Project Management Education for Value Creation

Masahiro Inoue, Keio University, Japan
Tomoko Maruyama, Ehime University, Japan

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Abstract
Project management is a fundamental knowledge and skill in the field of engineering. Conventional project management has been based on a waterfall process to achieve deliverables while balancing the scope, schedule, and cost. Today, project management aims to not only obtain deliverables but achieve outcomes for value creation with sustainability. Furthermore, the project management process has become more diverse, including waterfall, agile, and a combination of them. The Project Management Body of Knowledge and the Standards have shifted from the methodologies defining detailed processes to the general principles. Project management education in universities should respond to value creation in diverse project models. However, the general principles are difficult to learn for students with limited practical project experience. Careful consideration should be given to designing project management educational programs. We researched the requirements for project management education for value creation in diverse processes and analyzed the gaps between recent demands and current project management education in universities. We propose a framework for project management education to achieve the learning outcomes for the program and allocate learning outcomes to projects, exercises, and lectures of project management education programs for value creation.

Keywords: Project Management, Education, Value Creation, Framework

1. Introduction

1.1 Systems Engineering and Project Management

Engineering, particularly systems engineering, is closely related to project management (PM). Systems engineering and PM provide information that spans the entire engineering process. Systems engineering serves as the basis for comprehensive problem-solving. It is a systematic methodology for defining, analyzing, modeling, designing, and implementing solutions to real-world problems. In contrast, PM is a framework for problem-solving projects that includes planning, organizing, teamwork, communication, and management.

1.2 Project Management Education

Conventional PM uses the waterfall process to obtain desired deliverables while balancing scope, schedule, and cost. Currently, projects aim for deliverables and outcomes for value creation and solving social issues. In addition to the waterfall process with well-defined specifications at the beginning of the project, followed by design, implementation, testing, and operation, PM uses the agile process and a combination of both processes. The agile process repeats the development processes of planning, design, implementation, and testing in short cycles, considering changes in requirements as a precondition to achieving high-value results.

As a result, the PM body of knowledge and standards are shifting from process-defined methodologies to principle-centered contents, such as action guidelines.

PM education in many universities has been process-based, focusing on the waterfall process. Currently, there is a need for PM education that responds to value creation and rapid change. However, project experiences can provide insight into the essence of PM principles, such as action guidelines. Understanding such ideas is challenging for undergraduate and master's degree students who lack practical experience in project execution. In addition, it is difficult for students to take adequate actions if they only have knowledge of the principles.

Based on the demand for PM for value creation, herein we review and analyze the effectiveness and weaknesses of PM education integrated into engineering education. Furthermore, we emphasize engineering education and value-generating projects. Finally, we present the learning outcomes of PM education for value creation and discuss how educational programs should be designed in terms of projects, exercises, and lectures.

2 Project Management Education Initiatives Integrated Into Engineering Education

2.1 Systems Engineering and Project Management Education

This section presents the benefits and challenges of integrating PM education into engineering education. Systems engineering and PM are common frameworks that serve as the basis for the real-world activities of engineers. They share many similarities, as education in both knowledge and practical experience is required in both disciplines. Fig. 1 shows the relationship between systems engineering and PM. Both disciplines share an interdisciplinary approach to achieving quality, cost, and delivery (QCD), and they share concepts such as scope, time, cost, quality, and risk management.

However, each discipline comprises many unique areas. Systems engineering provides a technical framework for constructing system components, and its unique areas include design, modeling, and optimization. However, PM is a management framework for the successful implementation of projects, and its unique areas include human resources and communication management.

These two disciplines share some techniques and tools, such as brainstorming, work breakdown structure, the critical path method, earned value management, the analytic hierarchy process, and quality function deployment. The knowledge and skills of both disciplines are effective for engineers who promote systems development, and coordinated education is effective.

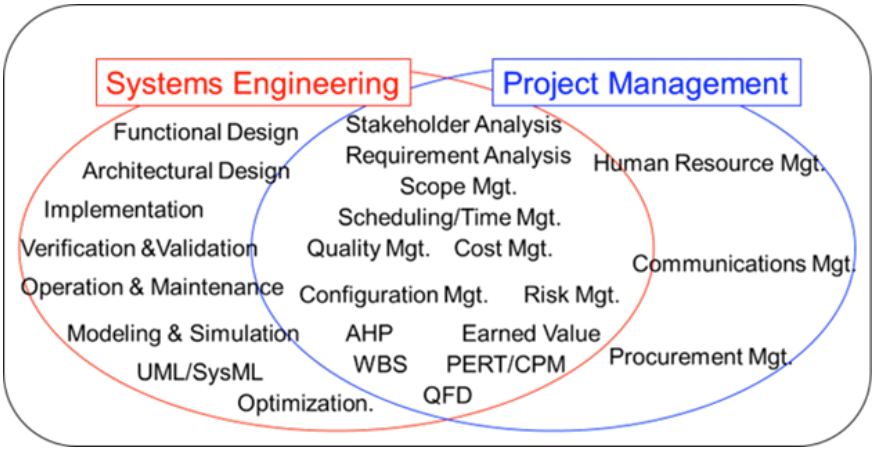

Figure 1: Relationship Between Systems Engineering and Project Management

2.2 Project Management Education Integrated Into Engineering Education

Educating students who have little practical experience in subjects that depend on empirical knowledge, such as systems engineering and PM, is a major challenge. It is essential to provide students with experience, both real and simulated, and careful coordination of the sequence of lectures, exercises, and projects is essential to their understanding. To address this issue, Inoue and Hasegawa (2010) (2013) have implemented an educational program in which projects, exercises, and lectures are programmed in an evolutionary manner, as shown in Fig. 2. In undergraduate and master's degree programs, project-based learning courses and lectures are scheduled alternately to foster awareness of problems through exercises, understand theories and techniques as a means of problem-solving, and repeat projects in problem-solving by applying such theories and techniques.

As shown in Fig. 2, Systems Engineering A (problem discovery and solving) is scheduled for the second semester of the second year. The content includes systems engineering and system life cycles, problem-solving processes, system requirements definition, system functional design, system evaluation methods, and special lectures from the industry. Simultaneously, System Engineering Exercise A, an exercise course, and a project are organized.

Systems Engineering B (quantitative decision-making methods) is offered in the first semester of the second year. The content includes decision-making methods, stochastic and statistical analysis methods, simulation, and scheduling methods, as well as special lectures from the industry. Simultaneously, the exercise of quantitative decision-making methods, Systems Engineering Exercise B, is arranged and the project is implemented.

PM courses are offered in the first semester of the third year. The course contents include management processes, project initiation, scope management, time management, cost management, exercises in PM tools, risk management, quality management, human resource management, communication management, special lectures on industry, and PM planning exercises. System Engineering Exercise C, which is an exercise course, also runs simultaneously with projects that address real issues in the industry and local communities.

In master's degree programs, a short-term abroad program for global project-based learning (Inoue, 2016) (Inoue, 2020) in collaboration with the industry and local communities is offered, during which students execute projects that solve sustainable development goals (SDG) and industrial issues in cross-cultural environments with students from oversea universities. In addition, as education for soft skills, such as leadership, students acquire leadership skills and gain diverse experiences through repeated simulated exercises using meeting simulators (Inoue & Maruyama, 2014), which they can apply to projects, capstone projects, and global project-based learning.

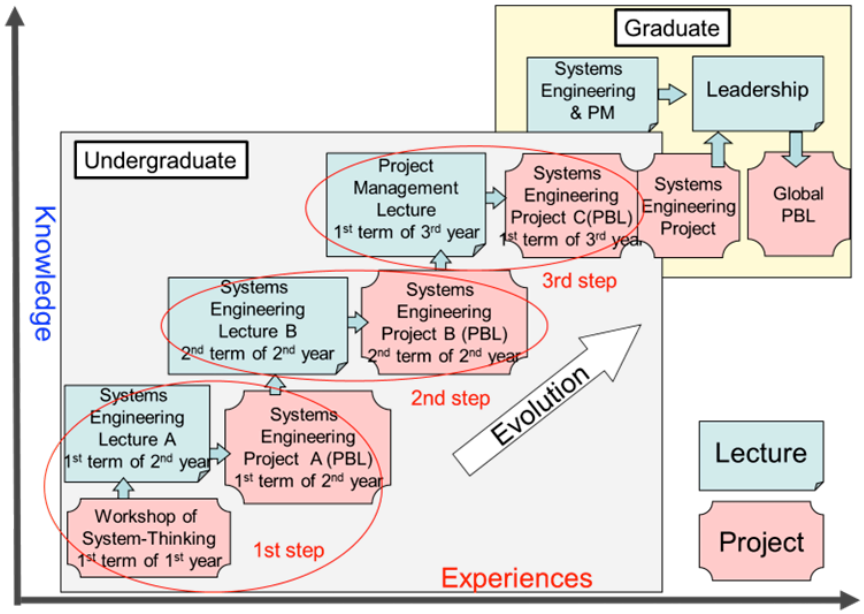

Figure 2: Project Management Education Integrated into Engineering Education

3 Engineering Education and Projects for Value Creation

3.1 Value Creation

It is necessary to clarify the project stakeholders and envision the value for each stakeholder. Value can be diverse, including economic value and social value and it changes over time. It also changes with social changes, technological changes, and changing needs. The value of a project may not be clear at its conception stage. It is unclear how stakeholders will find value; therefore, a prototype may be required to verify value.

3.2 Projects for Value Creation

Challenge-based learning (CBL) is project-based learning for value creation and is being introduced mainly in engineering universities (Rådberg, 2020). CBL is based on the identification, analysis, and design of a solution to a sociotechnical problem. The learning

experience is typically multidisciplinary, involves different stakeholder perspectives, and aims at finding a collaboratively developed solution that is environmentally, socially, and economically sustainable. It is necessary to define the knowledge and skills required to implement CBL. It is necessary to consider how such knowledge and skills can be taught in the lectures.

3.3 Project Canvas for Value Creation

A project framework for value creation has been proposed. Nieto-Rodriguez (2021) proposed a project economy, in which the Project Canvas is employed as a framework for value creation. As shown in Fig. 3, the framework comprises foundation, people, creation, investment, and benefit.

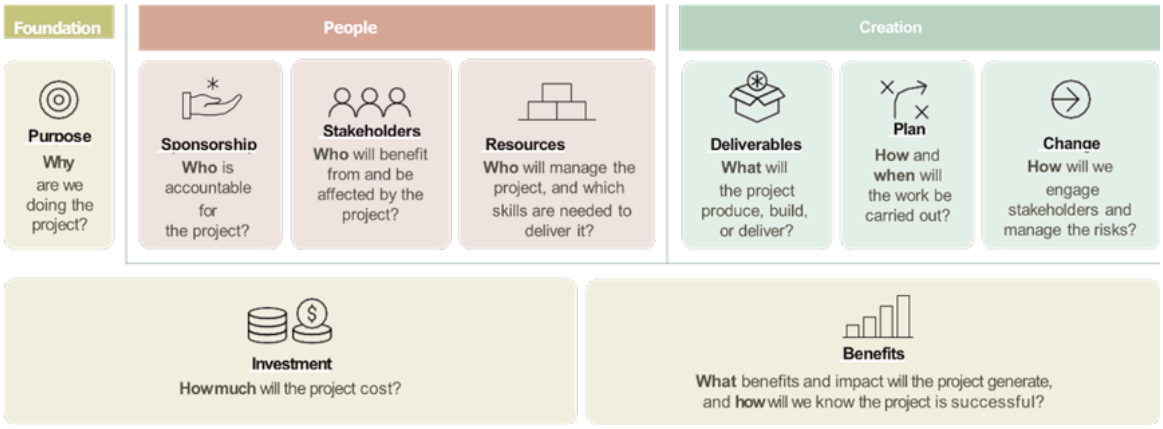

Figure 3: Project Canvas

3.4 Framework for Project Management Education

The Project Management Institute (PMI), a professional association for PM, has developed a framework for PM education (PMI, 2025) by academics for academics. It is designed with a module structure that considers various engineering disciplines. The curriculum framework defines knowledge modules (KMs) and sets learning and educational objectives for each KM, as shown in Fig. 4. Multiple KMs are collected to form courses, and educational programs are designed by sequencing multiple courses.

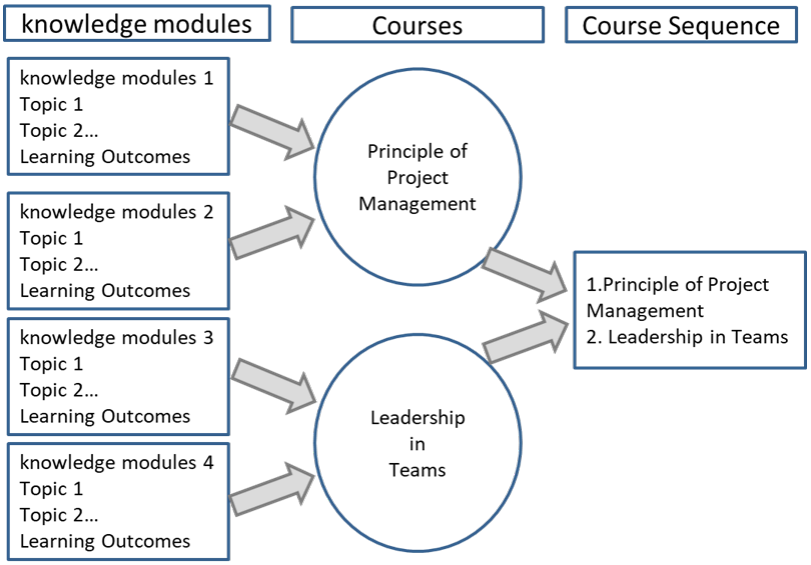

Figure 4: Mapping Knowledge Modules to Design a Sequence of PM Courses

Each KM has a distinct set of learning outcomes, and the PM curriculum should be flexible so that the KM framework can be easily adopted in many disciplines and industrial domains. The guidelines should offer flexibility in collating topics into courses to create relevant curricula in different academic situations and countries. KMs have three categories: (1) technical knowledge; (2) behavioral skills, capabilities, and competencies; and (3) strategic awareness.

(1) Technical KMs include the basic theory and practice of PM. They provide students with a comprehensive technical understanding of the common themes and principles of PM. Technical KMs explain how one can apply one's knowledge to meet project requirements.

(2) Behavioral KMs consider the personal, behavioral, and organizational aspects of PM and provide students the opportunity to develop both personally and professionally. They integrate the well-rounded PM knowledge of an individual with communication, management, and organizational competence.

(3) Strategic KMs consider the business, commercial, and organizational aspects of PM, including strategic issues, program and portfolio management, and governance. They also include emerging topics in PM, such as agile approaches to PM, international issues, and global projects.

3.5 Project Management Body of Knowledge and Standards

PMI (2021) published the Project Management Body of Knowledge (PMBOK) Guide. Until its sixth edition, the PMBOK Guide focused on PM processes, knowledge areas, and techniques, but several changes have been made since its seventh edition, with the PM processes and principles being replaced by knowledge and performance areas, respectively. Project principles are guidelines for behavior during project execution, and they represent the principles of responsibility, respect, fairness, and integrity. The project performance areas are activities that aid in the effective delivery of project outcomes.

Here, we examined the learning outcomes of eight performance areas based on our perspective, assuming PM education in universities, including stakeholder performance, team performance, development approaches and life cycle performance, the performance area of planning, project work performance, delivery performance, measurement performance, and uncertainty performance.

The learning outcomes of stakeholder performance include the ability to effectively identify, analyze, and engage stakeholders. The learning outcomes of team performance include the ability to develop critical thinking and human relations skills and tailor multiple leadership styles. Development approaches and life cycle performance include an understanding of waterfall and agile development approaches and the ability to select and execute a development approach that matches the project deliverables. For the performance area of planning, the learning outcomes include understanding schedule and cost-estimation methods and being able to develop a plan, and those of project work performance include being able to focus on what the project team should work on, balance competing constraints, and implement a continuous learning process. The learning outcomes of delivery performance include the ability to define scope based on requirements and understand quality and change costs. Measurement performance includes the ability to evaluate performance and establish effective measures, and uncertainty performance includes being able to manage risk.

4 Results and Conclusion

4.1 Target Projects for Value Creation

(1) The target project is more than just a project to create deliverables satisfying QCD against predetermined goals. It is a cross-disciplinary engineering project that analyzes the value of diverse stakeholders, discovers goals, and creates valuable outcomes.

(2) It is difficult to determine the detailed goals of a project at the beginning of the project. In addition, the goals of a project can change with time. The agile process, the waterfall process, or a hybrid of both can be employed in a project.

(3) Engineers must be able to make comprehensive judgments to realize a sustainable society, considering technological as well as political, economic, historical, and cultural backgrounds and constraints.

4.2 Scope of Project Management Education

(1) PM education should be integrated into engineering education, and the correlation between systems engineering and PM is particularly important.

(2) It is important to introduce education that provides knowledge and experience for value creation, problem-finding and problem-solving processes with diverse stakeholders, and cross-cultural and interdisciplinary mixed teams.

(3) Engineering education targets not a single technology but cross-disciplinary technologies. It also provides knowledge and skills for solving social issues, such as the SDGs.

4.3 Curriculum Framework and Pedagogy

(1) For PM and systems engineering, which require practical experience, an effective curriculum should repeat lectures, exercises, and projects in stages.

(2) The design method of structuring courses with a combination of KMs with clearly defined learning outcomes is highly versatile and can respond to changes in societal demands.

(3) PM principles are KMs, but it is difficult for students to correlate their superficial understanding of PM principles with their actions. Students must have the opportunity to apply such principles in practice and have a chance to reflect on them. It is vital to incorporate such principles as a perspective for evaluation and reflection in project-based learning courses. Case studies are also effective, as students can reflect on PM principles through simulated case studies.

(4) Only PM principles are not enough for planning and designing a project. Knowledge acquisition and exercises on problem-solving and tools, along with the PM process, are necessary.

(5) KMs change in response to changes in time and project concepts and emphasis. Educational programs can be made flexible by incorporating or substituting KMs in courses, and KMs can be shared across universities.

References

Inoue, M., & Hasegawa, H. (2010). Systems Engineering Education Based on Evolutional Project-Based Learning, *Journal of JSEE*, Vol. 58, No.1, pp. 1_89-1_94, 2010, doi.org/10.4307/jsee.58.1_89

Inoue, M., Hasegawa, H., & Chen, X. (2013). Creation of Systematic Curriculums for Interdisciplinary Education and Assessment of the Learning Outcomes, Journal of JSEE, Vol. 61, No. 2, pp. 2_55-2_61, doi.org/10.4307/jsee.61.2_55n

Inoue, M., Hasegawa, H., Mano, K., Furukawa, Y., Yamazaki, A., & Khantachawana, A. (2016). Development of an Engineering Education Program for Innovation in Global Environment, Journal of JSEE, 2016, Vol. 64, No.5, pp.5_101-5_108, doi.org/10.4307/jsee.64.5_101

Inoue, M., Maruyama, T., & Nagaya, H. (2014). Project Management Education Embedded in Engineering Education and Research for Fostering Generic Skills, INNOVATIONS 2014: World Innovations in Engineering Education and Research, iNEER, Potomac, MD, USA, pp.27-36.

Inoue, M., Oda, S., Hasegawa, H., Mano, K., Yamazaki, A., K., Khantachawana, A., & Anityasari, M. (2020). Project Management of Global Project-based Learning Course for Innovation and Sustainable Development, Proceedings of the World Engineering Education Forum and the Global Engineering Deans Council (WEEF/GEDC), Nov. 16-20.

Nieto-Rodriguez, A, (2021). The Project Economy Has Arrived, Harvard Business Review. Nov/Dec2021, Vol. 99 Issue 6, p38-45.

PMI (2015). GUIDELINES FOR UNDERGRADUATE PROJECT MANAGEMENT CURRICULA AND RESOURCES, 15 January.

PMI (2021). A Guide to the Project Management Body of Knowledge, Project Management Institute.

Rådberg, K., K., et al. (2020). From CDIO to challenge-based learning experiences – expanding student learning as well as societal impact?, European Journal of Engineering Education, 45:1, 22-37.

Contact email: inouem@keio.jp