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Work Allocation Algorithm (WA2): An Operations Research Approach

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Abstract— The objective of this paper is to deep dive into Linear Programming (LP) approach for solving "Optimal allocation of work mix in a cross-training environment". One need that is often practiced by industries is to come up with optimal number of resources required to run the operations without compromising the customer service. This paper sheds light on the problem of resource optimization using Linear Programming approach.

The mathematical formulation considers various parameters like Associate's availability (hours), Historical Performance (Items processed per hour), Service Level Agreement (SLA) of work-mix in its formulation. The optimization-based solution is implemented in a typical back-office processing unit in a financial organization.

Index Terms— Back-office operations, Demand, Linear Programming, Resource allocation, Optimization, Service Level Agreement, Supply

1 Introduction

A back office or a transactions processing environment is one where the client or a third party comes up with a request either online or offline to be resolved by the organization. The transactions get processed by cross trained associates of operations headed by an operations manager. It is in the best interest of the organization to cater to these incoming requests by offering the best customer experience without missing client level SLAs and at the same time balancing this with the cost of operations. This calls for optimizing the cost of operations, the largest chunk of the cost being the associate or labor cost. Allocation of the right work to the right associate, maintaining quality and at the same time maximizing the throughput is the way to achieve this optimized cost.

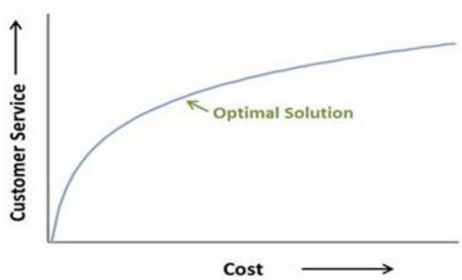

Fig. 1. Figure shows the trade off between cost of operations and customer service.

This can be achieved using multiple techniques and this paper focusses on one such technique. Here the variables are associate specific and dynamic in nature. This uses a framework built to input various parameters (decision variables) like associate's availability, historical performance, quality, and skillset data along with volume forecast (demand), and priorities of job in order of SLAs etc. The core of it is a simplex optimization algorithm to iterate to an optimal solution that reduces the overall effort by the team. A minimization problem (objective function) with multiple constraints to capture the business parameters is formulated and the result is an optimized allocation which can be easily adopted and implemented by the managers. This would help the manager in taking better decisions to optimize the service delivery against the cost of operations.

In the following sections, paper describes the approach in detail along with mathematical formulation.

2 Methodology

2.1 Application of LPP in Resource Allocation

Linear programming problem used here is application of **Allocation of resources** in operations where the decision variables are proportion of work that can be allocated to the trained associates based on their historical productivity/performance. Assigning the right proportion of the right work-mix to the right associate, helps business process the work in an efficient manner.

Here, the objective is to minimize the total available hours of associates. For example: In most of the cases, the associates work for 8 hours shift and if there are ***"n"*** associates working in a department, then the total available time to process the department's work is ***8n***. There could be many possible combinations of total available hours based on number of associates as well as their shift timings. The objective to find out optimal processing time comes with certain constraints like

1. Total processed volume by cross trained associates cannot be more than the total demand (Forecast).
2. Constraint on available hours of associates (8 hours, without any Overtime).
3. Constraint on maximum volume processed by an associate.
4. Constraint on least amount of volume that can be processed by an associate.

If there are multiple streams of work that must be processed in a certain priority, then that can be accommodated in the model in which each and work stream will be treated sequentially in the given priority. Ordering of work stream is important if we have service level agreement (SLA) based on work streams. In case of sequential processing where simplex method is applied

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to each work stream sequentially, constraints of LPP at a given instance of time may be dependent on the result obtained from previous work stream. For example, availability of resources to process the work keeps on reducing in each step.

The implementation of work allocation across associates can be applied at hourly, daily or weekly level based on business requirements.

2.2 Optimization Formulation

Objective Function: Optimize the total processing hours by changing the decision variable, which is proportion of work processed by associates

Constraints:

For a given work stream

1. Total processed volume by associates is greater than or equal to total demand of each work stream.
2. Volume processed by associates is less than or equal to the amount of work an associate can process (total available time * associate's productivity) in each workstream.
3. Allocated hours are less than or equal to the available hours of associates for ach workstream.

2.3 Mathematical Formulation

Objective Function:

$$\text{Objective} = \text{MIN} \sum_{j=1}^{k} \sum_{i=1}^{n_j} \left(\frac{V_{i,j}}{IPH_{i,j}} \right) \quad (1)$$

j=1 to k are work streams with different priority, 1 being highest priority

i= 1 to n are associates skilled for work stream J_k

$V_{i,j}$ is volume allocated to associate i for work stream j

$IPH_{i,j}$ is $\frac{\text{Items}}{\text{Hour}}$ for work stream J for associate i

Constraints:

1. Constraint on volume allocated:

$$\sum_{i=0}^{n} V_i \geq \text{Demand for workstream J} \quad (2)$$

2. Constraint on maximum volume processed by an associate:

$$Vi \leq IPH_i \times AVAIL_i \quad (3)$$

$AVAIL_i$ is availability of associate i, after applying universal utilization U

3. Constraint on availability of each associate:

$$\frac{V_i}{IPH_i} \leq AVAIL_i \text{ for associate I} \quad (4)$$

To make it more realistic, following variations of basic algorithm were considered. These incorporate customizations and/or additions to existing constraints considered earlier.

2.3.1 Minimum Allocation Guarantee

This tries to allocate a minimum amount of work to each associate in case of low demand, so that all associates have some work to process. Considering the greedy nature of algorithm, associates who are new or less trained would not get anything to process, so this constraint will take care of same.

New Constraint:

$$V_i \geq \text{MIN for work stream J} \quad (5)$$

MIN can be set as some percentage of total demand and can be customized based on need.

2.3.2 Maximum Burnout Cut – Off

In this, the constraint on Max volume allocated (please refer "(3),") is slightly different and is dictated by the maximum % of demand, which can be decided by operations manager. The algorithm tries to give maximum work to most efficient associate. So, this will help in reducing the burden on those associates and will reduce burnout.

Constraint 2:

$$V_i \leq IPH_i \times AVAIL_i \times MAX\% \quad (6)$$

MAX% can be set as some percentage of total demand and can be customized based on need.

2.3.3 Associates level Utilization

In this customization the availability of each associate is different and is based on associate specific utilization. Instead of applying a universal utilization for all associates, an associate specific utilization is applied.

In Equation (3), the availability now becomes

$AVAIL_i$ which is availability of associate i at utilization U_i

Constraint 2:

$$V_i \leq IPH_i \times AVAIL_i \text{ For associate i=1 to n} \quad (7)$$

If the solution is infeasible, try changing the limitations set on constraints. Example, in case Demand constraint (constraint 1) is not met, there will be backlog (Backlog = Demand – Processed Volume). This backlog can be converted to overtime by working extra hours which will be operations manager's discretion.

3 Recommendations

This helps managers understand if they have sufficient supply to match the demand.

1. Overtime required: In case of backlog, WA2 estimates the overtime required to process the backlog along with the recommended list of associates.

2. Hours Optimization and Backlog Reduction: The algorithm optimizes the total available time so that the associate have more time to work on Projects, Trainings, Personal development. Optimization of total available time leads to reduction in backlog.
3. Proactive/ Reactive Planning: Helps managers in proactively plan upcoming weeks. It also provides capability to run it reactively on any given day/time in case of known open items.
4. Proactive planning leads to fix or schedule associate's vacation in advance and plan for meetings and trainings.
5. Training Needs: Consistent backlog along with unallocated hours is an indication of training requirements for few associates.
6. Shift Optimization: Helps aligning shift timings with incoming work.
7. Increased compliance to formal processes like maintaining associate schedules, skill matrix and historical data (hours input).

4 Conclusion

Allocation of resource is very critical to the operations in industry. Of late, abundance of data in industry has led to the development of advanced algorithms for optimal resource allocation. The technique used here "WA2" uses one such algorithms to optimize the total processing time by leveraging the historical associate level data and other operations levers. Translating decisions in terms of cost to organization (overtime, resource sharing) helps in making scale and efficiency decisions. This can be scaled up and applied to any other type of setup for optimum results.

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