

Balancing Operating Room Utilization Through Volatility-stratified Surgical Portfolios

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Abstract

Operating room (OR) capacity utilization plays a critical role in improving patient care and enhancing financial performance in healthcare. However, traditional OR planning approaches and limited flexibility in resource allocation often struggle to balance scheduled elective surgeries with unpredictable emergency cases, leading to inefficiencies such as overtime and undertime. We propose a design science approach comprising four key stages to balance OR utilization. First, the problem framing and conceptualization phase involved close collaboration with hospital managers and surgeons to identify OR capacity challenges and explore demand-side flexibility strategies. Through in-depth discussions, we critically assessed the limitations of existing planning methods and identified opportunities for a more adaptive and efficient approach. Second, inspired by the volatility portfolio approach and the *layered spackling* strategy, we introduce a volatility-stratified surgical portfolio, categorizing surgeries according to medical advice and patient preferences. Surgeries are classified into emergency (high volatility), general elective (moderate volatility) and flexible elective (low volatility). By leveraging the low volatility as a buffer to absorb fluctuations, we accommodate emergency demand uncertainty while offering theoretical and practical insights into flexibility management in operations. Third, a simulation incorporating uncertainty and sensitivity analysis was conducted using real data from two hospitals before and during COVID-19. The stage, combined with machine learning, mixed integer programming, and empirical-based algorithm, demonstrates the effectiveness of the framework in balancing OR capacity utilization. Finally, the evaluation phase combined simulation-based assessments with practitioner validation workshops to examine the feasibility and applicability of implementing the framework in healthcare and other industries.

Keywords

Healthcare Management, Operating Room Planning, Design Science, Volatility Portfolio and COVID-19 case study.

Biographies

Lauri Saarinen is an Assistant Professor in the Department of Industrial Engineering and Management, School of Science at Aalto University. His research focuses on operations management, supply chain analytics, and decision-making under uncertainty. Lauri earned his PhD in Operations Management from the University of Lausanne, where his research centered on supply chain responsiveness and uncertainty management. He also holds a Master's degree and a Bachelor's degree in Engineering and Technology from Aalto University. Prior to his academic career, Lauri

worked in management consulting at Capacent. His consulting experience provided him with a strong foundation in practical problem-solving and strategic decision-making, which continues to inform his research. His research has been published in journals such as *Journal of Operations Management*, *Journal of the Operational Research Society*, and *Journal of the Knowledge Economy*, *Operations Management Research*, among others. His work provides insights into supply chain disruptions, food waste reduction strategies, and operations planning during crises.

Chao Pan is a visiting doctoral researcher in the Department of Industrial Engineering and Management, School of Science at Aalto University, Finland. He is also a doctoral researcher at the Research Centre for Operations Management, Faculty of Economics and Business. His research focuses on healthcare operations, scheduling, and operations research. He has been invited to serve as a reviewer for *Annals of Operations Research*. Before his PhD studies, he obtained a Bachelor's degree in Automation from Beijing Institute of Technology, Zhuhai, and a Master's degree in Industrial Engineering from Fuzhou University. In the practical project, he worked at TPV-tech in the Center of Intelligent Manufacturing Technology. As a core member of the development team, he developed an Advanced Scheduling System, which has been implemented at TPV-tech, the world's largest display manufacturer. He is deeply interested in the integration of operations management and operations research with practical applications.

Erik Demeulemeester is a Professor at the Research Centre for Operations Management at KU Leuven. He obtained a Bachelor's degree in business engineering in 1987, a Master of Business Administration in 1988, and a PhD in 1992, all from KU Leuven. Currently, he serves as the Chair of the Department of Decision Sciences and Management Informatics at the Faculty of Economics and Business at KU Leuven. His primary research interests lie in the areas of project scheduling and healthcare planning. He has published over 150 articles in renowned journals such as *Management Science*, *Operations Research*, *IIE Transactions*, and *European Journal of Operational Research*. He is currently a member of the editorial boards of the *European Journal of Operational Research*, *Journal of Scheduling* and *Computers & Operations Research*. He was also appointed to the Program Committee for the EURO XXVIII Conference in Poznan. Additionally, he serves as a core jury member for the EURO Excellence in Practice Award (EEPA), which has been and will be awarded at the EURO-k conferences in 2016, 2018, and 2019. In the past, he has organized two PMS workshops in Leuven and one ORAHS conference, which brought together around 120 researchers from around the world.