Information and Communications Technologies

QATAR UNIVERSITY جامعة قطر

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OPTIMIZATION MODELS FOR MULTIPLE RESOURCE PLANNING

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Abstract

- **M**ultiple **R**esource **P**lanning (MRP) is a very crucial undertaking for most organizations.
- MRLPs are very prevalent in today's organizational environments and are particularly critical for organizations that handle concurrent, time-intensive, and multiple-resource projects.
- MRP facilitates efficient allocation of resources and reduces costs.
- Using data obtained from the Ministry of Administrative Development, Labour and Social Affairs (ADLSA), an MRLP is proposed.
- A novel models and solution approach for the MRLP were proposed.
- The results show that the model performs well, even in higher instances.
- The positive results attest to the effectiveness of the proposed MRLP problem.

Introduction/Objectives

Create a solution that solves the key challenges that project managers encounter in day-to-day management of multiple projects.

Dealing with high project demands, uncertainties, project constraints, and dealing with competing priorities.

Enhance project scheduling within a given time horizon to get the optimal resource allocation solution.

Methods and Materials

***Input Data:**

n: Number of tasks,
R: Number of resources,
H: Time horizon,
b_{rt}: Capacity of resource *r* at period *t*,
m_j: Number of execution modes of task *j*,
a_{jrk}: Consumption of resource *r* by task *j* under mode *k*,
p_j: Processing time of task *j* under mode *k*,
r_j : start date of the project
d_j: Due date of task *j*,
w_j: Weight of task *j*,
σ_{rt}: Cost of adding one unit of capacity to resource *r* at period *t*.

***Decision Variables:**

x_{jk}: Binary variable that takes value 1 if task *j* is executed under mode *k*, and 0 otherwise.
y_{jt}: Binary variable that takes value 1 if task *j* is executed during period *t*, and 0 otherwise.
s_{jt}: Binary variable that takes value 1 if task *j* starts at the beginning of period *t*, and 0 otherwise (that means, $s_{jt} = 1 \Rightarrow$ task *j* starts at time *t*).
f_{jt}: Binary variable that takes value 1 if task *j* finishes at the end of period *t*, and 0 otherwise (that means, $f_{jt} = 1 \Rightarrow$ task *j* finishes at time *t+1*).
T_j: Tardiness of task *j*.
z_{rt}: Additional capacity of resource *r* at period *t*.

***Test Instances Ranges:**

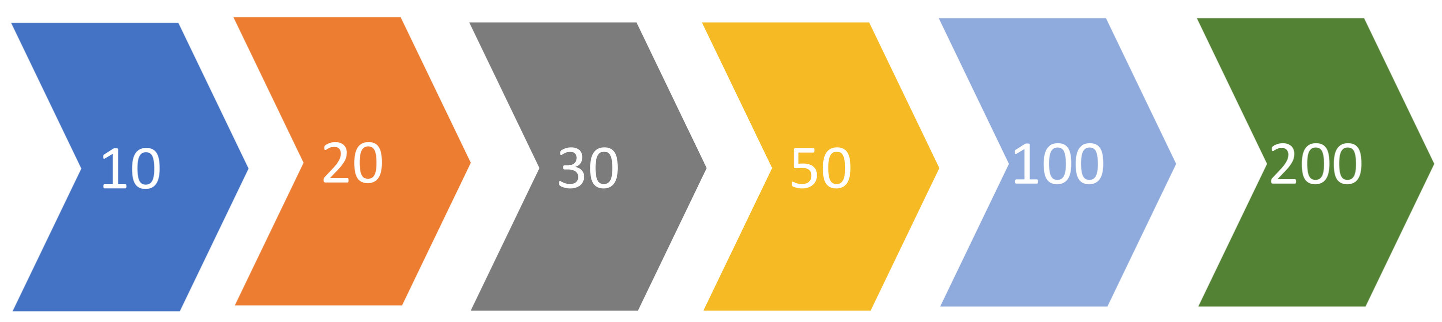

Figure 1. Number of projects ranges

Model Formulation

$$\textbf{Model } (MM, MR, FC): Minimize \sum_{j=1}^{n} w_j T_j + \sum_{r=1}^{R}\sum_{t=1}^{H} \sigma_{rt} z_{rt}$$

Subject to:

$$\sum_{k=1}^{m_j} X_{jk} = 1, \qquad j = 1, \dots, n$$

$$\sum_{t=1}^{H} S_{jt} = 1, \qquad j = 1, \dots, n$$

$$\sum_{t=1}^{H} f_{jt} = 1, \qquad j = 1, \dots, n$$

$$\sum_{t=1}^{H} t\, S_{jt} \geq r_j, \qquad j = 1, \dots, n$$

$$\sum_{t=1}^{H} t\, S_{jt} + \sum_{k=1}^{m_j} p_{jk}\, x_{jk} = \sum_{t=1}^{H} t f_{jt}, \qquad j = 1, \dots, n$$

$$\sum_{t=1}^{t} S_{jt} - \sum_{t=1}^{t} f_{jt} = y_{jt}, \qquad j = 1, \dots, n;\ t = 1, \dots, H$$

$$\sum_{j=1}^{n}\sum_{k=1}^{m_j} a_{jrk}\ u_{jkt} \leq b_{rt} + z_{rt} \qquad r = 1, \dots, R, ; t = 1, \dots, H$$

$$T_j \geq \sum_{t=1}^{H} t f_{jt} - d_j, \qquad j = 1, \dots, n$$

$$x_{jk} + y_{jt} \leq u_{jkt} + 1, \qquad j = 1, \dots, n;\ R = 1, \dots, m_j;\ t = 1, \dots, H$$

$$x, y, z\ binary,$$

$$T, s, f, u \geq 0,$$

Results & Discussion

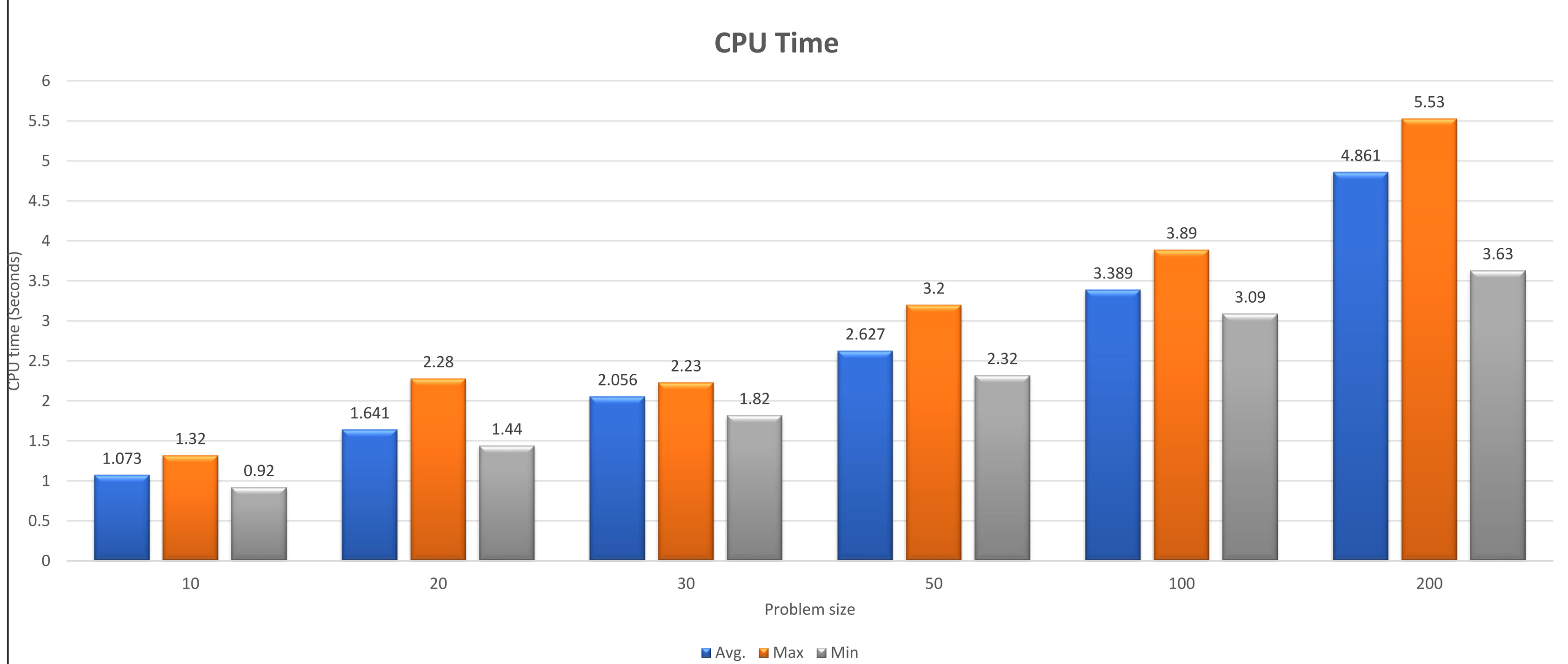

Figure 2. CPU time of the model

- As the complexity of the test instances increased, the CPU time has increased reasonably. The proposed model was performed within a very short time (seconds) even when increasing complexity of tasks number to 200.
- The maximum running time was completed in 5.53 seconds while the average time-solving time is between 1.073 and 4.861 seconds.

Conclusions

Provides a solution that minimizes time wastages and ensures efficient resource utilization for both single-mode and multi modes projects, while allows the combination of resources while considering restrictions and time constraints to achieve optimal scheduling and resource planning.

References

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