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Document Version
Final published version

Citation (APA)
Powell, D., Napoleone, A., Romero, D., Waschull, S., & Zanchi, M. (2026). Future-Proofing Production and Operations Management Education: An IFIP WG5.7 Benchmarking Study. In H. Mizuyama, E. Morinaga, T. Kaihara, T. Nonaka, G. von Cieminski, & D. Romero (Eds.), *Advances in Production Management Systems. Cyber-Physical-Human Production Systems: Human-AI Collaboration and Beyond - 44th IFIP WG 5.7 International Conference, APMS 2025, Proceedings* (pp. 509-519). (IFIP Advances in Information and Communication Technology; Vol. 768 IFIPAICT). Springer. https://doi.org/10.1007/978-3-032-03546-2_34

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Future-Proofing Production and Operations Management Education: An IFIP WG5.7 Benchmarking Study

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Abstract. Kongsberg Defence & Aerospace – a Norwegian multinational company that develops and delivers innovative technologies to safeguard people and critical infrastructure – is experiencing a fast-growing order backlog and a growing need for production managers to ensure efficient, high-quality and competitive production processes in its factories around the world. Recognizing this need, and through the establishment of a professorship in production management at the University of South-Eastern Norway, the company is seeking to establish a world class education program in production and operations management to develop and strengthen education in the field. As such, this paper sets out to benchmark production and operations management programs across the member institutions of the IFIP working group 5.7: Advances in Production Management Systems. We analyze both bachelor and master programs in the fields of engineering and management from 16 institutions spanning twelve different countries: Norway, the Netherlands, Mexico, Italy, Brazil, France, Denmark, Sweden, Switzerland, Australia, the UK and the USA. We also present the findings of an industrial focus group initiative in which participants considered the results of the global benchmarking study and identified areas for development based on gaps in the current offerings. The findings can be used by member institutions to help navigate current and future geopolitical challenges.

Keywords: Production and Operations Management · Engineering · Education · Benchmarking · Curriculum

1 Introduction

Production and Operations Management (POM) lies at the heart of industrial competitiveness, economic resilience, and sustainable development [1]. As global value chains become increasingly complex and vulnerable, the strategic importance of high quality

© IFIP International Federation for Information Processing 2026
Published by Springer Nature Switzerland AG 2026
H. Mizuyama et al. (Eds.): APMS 2025, IFIP AICT 768, pp. 509–519, 2026.
https://doi.org/10.1007/978-3-032-03546-2_34

POM education has grown significantly [2]. In Europe (particularly in countries like Norway, with high-value manufacturing sectors and a growing need for global supply chain integration) the need to foster next-generation capabilities in production planning, supply chain resilience, digitalization, and sustainability is urgent [3].

The ongoing geopolitical disruptions – ranging from the war in Ukraine and associated energy crises, to evolving trade realignments and critical raw material dependencies – have amplified the need for resilient and adaptive production systems [4]. These challenges place renewed pressure on manufacturing firms to optimize operations locally while navigating volatile global environments. Consequently, the demand for professionals with robust training in POM is escalating, as organizations seek talent that can lead business transformation with lean thinking and practice, digitalization, and circular production systems [5].

At the same time, the European Union's strategic autonomy agenda and green industrial policies, such as the European Green Deal Industrial Plan, have elevated industrial policy as a central concern [6]. Norway, though not a member of the European Union, aligns closely with European industrial frameworks and faces parallel challenges in decarbonizing its industry and securing supply chain independence. As such, ensuring that educational programs equip students with the skills needed to design, manage, and innovate within sustainable production systems is not only an academic concern, but a national and continental imperative [7].

Despite these pressures, education in POM remains fragmented across institutions and countries, with significant variation in curriculum depth, pedagogical innovation, and integration with industry needs [8]. As such, this study aims to benchmark the current state of POM education within the IFIP WG 5.7 network, identifying strengths, gaps, and opportunities for advancing the pedagogical and strategic quality of POM education in Norway and the wider global context.

Benchmarking current programs provides critical insight into how academic institutions can align more effectively with evolving industry and policy demands. This is especially timely as universities adapt to digitalization in teaching, remote collaboration, and the increased need for interdisciplinary systems thinking. We also conduct a focus group study with Norwegian industry to capture some of the important themes which industrial managers are demanding for future programs.

To guide the study, we pose the following two research questions:

RQ1: *What are the current focal topics in global POM educational programs?*
RQ2: *What should be included in future POM educational programs?*

The rest of the paper is organized as follows: in Sect. 2 we describe the research design for the study, which uses a mixed methods approach. In Sect. 3 – responding to RQ1 – we compare the POM educational offerings across 16 different institutions to uncover similarities and differences in approaches. Then, in Sect. 4, we present the results of a focus group study to address RQ2. In Sect. 5 we discuss the results before presenting our conclusions and avenues for further work in Sect. 6.

2 Research Design

In this study we employ a mixed-methods research design combining document analysis [9] with focus group research [10] to provide: i) a comprehensive understanding of the current state-of-the-art of POM education programs, and ii) important reflections and desired future directions for POM education in practice.

The document analysis involved purposive sampling of higher education institutions and the collection of documentation of their current POM education offerings, at both Bachelor and Master level. We were interested in both management (BBA, MBA) and engineering (BEng, MSc) programs. In total, 16 institutions were selected from a total of 12 countries, and we analyzed the documentation of 33 programs (18 Master programs and 15 Bachelor programs). To benchmark current POM program curricula, we used thematic analysis to identify the emergent themes and topics taught in each of the 33 programs. A tally system was used to count the frequency of occurrence across documents / course descriptions. The results were confirmed by discussing the analysis together with representatives (informants) from the institutions.

Thereafter, further qualitative data was collected using focus group research to capture emergent themes and future focus areas which industry representatives considered important for POM education. A focus group workshop was planned and executed on May 21st 2025 and considered the views of 20 professionals from 8 organizations in the South-East region of Norway.

3 Content Analysis: POM Education Programs

In this section we present the results of the content analysis stemming from the document analysis described previously. Table 1 presents a classification of the POM programs considered in this research, i.e., Bachelor or Master level and Engineering or Management specialization. Given the strong technical backgrounds of the IFIP WG5.7 member institutions, most programs are skewed towards an engineering major (25:8). Otherwise there is a good balance of Bachelor- contra Master programs (15:18).

Table 1. Overview of the Selected POM Education Programs

	Engineering	Management
Bachelor Programs	**Brazil** Bach. Production Engineering **France** Bachelor Quality, Industrial Logistics and Organization **Italy I** BSc. Management & Production Eng **Italy II** Bachelor Management Engineering Bachelor Mechanical Engineering **Mexico** BSc. Ind. Eng **Netherlands I** BSc. Mech. Eng **Netherlands II** BEng. Ind. Eng. & Man **Sweden** BSc. Industrial Engineering **UK I** Bach. Mech. & Manufacturing Eng Bach. Manufacturing Systems Eng **USA** Bach. Industrial Engineering	**Denmark** Bachelor of Economics & Business Admin **Norway I** Bachelor Business Adm **Netherlands I** BSc. Ind. Eng. Man
Master Programs	**Australia** MSc. Ind. Eng **Denmark** MSc. Management Engineering (OSCM) **Italy I** MSc. Management Engineering **Italy II** Master Management Engineering Master Mechanical Engineering **Norway I** MSc. Digital Transformation Executive Master in Systems Eng **Norway II** Master in Manufacturing 4.0 **Sweden** MSc. Ind. Eng. & Man **Switzerland** MSc. DMTEC POM **UK I** MSc. Ind. Eng MSc. Industry 4.0 Advanced Manufacturing **UK II** Manufacturing Engineering	**Norway I** MSc Innovation and Technology Man **Norway II** MSc. Global Manufacturing Management **Sweden** MSc. Sustainable Production Development **UK I** MSc. Lean and Agile Operations **UK II** Industrial Systems, Manufacture & Management

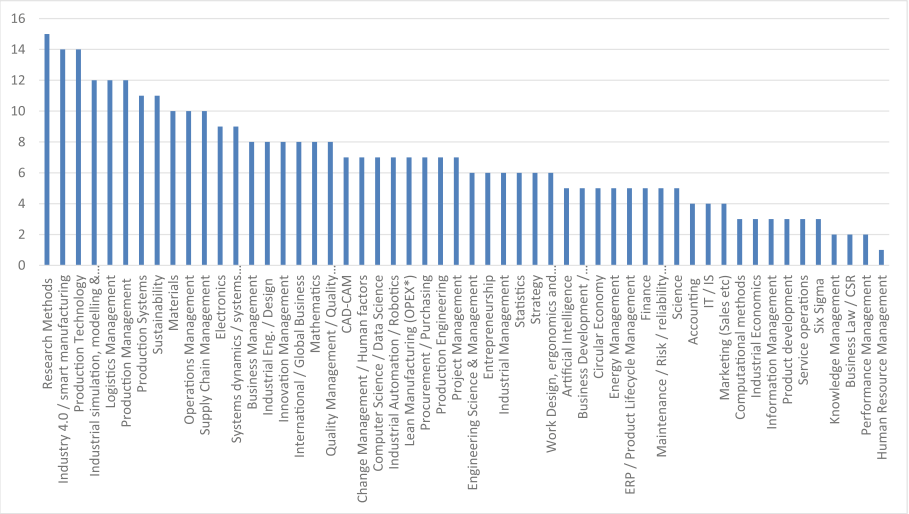

Fig. 1. Emergent themes from all POM curricula

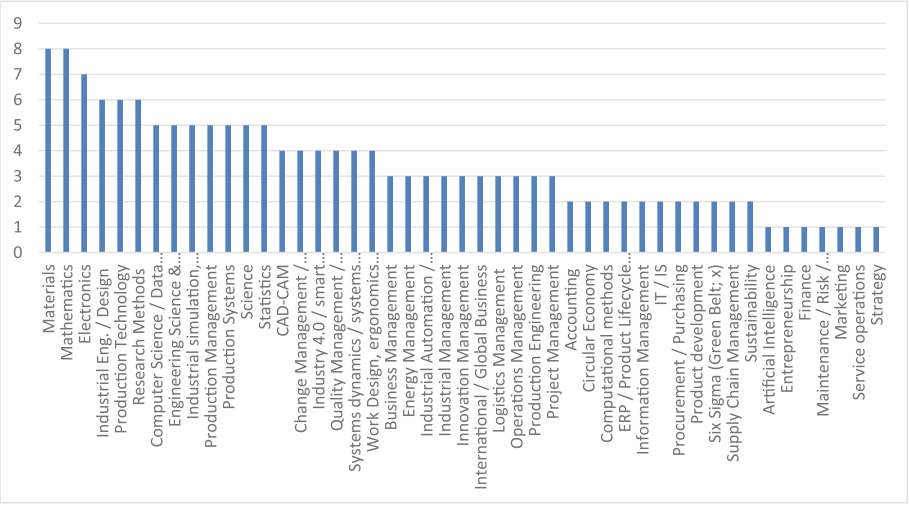

Fig. 2. Emergent themes from Bachelor POM curricula

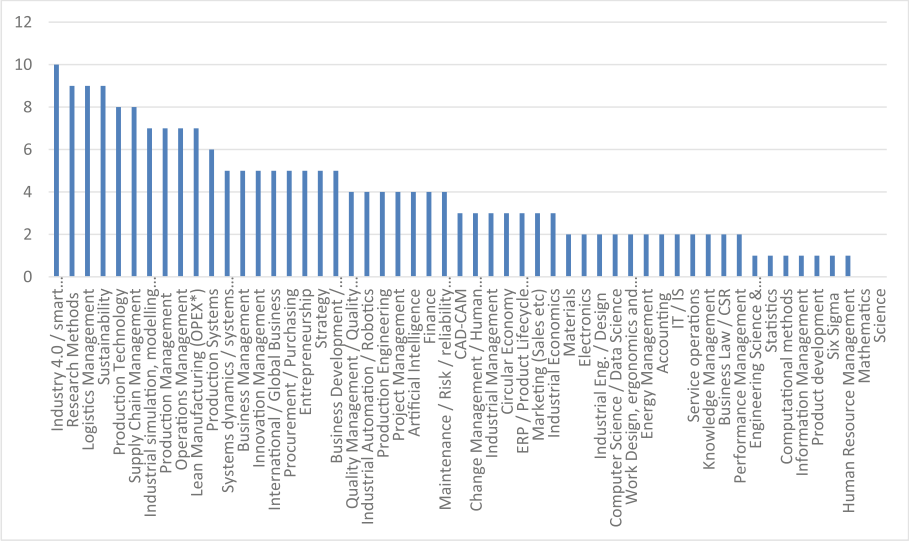

Fig. 3. Emergent themes from Master POM curricula

4 Findings from the Focus Group Workshop

On May 21st, 2025, a focus group workshop was conducted at the University of South-Eastern Norway (USN) with 20 participants from 8 different organizations in the region – both large companies and small- / medium-sized enterprises (SMEs). The main goals of the focus group were:

1. Understand which level of education that the industry currently demands (e.g., Bachelor or Master)
2. Analyze current and future industrial requirements for competencies in POM
3. Present an overview of the current state of POM programs worldwide (see Sect. 3)
4. Establish a common forum between local industry and USN.

Having decided to focus on developing a new Bachelor-level POM program early on in the workshop, participants were split into three smaller, mixed groups and were challenged to think about current and future problems that the industry is facing, as well as which themes / subjects they considered important to include in the new education program, categorizing in terms of immediate needs, needs in one year's time, needs in three years' time and needs in five years' time. The results are presented in Table 2:

Table 2. Results of the Industrial Focus Group Workshop

Immediate needs	Needs in one year	Needs in next three years	Needs in five years +
Business / employment law Human resource management Safety & security / HSE Cost-benefit analysis Competence management ERP, PLM, PDM, MES… Artificial Intelligence Problem-solving / Root cause analysis Performance management Data management	Production planning Queuing theory Layout planning & Material flow Bottleneck control / takt time Maintenance Materials science Regional factory / learning lab visit Employment law Organization design (e.g., matrix) Conflict management Team skills / Human factors / Diversity management 3D printing	Change management Continuous improvement Digitalization / AI Simulation tools Requirements specification for sourcing / ordering Lean & CI Human-machine interaction / human role in digitalization Industrialisation Sustainability / Circular economy	Digital twin Animated process documentation Industry-based bachelor project (Problem-based learning) Study tour to Japan Recruitment of students from high school Further development of Master program (beyond Bachelor)

Table 3. Top 10 themes across POM curricula

All programs	Bachelor	Master
Research Methods Industry 4.0 / smart manufacturing Production Technology Industrial simulation, modelling & analytics Logistics Management Production Management Production Systems Sustainability Materials Operations Management	Materials Mathematics Electronics Industrial Eng. / Design Production Technology Research Methods Computer Science / Data Science Engineering Science & Management Industrial simulation, modelling & analytics Production Management	Industry 4.0 / smart manufacturing Research Methods Logistics Management Sustainability Production Technology Supply Chain Management Industrial simulation, modelling & analytics Production Management Operations Management Lean Manufacturing (OPEX)

Table 4. Bottom 5 themes across POM curricula

All programs	Bachelor	Master
Human resource management	Strategy	Science
Performance management	Service operations	Mathematics
Business Law / CSR	Marketing	Human resource management
Knowledge management	Maintenance, risk, reliability	Six Sigma
Six Sigma	engineering	Product development
	Finance	

5 Discussion

In this section we discuss the findings of both the document analysis and the focus group research.

5.1 Document Analysis

Considering first an analysis of all emergent themes from the various POM curricula reviewed, it appears the top five most consistent topics across current POM education programs are *Research Methods, Industry 4.0 / Smart Manufacturing, Production Technology, Industrial simulation and modelling,* and *Logistics Management* (see Fig. 1). *Production Management, Operations Management and Supply Chain Management* follow closely in the top ten themes (it appears that many institutions / programs use these terms somewhat synonymously) (Table 3).

It is also interesting to consider the less prominent themes across the POM curricula (Table 4):

5.2 Focus Group

Following the focus group workshop with industry representatives, we were able to cluster the emergent themes into socio-technical aspects (see Fig. 4).

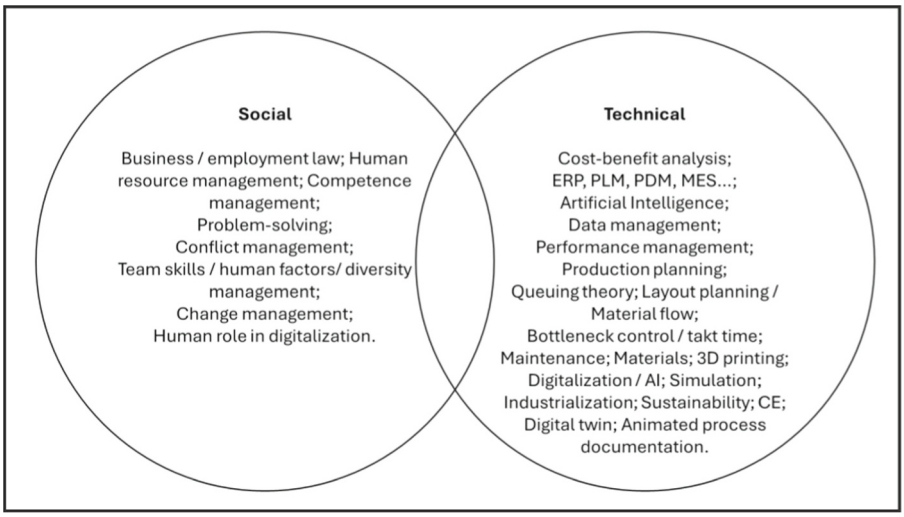

Fig. 4. Emergent themes from the focus group

6 Conclusions

The aim of this paper was twofold: first we wanted to benchmark current POM educational programs on a global scale, and second, we wanted to identify potential gaps in said offerings. To do so, we posed the following research questions:

RQ1: *What are the current focal topics in global POM educational programs?*
RQ2: *What should be included in future POM educational programs?*

To answer RQ1, we performed a document analysis of 33 POM program curricula, spanning 16 institutions from 12 different countries. This provided us with an overview of the most prominent themes in POM education today.

We then conducted focus group research with representatives from Industry to collect contemporary perspectives of concerns and possible gaps in POM education, that will be used to guide discussions at a special session on "the future curriculum of production management" at the 2025 APMS conference in Kamakura, Japan.

Given the rapidly evolving industrial context, a key area for future research is how to better integrate interdisciplinary approaches within POM education. Future production and operations managers need to navigate complex, cross-disciplinary challenges and understand intricate cause-effect relationships in socio-technical systems. This calls for a shift in educational design. The complexity is further underscored by the fact that POM itself is already a highly interdisciplinary field, encompassing a wide range of themes, as also shown in Figs. 2, 3, and 4.

One promising direction is the adoption of problem-based learning (PBL) approaches. PBL encourages students to engage with real, complex, and ill-structured problems. It supports the development of skills to connect knowledge across disciplines, apply appropriate tools, and reflect on practical challenges in diverse operational contexts. This approach is particularly relevant in light of the increasing complexity of

industrial systems, global uncertainties, and the growing need to align operational decisions with broader strategic objectives. In today's context, operations managers must demonstrate strategic thinking even in day-to-day decisions, as these can have significant long-term implications, particularly in areas such as capacity planning, technology adoption, and sustainability initiatives.

In future research, we aim to investigate the requirements and challenges of implementing PBL in POM education, for both students and educators, with the goal of developing globally relevant recommendations for curriculum reform.

Another emerging issue observed in POM programs is the growing difficulty in finding skilled workers. This raises the question of whether and how educational programs can prepare students to increasingly rely on digital tools and automation to complement or replace certain POM tasks. Exploring the implications of digitalization on workforce development and curriculum content represents another important direction for future research.

In conclusion, the fact that leading industrial players like Kongsberg Defence & Aerospace are actively investing in the development of POM education to build future capabilities highlights the importance of collaboration between academia and industry in shaping the future of POM education.

Acknowledgments. The authors acknowledge the support from and fruitful dialogue with colleagues from the IFIP Working Group 5.7, namely: Anne Zouggar (University of Bordeaux), Alexandra Lagorio and Paolo Gaiardelli (UniBG), Alessia Bilancia and Federica Costa (Polimi), Jannicke Baalsrud Hauge (KTH), Jan Ola Strandhagen (NTNU), Eivind Arne Fauskanger and Silja Sverreson (USN), Ann-Louise Andersen (Aalborg University), Guilherme Tortorella (UniMelb), Richard Morgan (UWTSD), Tim Minshall (IfM), Alejandro Frank (UFRGS), Thorsten Wuest (USC), and Torbjorn Netland (ETH Zurich).

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

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