Enhancing Productivity through Manpower Optimization

IE3100M Systems Design Project | Department of Industrial Systems Engineering and Management

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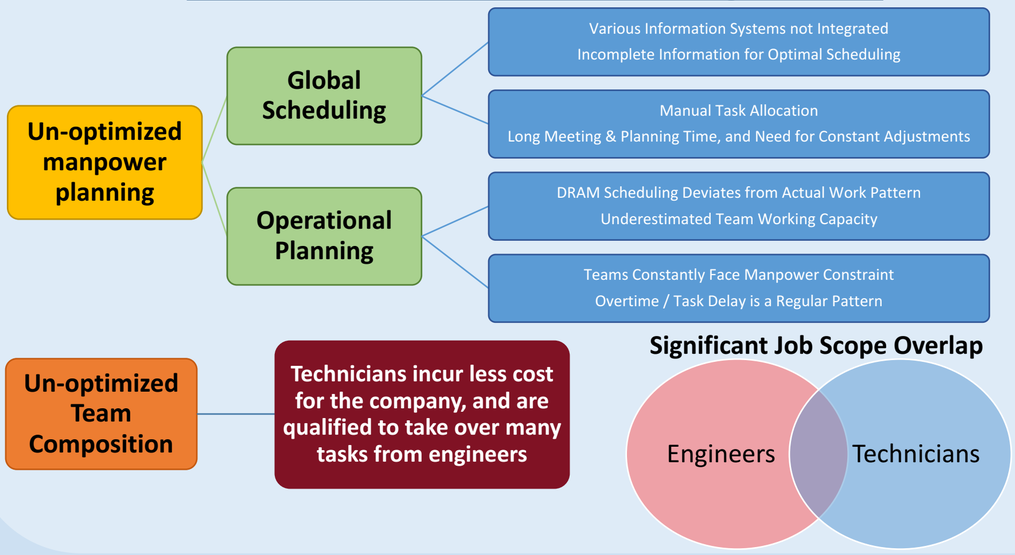
1. Background

The Line Maintenance Division (LMD) in SIA Engineering Company (SIAEC) is an increasingly important business segment due to the increasing amount of air traffic in Singapore. This results in a need for more handlers as the aircrafts transit through Changi Airport.

To increase the company's profitability and competitiveness in the aviation maintenance, repair, and overhaul (MRO) industry, our project seeks to optimise the existing workflow process and human resource in order to meet job demands in LMD.

2. Problem Description



3. Objectives

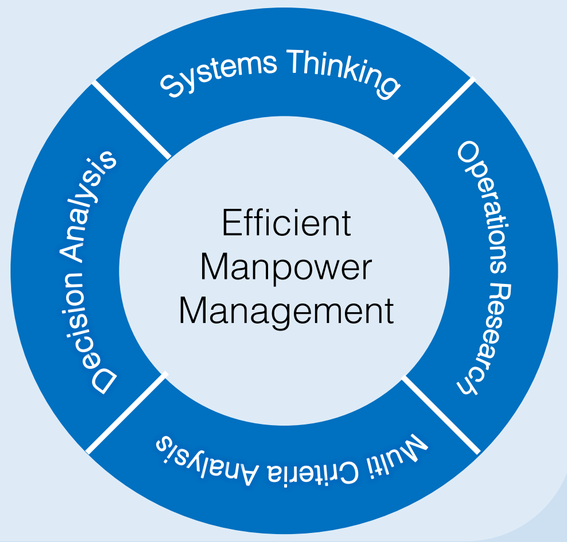
To re-engineer the current job scheduling and manpower allocation process to eliminate redundant and time-consuming workflow processes.

To increase cost-effectiveness in meeting jobs demand through altering the team composition of engineers and technicians.

Improve the accessibility and visibility of information for all stakeholders by designing an integrated system.

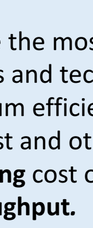
4. Methodology

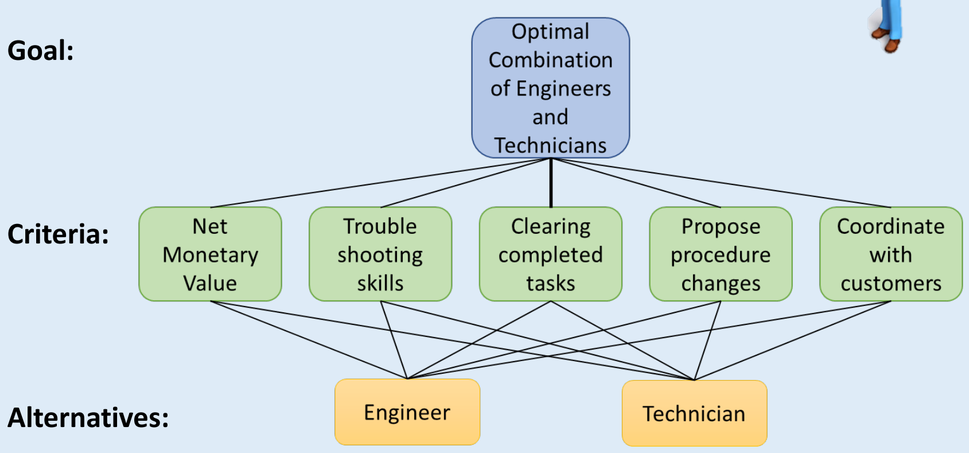
- **Systems Thinking** – Mapping out the maintenance processes to determine areas of opportunities to improve efficiency.
- **Decision Analysis** – Usage of tools such as the Analytic Hierarchy Process to systematically quantify qualitative criteria for better decision making.
- **Operations Research** – Formulating complex problems using mathematical models to achieve optimal results.
- **Multi Criteria Analysis** – Accounting of the cost and benefits of labor force composition to provide quantifiable indicators to aid in managerial decision making.



5. Optimization of Manpower Makeup

Multi Criteria Decision Analysis





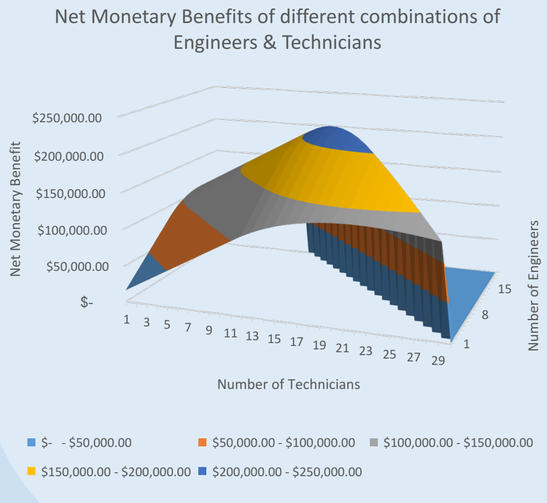
The Multi Criteria Decision Analysis (MCDA) models how different Business Units (BU) quantify contributions that engineers and technicians can bring about.

Depending on the nature of tasks that each BU usually take on, different weightage can be allocated to each criteria.

Using **Cost Accounting** concepts, the net monetary benefit of engineers and technicians are calculated.

Output will help BU estimate the most optimal number of engineers and technicians they should have for maximum efficiency when taking into account cost and other factors. This results in **reducing** cost of **OT clocked** and **increasing throughput.**

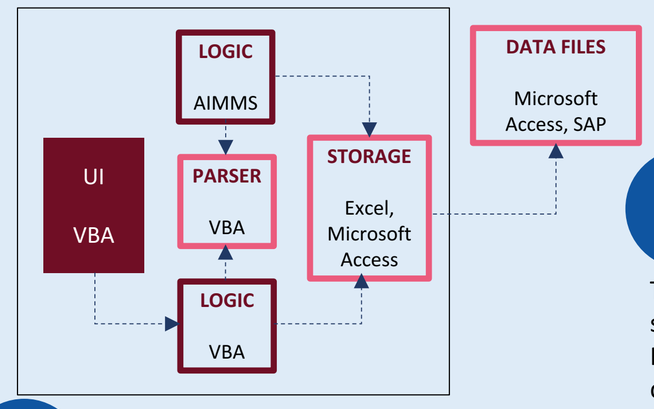
Cost Analysis of Labour Combination



6. Global Optimization of Job Scheduling

Step 1 — Design System to Integrate Necessary Information for Optimization

Relevant information such as engineer skill sets, shift patterns and task information will be pulled from various systems into one program to enhance accessibility and for computational purposes to be used for optimization.

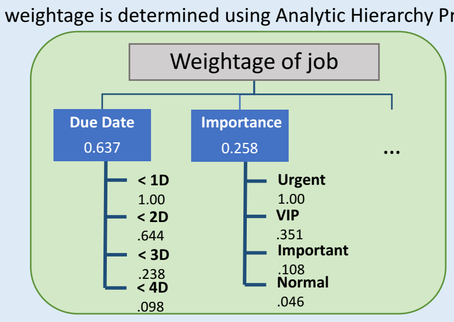


Step 2 — Mixed Integer Programming (MIP) Formulation

Objective Function:

Maximizing Total weightage of jobs being done

The weightage is determined using Analytic Hierarchy Process.



Assumptions:
- Engineers who are allocated jobs are present that day
- Jobs can be completed within stated process time

Constraints:
- Plane ground time
- Total working hours
- Engineers' shifts
- Engineers' competency and certifications

Step 3 — Heuristic Approach

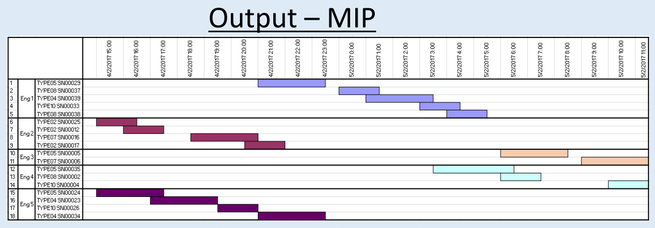
Limitations of MIP:
- Time complexity of MIP is high
- Currently not possible to run for huge data sizes

Considerations:
- Reduce problem size by filtering out "non-essential" jobs using a cut-off weightage method
- Reducing decisions for actual job start time
- Priority to higher weightage jobs

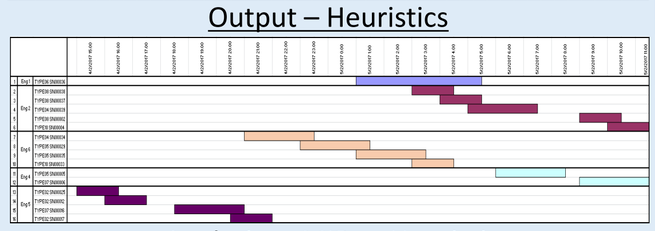
Step 4 — Output and Analysis

The Gantt charts are a visualization of the optimal schedule computed from the MIP and heuristics. From this data set, the schedule is significantly different. Total number of jobs assigned from the MIP is more than the heuristic approach.

Output – MIP



Output – Heuristics



Analysis – MIP vs Heuristics

	MIP	Heuristics
Optimality	Exact optimal solution	Feasible solution but may not be optimal
Efficiency	Large space and long time needed due to complexity	Quick solution

7. Conclusion

Manpower Configuration Optimization with MCDA

- Cost analysis has enabled LMD to quantify the cost and benefits offered by each unit of labour.
- It also allows LMD to revise the composition of their teams to obtain the most cost-effective level.
- The use of MCDA allows integration of qualitative factors for a more holistic analysis.

Global Optimization of Job Scheduling Using MIP

- Implementing a system that integrates the necessary information together allows management to have better visibility of day to day operations and to make better decisions for their scheduling processes.
- Transforming experienced based planning with automation will reduce the time taken for an executive to be competent in allocating manpower.
- Automating the scheduling process with Excel VBA and AIMMS has greatly reduced the time taken to allocate jobs as compared to the current manual scheduling process.
- The MIP and heuristic approach each has certain trade-offs. As the problem size increases, one has to be willing to compromise optimality for efficiency. It is important to be mindful of these trade-offs when using either approach.

8. Future Direction

Scaling of Job scheduling Prototype:
- Manpower resource is usually uncertain at the time of scheduling. Designing a probabilistic component that predicts whether an engineer is available that day based on historical data might improve the accuracy of the model.
- Interactions between towing teams and availability of spare parts are integral in the maintenance process. If the current model is deemed to be practical, expanding it to consider these factors could streamline the scheduling processes even further.

Refining of Cost analysis to improve accuracy of prediction:
- This model is built based on average values of cost and benefits provided by each unit of labor. It could be improved by further refining the distinction between engineers and technicians of differing skillsets and experience.