

Problem Based Learning for Techno-economic Analysis for Logistics System Course: Cases in State-owned Warehouse

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Abstract

This paper discusses the Problem-Based Learning (PBL) in Techno-economic Analysis for Logistics System course for Undergraduate Industrial Engineering Students. The cases are in a State-owned Warehouse. The course is an elective course. We propose a methodology that extended the concept and techniques for solving problems, so the objectives of learning are not focusing on solving the problem in the case, but to have the development of other desirable skills and attributes and also can solve other problems with the experience they have. The students are grouped in some small groups, with each different problem that they find in the case. In the group that has the same topic, each member of the group has a different task. Practically, in the warehouse system, they can face problems such as purchasing, inventory and storage management, and distribution. A small group can choose one of the problems and a member of the group can choose to solve the problem with different commodity or different method. At the end of the semester, each student should make a white paper that has to be consulted with the lecturer during the semester. PBL can be implemented successfully in the course and help achieving the course goals.

Keywords

Problem-Based Learning, case study, elective course, Undergraduate level and Industrial Engineering.

1. Introduction

The world is changing so rapidly, that push students should learn with different way from how students learned in one decades or older and problem based learning is an educational strategy that will help students build the reasoning and communication skills necessary for their success today (Duch et al., 2001). University students today are of course very different compared to the previous ones, and they should learn with the way that suitable for them. Problem-Based Learning (PBL) is one of the approaches to improve higher education, and it is very beneficial for engineering disciplines (Yusof et al, 2005; Cruz, and Dominguez, 2016; Machado-Toledo et al, 2018; Murray et al, 2018).

PBL is an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem (Savery, 2006). Gorghiu et al, 2015 mentioned that PBL tries to overcome the disadvantage of traditional learning and it represents an effective way of working with students who may thus be helped to build basic skills in various domains or curricular areas. The focus in PBL centres on helping students to utilize their previous knowledge and ways of thinking, and constructing it into a new form that is understandable and meaningful to them (Savin-Baden, and Major, 2004). According to Kiley et al (2000) that in PBL, the students start with a problem, identify what they do and don't know, gather information, share the information and apply it to the problem again as shown in a learning cycle depicted in Figure 1. Barret (2005) mentioned the four key characteristics of PBL are the problem, the PBL tutorial, the PBL process and Learning.

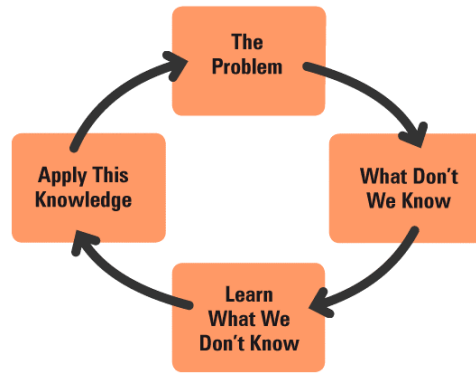


Figure 1. PBL Cycle (Kiley et al, 2000)

2. Object Study

BULOG is a state-owned general company in Indonesia engaged in food logistics, and its business includes logistics/warehousing, transportation businesses, trading in food commodities and retail businesses. The company has also public duties from the government, to maintain basic purchase prices for grain, stabilizing prices, especially basic prices, distributing rice to the poor (Raskin) and managing food stocks. BULOG conducts management of rice, sugar, soybean, meat, fish and also edible oil, flour, red rice, mineral water, etc (BULOG, 2018).

Management of grain and rice is the most important obligation of BULOG. Related to the management of rice, BULOG has obligations to conduct procurement of grain and rice in the country to provide and distribute subsidized rice for low-income groups with the RASKIN program, and to provide and distribute rice to maintain the stability of rice prices, deal with emergencies, disasters, and food insecurity. Figure 2 shows the management of grain and rice conducted by BULOG (BULOG, 2018).

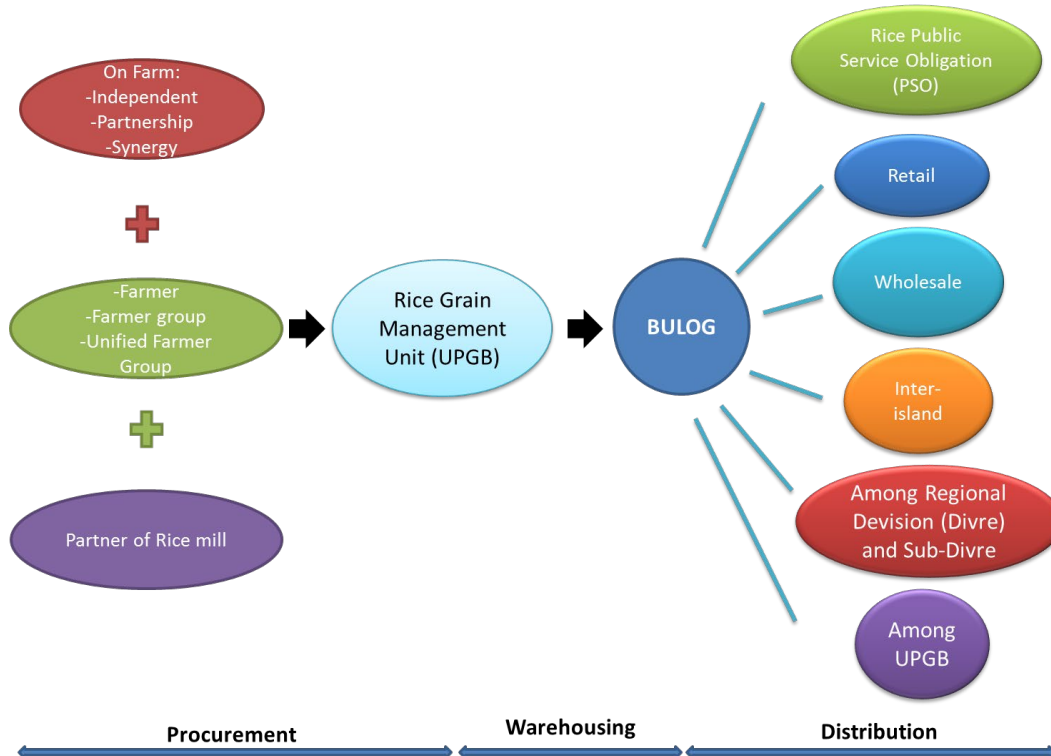


Figure 2. The management of grain and rice conducted by BULOG

For other commodities, the main operations are almost the same. Those are procurement, warehousing and distribution. As a company, BULOG has to be profitable. But, inevitably BULOG must play the role for Public Service Obligation (PSO).

3. Methods for Teaching and Learning

3.1 Techno-economic Analysis for Logistics System

The course of Techno-economic Analysis for Logistics System is an elective course, so students take this course for better understanding in research area that supposed to be chosen in their undergraduate thesis. The course code is TI-144069. The goals to achieve after the students complete this course is students can identify, analyze and propose solutions of the logistics system problems from the techno-economic aspects, with several case studies.

Based on Learning Outcomes (LO) related for Industrial Engineering Undergraduate Degree Program, the course intended to comply with the competencies expected to be achieved by students. The expected competencies for the students after completing in Techno-economic Analysis for Logistics System Course are:

- Students understand the concept of techno-economic analysis and the problem in logistics system is based on the level of decision (strategic, tactical, operational) in the 3 (three) cycles of the main activities, namely: procurement, warehousing, and distribution.
 - Students understand the basic concepts and are able to use quantitative methods to solve SC problems that are in accordance with the level of decisions and the main activity cycle.
 - Students are able to develop and design a logistics system that is efficient and effective for the entire system
- In general, students are expected to be able to solve integral system problems involving business processes in logistics system efficiently and effectively for the entire system.

Table 1. Learning Outcomes for Industrial Engineering Undergraduate Program in UNS

LO	Description
LO1	Mastering the theoretical concepts of natural science, engineering mathematics applications; engineering principles, and engineering design needed for integrated system analysis and design
LO2	Ability to apply mathematics, science, and engineering principles to solve complex engineering problems in integrated systems (including human, material, equipment, energy, and information)
LO3	Ability to identify, formulate and analyze complex engineering problems in integrated systems based on analytic, computational or experimental approaches
LO4	Ability to formulate solutions for complex engineering problems in integrated systems with regard to economic factors, public health, safety, social and environmental (environmental consideration)
LO5	Mastering system design principles and techniques integrated with the system approach
LO6	Ability to design integrated systems in accordance with applicable technical, safety and health standards by considering aspects of performance and reliability, ease of application and sustainability, as well as paying attention to economic, social, and cultural factors
LO7	Ability to research and investigate complex engineering problems in integrated systems using basic engineering principles and by carrying out research, analysis, interpretation of data and synthesis of information to provide solutions
LO8	Mastering knowledge about communication techniques and the latest and latest technological developments
LO9	Mastering the latest principles and issues in the economy, social, ecology in general
LO10	Ability to choose resources and utilize information technology and computation-based engineering design and analysis tools that are suitable for engineering activities
LO11	Ability to make effective written and oral communication
LO12	Understanding professional responsibilities and ethical aspects of professionalism
LO13	Ability to recognize needs, and manage self-learning for daily life
LO14	Ability to collaborate in a work group

Source: Faculty of Engineering UNS, 2017

Expected LO for Industrial Engineering Undergraduate Program can be seen in Table 1. The relevant LOs identified for the Techno-economic Analysis for Logistics System Course are LO3 and LO4. Detailed descriptions of each relevant LOs are shown in Table 2.

Table 2. Detailed descriptions of relevant LOs for Techno-economic Analysis for Logistics System Course

LO	Description
LO3	Ability to formulate deterministic problems into the formulation of linear programming models and derivatives such as transportation, transshipment, and assignment models.
	Ability to model stochastic problems into network analysis formulations, dynamic programs, markov analysis, queuing theory and game theory (game theory)
	Ability to formulate a simulation model of the integrated system problems provided
	Ability to recognize the symptoms of the problem and damage the problem of designing or repairing a real integrated system
LO4	Ability to formulate a model of the problem formulated
	Ability to formulate steps to find solutions and analysis of the formulation of models formed
	Understand the management cycle and its role in the operation of integrated systems or companies
	Understand basic business concepts, functions in business and business environment that can be utilized in the framework of designing, repairing and installing integrated systems
	Understand the basic concept of organizing a company
	Understand the concept of marketing products both goods and services
	Understand the concept of manufacturing systems
	Understand the concept of the logistics system

Source: Faculty of Engineering UNS, 2017

3.3 Problem-Based Learning in Techno-economic Analysis for Logistics System Course

Industrial Engineering Department of Universitas Sebelas Maret has two programs, Undergraduate Program and Master Program. For Undergraduate Program, the periods of education are 4 years (8 semester with 145 minimum credits). The undergraduate program had been running since 1998. Techno-economic Analysis for Logistics System Course is an elective course with 2 credits. The typical semester structure of the program is as follows: 16 weeks, 14 sessions for regular sessions and 2 sessions for examinations. The regular sessions can be conducted in class or as a visit to industry.

In the 2018/2019 academic year, 9 students took the course. They were group into small groups consist of 2 to 3 students. The schedule of the activities during the 16 weeks is as follows:

1. In the first 2 weeks, the lecturer delivers introductory material students and instructs students to conduct a literature review about techno-economics.
2. In the next 4 weeks, the lecturer teaches the material of the course and asks the the students to prepare for the observation in the object study with related theory and information.
3. In 7th to 14th week, students begin their observation in the object study.

The students must:

- a. find the common topic of the small group, and they discuss the similar problem in the group. Each group should choose 1 topics about logistics system based on their observation.
- b. determine problem for each student. Each student in the small group must determine 1 problem that must be different from other students in the group. The difference can be in its method, or in its commodity.
- c. formulate the problem for each student, collect data, and propose a solution for the problem. It is better for each student to have a reference model for the solution based on the article in the journals, proceedings or books.

Because each member of the small group has the similar problem, so the can discuss and share the problem to discuss in their small group. They can help each other and improve the solution to propose

- d. write a white paper according to the solution they propose.

During these periods in the class, the lecturer gives course materials and provide a time for discussion eith the students about the problems in the object study.

4. In 15th week, each students present in the class, about the results of their case studies to get improvements for their white paper.
5. In 16th week, each students must submit the white paper and do the course examination.

The mark for students are based on their activities in the class, their white paper and the examination.

From the object study, we found 3 main operations of logistics, namely procurement, warehousing and distribution Regarding to the PBL approach, students were assigned to observe the real activities in each operation. Based on the level of the decision, the students found the problems in the suitable level. Table 3 shows the titles of students' article writing activities based on the case study. The table shows the logistics sections and the decision level of each paper. The small group consist of 2 to 3 students. The list of the white papers is shown in Table 3.

Table 3. White papers as tasks of the course

No.	White Paper title	Small group	Logistics section			Decision level		
			Procurement	Warehousing	Distribution	Strategic	Tactical	Operational
1	Rice Inventory Management with ABC-FSN Classification consideration in Perusahaan Umum BULOG Sub-Regional Division III Surakarta	1		√			√	
2	Inventory Management Using ABC-VED Classification in Perusahaan Umum BULOG Sub-Regional Division III Surakarta			√			√	
3	Efficiency Analysis of Wheat Flour Inventory in Perusahaan Umum BULOG Sub-Regional Division III Surakarta	2		√			√	
4	Analysis of Rice Inventory in Perusahaan Umum BULOG Sub-Regional Division III Surakarta			√			√	
5	Costs Optimization of Rice Distribution using Transportation Method in Perusahaan Umum BULOG Sub-Regional Division III Surakarta: A Case Study	3			√			√
6	"Rastra" Rice Distribution Optimization With The Transportation Model in Perusahaan Umum Bulog Sub-Regional Division III Surakarta.				√			√
7	A Linear Programming for Optimization of "Rastra" Rice Distribution in Perusahaan Umum Bulog Sub-Regional Division III Surakarta: A Case Study				√			√
8	Benefit Cost Ratio Analysis of The "Rastra" Program in Perusahaan Umum BULOG Sub-Regional Division III Surakarta	4	√	√	√	√		
9	Benefit Cost Ratio Analysis of Sugar Management in Perusahaan Umum BULOG Sub-Regional Division III Surakarta		√	√	√	√		

4. Discussion

In Odd Semester in the academic year of 2018-2019, we used the PBL approach in teaching and learning for Techno-economic Analysis for Logistics System Course with the cases in a state-owned warehouse located in Surakarta, Indonesia. The previous year of 2017-2018, the cases were in private Small and Mid-size Enterprises (SMEs) of Tofu and Tempeh located in Mojosongo, Surakarta, Indonesia. The teaching and learning process using the PBL approach that can encourage and train the students to develop skill to solve the problems and other

problems based on their experience the course, to have the ability to write academic writing, and to collaborate with other team members.

As an elective course, Techno-economic Analysis for Logistics System Course should be able to give better student's capability in the area that they are interested to study. Commonly, when students study engineering courses, they will face difficulties to understand the course if they only study the textbook and materials only in the class. With the implementation of PBL, students can find and understand the real problem in the object study. It will give them better understanding the course materials.

Forming small groups to face the similar topic, will encourage them to discuss and help each other to solve the problem. From the discussion and the collaboration, it will improve the capability of the student to solve other problems from their experience in the group. Forming small groups will improve their capability not only in understanding the course materials but also in collaboration with their group members, such as for administrative issues, collecting data, analyzing, and problem solving. It will give them experience to work in a team, that will be beneficial for their future.

To measure the achievement of the students to the goals course, at the end of the semester, students must submit a white paper as a report for the study. Based on the criteria considered students, the lecturer will give marks to white paper produced by each students. An examination to measure the achievement of the goal of the course were also conducted at the end of the semester. From the result of the examination, the lecturer were satisfied with result of the examination. The impact of the PBL method in the course improve the ability of the students to achieve the goals of the course. The students have better understanding the course materials, better ability to solve the problem of their own and better ability to solve similar problem from their discussion with other member of the small group.

Based on the feed backs given by the students after the end of the semester, they mentioned from the case study, makes them have better understanding the problem, the way to solve, to solve the similar problem and improve their knowledge related to the materials of the course. They also commented that joining the small group with the similar problem, makes them discuss their problem and collaborate in the case study. It is another benefit of the PBL to get a soft skill for working in a teamwork.

5. Conclusion

This paper discusses the implementation of problem-based learning in a Techno-economic Analysis for Logistics System Course for Undergraduate level of Industrial Engineering Students. The method for teaching and collaborative learning was proposed with some cases in a state-owned warehouse. Problem based learning approach was used in the course to improve students' abilities, including problem identification and analysis, data collection and analysis, proposed solutions and recommendation. The formation of the small group of with similar topic help student for better understanding with some discussions and collaboration to solve the problem. A white paper as a proposal for solving the problems must be submitted and presented to show how the students can understand the problem and propose the solution to measure the achievement of the course goals. An final examination is also conducted at the end of semester to complete the measurement of the student achievent. From the feed backs of students, the students received many benfit and are satisfied with results. From this study, it can be concluded that PBL can help students achieve the course goals of Techno-economic Analysis for Logistics System.

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Biography

Dr. Muhammad Hisjam is with the Department of Industrial Engineering, Faculty of Engineering, Universitas Sebelas Maret, where he has been since 1998. He received his Bachelor degree from Universitas Gadjah Mada, Indonesia in 1986, and a Master degree from Institut Teknologi Bandung, Indonesia in 2002. He received his Ph.D. in Environmental Science from Universitas Gadjah Mada, Indonesia in 2016, with his dissertation title is “Sustainable Supply Chain Model in Export Oriented Furniture Industry in Indonesia (Case in Perum Perhutani)”. His research interests are in supply chain, logistics, business and sustainable development. He has published some papers in Journals, Conference Proceedings, and chapter books in his research area.