

Invitation

You are cordially invited to the public defence to obtain the academic degree of

DOCTOR OF BUSINESS ECONOMICS

by Jakob Snauwaert

Data and solutions for project scheduling with multi-skilled resources

Supervisor:
Prof. dr. Mario Vanhoucke

Friday, 2 December 2022 at 15h
in Auditorium Vandenhove, Campus Boekentoren
Paviljoen Charles Vandenhove – Rozier 1, 900 Gent

Please confirm your attendance no later than 25 November by email to
Jakob.Snauwaert@ugent.be

EXAMINATION BOARD

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Abstract

To tackle budget overruns, exceeded deadlines and other frequently occurring problems in projects, the research field of project management was founded. In recent decades, the focal point of this research has been on creating baseline schedules for projects that can be proactively implemented to estimate total project duration and total project cost. This dissertation studies a project scheduling problem, called the multi-skilled resource-constrained project scheduling problem (MSRCPSP), in which the workers are characterized by a set of skills. A skill is defined as the capability of a worker to perform a certain job in an activity. Hence, two decisions need to be made in the MSRCPSP: the scheduling order of the activities and the assignment of workers to the required skills of the activities.

Chapter 2 presents a new generation procedure for artificial instances of the MSRCPSP. Skill parameters are created to generate the availability and the variability of the skills in the workforce, while resource parameters are implemented to control the number of resources in the workforce as well as how the skills will be distributed along the resources. Based on these parameters, the complexity of multi-skilled project instances is investigated.

In **Chapter 3**, we develop a state-of-the-art genetic algorithm for a new problem that extends the MSRCPSP with variable durations based on the skill level of the multi-skilled resources. The concepts of breadth and depth are introduced to characterise the resources in this problem. Breadth signifies the perceived amount of skills that a worker masters. Depth is the efficiency or skill level at which work can be performed by a resources.

Chapter 4 proposes 7 different continuous and time-indexed formulations for 6 different extensions of the MSRCPSP. These 6 extensions each incorporate hierarchical skill levels into the problem with a varying impact. To solve these problems, the dataset of Chapter 2 was extended into a modular dataset with hierarchical skill level information. Moreover, the impact of the hierarchical skill levels was analyzed for each of the different problems and their specific objectives.

The primary goal of **Chapter 5** is to analyze the complexity of assembling multi-skilled workforces given a set of activities with specific skill requirements. If there are no restrictions on the multi-skilled workforce, it is trivial to create a feasible workforce that can fulfil all the given skill requirements. However, imposing restrictions on the characteristics of the workforce substantially complicates this problem. For each of the problems in this chapter a complexity proof is given, together with its empirical hardness.

Using the gathered knowledge about solution procedures for multi-skilled resource-constrained project scheduling problems and the intricacies of hierarchical skills and their impact on objectives, a problem-specific algorithm is developed in **Chapter 6** for each of the 6 problems of Chapter 4.

Curriculum vitae

Jakob Snauwaert (°1994, Ghent) obtained his Master of Science in Business Engineering at Ghent University in 2017. He started as a doctoral researcher at Ghent University in October 2017 at the Department of Business Informatics and Operations Management. Jakob presented his work at several international conferences: the 17th and 18th International Conference on Project Management and Scheduling (Toulouse - online, 2021 and Ghent – online, 2022) and the 30th, 31st and 32nd European Conference on Operational Research (Dublin, 2019, Athens – hybrid, 2021 and Espoo, 2022). At the 18th International Conference on Project Management and Scheduling in Ghent, Jakob was a prize winner in the Best Student Paper Competition. Chapters 2 and 3 of his dissertation have been published in the European Journal of Operational Research. Chapter 4 has been published in Computers and Industrial Engineering.