imposed on decision variables that limit their values are called constraints.
By applying LPP to guide the schedule of library staff:

Application Example of Management Operation Research Methods

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 below

Problem*

A library has 5 staff members (A, B, C, D, and E) and operates 7 days a week, with morning (9am-1pm) and afternoon (1pm-5pm) shifts. The library wants to create a schedule that meets the following requirements:
1. Each staff member works a maximum of 20 hours per week.
2. At least 2 staff members are present during each morning shift.
3. At least 3 staff members are present during each afternoon shift.
4. Staff member A is unavailable on Mondays and Fridays.
5. Staff member B is unavailable on Tuesdays and Thursdays.
6. Staff member C prefers to work only morning shifts.
7. Staff member D prefers to work only afternoon shifts.

Decision Variables

x_{ij} = 1 if staff member i works on day j (morning shift)
y_{ij} = 1 if staff member i works on day j (afternoon shift)

Objective Function

Minimize the total number of staff hours worked:

Constraints

1. Maximum hours per staff member: $\sum(x_{ij} + y_{ij}) \leq 20$ for each staff member i
2. Minimum morning staff: $\sum x_{ij} \geq 2$ for each day j
3. Minimum afternoon staff: $\sum y_{ij} \geq 3$ for each day j
4. Staff availability: $x_{ij} = 0$ for staff member A on Mondays and Fridays, and $x_{ij} = 0$ for staff member B on Tuesdays and Thursdays
5. Staff preferences: $x_{ij} = 0$ for staff member D (afternoon preference), and $y_{ij} = 0$ for staff member C (morning preference)

Solution by python programme

```
import numpy as np

from scipy.optimize import linprog

# Number of staff and days

num_staff = 5

num_days = 7
```

```
# Number of decision variables: each staff member has 2 variables per day (morning and afternoon shifts)
num_vars = 2 * num_staff * num_days
# Coefficients for the objective function (minimize total hours worked)
# Each variable represents one hour of work (so coefficients are 1 for each shift)
c = np.ones(num_vars)
# Define the inequality constraints (Ax <= b)
# 1. Maximum hours per staff member
A_ub = np.zeros((num_staff, num_vars))
for i in range(num_staff):
    for j in range(num_days):
        A_ub[i, 2 * (i * num_days + j)] = 1  # morning shift x_ij
        A_ub[i, 2 * (i * num_days + j) + 1] = 1  # afternoon shift y_ij
b_ub = np.full(num_staff, 20)  # Maximum 20 hours per staff member

# 2. Minimum morning staff
A_eq_morning = np.zeros((num_days, num_vars))
for j in range(num_days):
    for i in range(num_staff):
        A_eq_morning[j, 2 * (i * num_days + j)] = 1  # morning shift x_ij
b_eq_morning = np.full(num_days, 2)  # At least 2 staff for morning shift each day
# 3. Minimum afternoon staff
A_eq_afternoon = np.zeros((num_days, num_vars))
for j in range(num_days):
    for i in range(num_staff):
        A_eq_afternoon[j, 2 * (i * num_days + j) + 1] = 1  # afternoon shift y_ij
b_eq_afternoon = np.full(num_days, 3)  # At least 3 staff for afternoon shift each day
# Combine both morning and afternoon constraints
A_eq = np.vstack([A_eq_morning, A_eq_afternoon])
b_eq = np.hstack([b_eq_morning, b_eq_afternoon])
# 4. Staff availability constraints
```

```
# Staff member A unavailable on Monday and Friday (x_A1 = 0, x_A5 = 0)
for j in [0, 4]:  # Monday and Friday
    A_eq = np.vstack([A_eq, np.zeros(num_vars)])
    A_eq[-1, 2 * (0 * num_days + j)] = 1  # x_Aj (staff A's morning shift)
    b_eq = np.hstack([b_eq, np.array([0])])
# Staff member B unavailable on Tuesday and Thursday (x_B2 = 0, x_B4 = 0)
for j in [1, 3]:  # Tuesday and Thursday
    A_eq = np.vstack([A_eq, np.zeros(num_vars)])
    A_eq[-1, 2 * (1 * num_days + j)] = 1  # x_Bj (staff B's morning shift)
    b_eq = np.hstack([b_eq, np.array([0])])
# 5. Staff preferences
# D prefers afternoon shifts (x_Dj = 0 for all days)
for j in range(num_days):
    A_eq = np.vstack([A_eq, np.zeros(num_vars)])
    A_eq[-1, 2 * (3 * num_days + j)] = 1  # x_Dj (staff D's morning shift)
    b_eq = np.hstack([b_eq, np.array([0])])
# C prefers morning shifts (y_Cj = 0 for all days)
for j in range(num_days):
    A_eq = np.vstack([A_eq, np.zeros(num_vars)])
    A_eq[-1, 2 * (2 * num_days + j) + 1] = 1  # y_Cj (staff C's afternoon shift)
    b_eq = np.hstack([b_eq, np.array([0])])
# Solve the linear programming problem using linprog
result = linprog(c, A_ub=A_ub, b_ub=b_ub, A_eq=A_eq, b_eq=b_eq, method='highs')
# Check the result
if result.success:
    print("Optimal solution found:")
    # Interpret the result
    schedule = result.x.reshape((num_staff, num_days, 2))
    for i in range(num_staff):
        print(f"Staff {chr(65+i)}:")  # A = 65, B = 66, etc.
        for j in range(num_days):
```

```
print(f"  Day {j+1}: Morning = {schedule[i][j][0]}, Afternoon = {schedule[i][j][1]}")
else:
    print("Optimization failed:", result.message)
```

Substitute specific values hereinto. And the optimal solution of the above problems can be obtained by linear programming method

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.. In addition to the example 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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