

Learning a Supply Chain Management Course by Problem Based Learning: Case Studies in the Newspaper Industry

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Abstract

The paper illustrates the applications of problem-based learning in a Supply Chain Management (SCM) course for Industrial Engineering Students. As engineers' candidate, they must be able to understand and be capable in the design process, i.e. identification of need, problem definition, search, constraint, criteria, an alternative solution, analysis, decision, specification, and communication. We propose an active methodology for teaching and collaborative learning, which considers the student as being the center of the learning process and newspaper industry to capture the real system problems in Problem Based Learning (PBL) approach. In a semester, we introduce SCM Course by emphasizing the matter of the design process and techniques for solving problems in the newspaper industry, including problem definition and planning, data collection and analysis, and recommendations and implementation. In order to improve the capabilities of engineers' candidate, we propose an innovative way to learn a case study by assigns students to follow the real activities in the supply chain processes, identify problems with the method 5W1H, and discuss alternative solutions with the problem's owner before the proposed improvements. A team project report is presented to show how to design, improve, and install of integrated systems has been developed in a semester of SCM Courses. Particularly, this study was implemented successfully in an undergraduate course of SCM.

Keywords: Design Process, Industrial Engineering, Problem Based Learning, SCM Courses

1. Introduction

It has been an important matter that higher education programs in this decade need to prepare undergraduate students to live, work, and thrive in an uncertain and risky world that demands students develop both knowledge and competencies (Dawe et al. 2005 and Jones et al. 2010). This educative endeavor has increased concern in professions like engineering. Industrial engineering, is one of the engineering subjects, contributes to the development of industrial revolution (Bilge et al. 2016). This matter is inseparable from the role of universities as education providers and producers of industrial engineering graduates (Hoernicke et al. 2017; Abdullah et al. 2012; Sengupta et al. 2018). As engineers' candidate, industrial engineering graduates must be able to understand and be capable in the design process, i.e. identification of need, problem definition, search, constraint, criteria, an alternative solution, analysis, decision, specification, and communication. Hence, industrial engineering education is highly concerned (Braghirolli et al. 2016; Bures, 2015; Palma et al. 2012; Moreno et al. 2012; Ayob et al. 2013) so that universities can perform their responsibility to form quality graduates who will be armed with the knowledge needed in industrial practice (Miller and Bures, 2015).

Teaching strategies and learning method play an important role in the success of creating quality graduates (Walshe et al. 2013; Applin et al. 2011; Gorghiu et al. 2015). Universities are expected to produce industrial engineering graduates who are professional and relevant to the needs of industry and society and able to keep abreast of developments in science and technology (Kádárová et al. 2014)). Therefore, it is important to develop relevant learning method in order to enhance the competencies of industrial engineering students, including self-directed learning, lifelong learning, problem-solving, critical thinking, and communication (Jamaludin et al. 2012 and Carriger, 2015). Hence, it is important to use problems as a driving force for learning (Duffy and Cunningham, 1996; Weiss, 2003).

Problem-Based Learning (PBL) has been identified as an approach to higher education that supports contextualization of knowledge and skills essential to professional practices in the current education environment (Wyness and Dalton, 2018; Liu et al 2019; Yew and Goh, 2016; Loyens et al. 2015; Alrahlah, 2016); Carriger, 2016). PBL is a student-centered teaching and learning methodology in which the problem comes first whereby the new knowledge is constructed on the foundation of prior knowledge. PBL environment is designed and executed to be inductive and cooperative (Savery and Duffy, 1995; Yusof et al. 2012). Unlike the conventional teaching approach, PBL enables the students to become producers, rather than consumers, of knowledge. Case studies in real system problems develop students' cognitive and metacognitive skills, and also empower them to be self-directed and lifelong learners (Gurses et al. 2015; Moutinho et al. 2015; Jalani and Sern, 2015; Sangestani and Khatiban, 2013). PBL encourages students with the essential technical skills required in the workplace (Walshe et al. 2013; Ari and Katrancı, 2014; Oganisjana and Laizans, 2015). The main objectives of PBL are placed on critical thinking, problem-solving and team working skills (Mat et al. 2012; Tan et al. 2016; Hmelo-Silver, 2004).

There have been several studies regarding the implementation of PBL in engineering education. Yusof et al. (2005) described the efforts in promoting PBL in engineering courses in a university. Final remark showed that the pilot implementation was highly successful in encouraged other faculties to promote the implementation of PBL in many classes. Helmi and Yusof (2008) and Yusof et al. (2012) developed a framework for integrating cooperative learning and PBL, which later was named Cooperative Problem-Based Learning (CPBL). Continuing this research, Helmi et al. (2012) explains the methods used in determining the enhancement of problem-solving skills in engineering students through CPBL. This study showed that PBL does enhance students' problem-solving skills and resulted in a guideline for those who are going to apply CPBL in their teaching. Then, Alwi et al. (2012) described teaching and learning strategies to instill sustainability awareness in first year engineering students and showed that this project enhances students engineering solving capabilities, communication skills, and interpersonal skills. Meanwhile, Basri et al. (2012) applied a PBL approach in the teaching and learning process in the Introduction to Environmental Engineering course. This study showed that the PBL approach enhances the level of environmental awareness among students to gain the ability in identifying the sources of pollution and its impact on the environment and the controlling methods. Harun et al. (2012) described the approaches in motivating students to learn in a PBL environment. This study revealed that through systematic motivation given by the facilitator, the level of students' motivation can be increased to encourage them to reach deep learning.

Supply Chain Management (SCM), one of the courses in engineering education, requires students to understand the integrated system that involves business processes ranging from suppliers to consumers in the supply of products. Design process and techniques are required for solving problems in the real supply chain system, for instance, problem definition and planning, data collection and analysis, and recommendations and implementation. An innovative way to learn a case study is needed in order to improve the capabilities and competencies of the students. Therefore, in this study, we implemented PBL framework in a Supply Chain Management course. We chose the newspaper industry as a case study to deliver a better understanding of the real system problems.

The remainder of the paper is organized as follows. Section 2 presents the literature review regarding the strategic roles of industrial engineering and problem-based learning. Section 3 discusses the teaching and learning methodology, highlighting the process of PBL approach in the SCM course. Section 4 discusses the benefits of the implemented PBL towards students' capabilities. Section 5 concludes by summing up the work.

2. Literature Review

2.1 Strategic Role of Industrial Engineering

Industrial engineering is concerned with the design, improvement, and installation of an integrated system of people, information, equipment, and energy. It draws upon specialized knowledge and skills in the mathematical, physical and social sciences together with the principles and methods of analysis and design to specify, predict and evaluate the results to be obtained from such system (IIE).

Based on the definitions formulated by IIE above, a conclusion can be made that the mission and role of Industrial Engineering disciplines can essentially be grouped into three topics which can then be used as the main foundation for developing this discipline; that is, first, is closely related to the problems that concern the dynamics of material flow that occur on the production floor. Here will emphasize the principles that occur during the transformation process -- often also referred to as value-added processes -- and the material flow that takes place in a continuous production system until it increases to the problem of distribution flow from the final product (output) to consumers. The second topic relates to the dynamics of information flow. The main problem examined in this case concerns the flow of information needed in the management decision-making process, especially in the operational scale. Matters relating to aggregate production planning, quality control, and various types of production / operational management problems will be the principal study. Furthermore, the third topic tends to bring this Industrial Engineering discipline to move towards macro-strategic issues. The problems faced are no longer related to the problems that arise in the line of production activities or production management but continue to widen to the problems of production systems/industry and environmental systems that have a significant effect on the industry itself. This third topic tends to bring industrial engineering disciplines to stay away from technical issues (deterministic-physical-quantitative) that are commonly found on the production line (first topic) and deal more with non-technical issues (stochastic-abstractive-qualitative). Faced with complex, multi-variable and/or multi-dimensional problems; then the Industrial Engineering discipline will require a strong foundation (in the fields of mathematics, physics, and socio-economics) to be able to model, simulate and optimize problems that must be solved.

The higher education in industrial engineering must be able to follow and capture the direction of the development of science-technology that is accelerating along with the demands of society (including industry) users of higher education services. Here higher education must be able to prepare qualified human resources and meet the demands of the requirements and competency standards of internationally effective work. By referring to the ABET-Engineering Criteria 2000, an Industrial Engineering professional must not only master the expertise of Industrial Engineering; but also must have insight, understanding, and ability as well as (a) the ability to work in groups (organizations), (b) understanding of social responsibility and professional ethics, (c) the ability to communicate both oral and written, (d) awareness environment (natural and social), (e) high sensitivity to various problems faced concerning various kinds of contemporary, actual and situational issues and (f) organizational, management and leadership abilities, and so on. Based on the ABET Engineering Criteria 2000, an industrial engineering professional is not only expected to have good academic skills and professional competencies in engineering but also has insight and sensitivity to all problems that exist in industry and society.

Universities which contribute to producing industrial engineer graduates must concern its industrial engineering education. Therefore, universities can perform their responsibility to form quality graduates who will be armed with the knowledge needed in industrial practice. Thus, universities can support the decisive role of industrial engineers as transmitters and introducers of progress. Regarding this matter, there are several specific competencies which an industrial engineer must have and they must be noted by the university, for instance:

- Able to apply math, sciences, and engineering principles to solve a complex problem in an integrated system (consist of a man, material, equipment, energy, and information)
- Able to identify, formulate, and analyze engineering complex problem in an integrated system using an analytical, computational, and experimental approach
- Able to generate solutions of engineering complex problem in integrated system considering an economic factor, public health and safety factor, culture factor, social factor, and environment factor
- Able to design an integrated system according to technical, environmental health and safety standard, considering performance and reliability aspect, ease of implementation and sustainability, in regard to economic factor, social factor and cultural factor

- Able to observe and investigate the engineering complex problem in integrated using engineering principles, and able to conduct research, analysis, data interpretation, and information synthesis in developing solutions
- Able to select resources, utilize appropriate engineering design and analysis ICT-based tools to conduct engineering activities

2.2 Problem Based Learning

Problem Based Learning (PBL) is a set of teaching models that use problems as a focus for developing problem-solving skills, material, and self-regulation (Hmelo-Silver, 2004; Serafino & Cicchelli, 2005, Egen and Kauchak, 2012). PBL is a learning approach that uses real-world problems as a context for students to learn about critical thinking and problem-solving skills, and to acquire essential knowledge and concepts from the subject matter. PBL is learning based on a cognitive theory which includes constructivism learning theory. According to constructivism theory, thinking and problem-solving skills can be developed if students do themselves, discover, and move the complexity of existing knowledge. Woolfolk (2007) stated that the goals of problem-based learning are to help students develop flexible knowledge that can be applied in many situations, in contrast to inert knowledge. Other goals of problem-based learning are to enhance intrinsic motivation and skills in problem-solving, collaboration, and self-directed lifelong learning.

Based on the theory developed by Barrow, Min Liu (2005) describes the characteristics of PBL, namely:

1. Learning is student-centered; The learning process in PBL focuses more on students as learning people. Therefore, PBL is also supported by the constructivism theory where students are encouraged to develop their own knowledge.
2. Authentic problems form the organizing focus for learning; Problems presented to students are authentic problems so students are able to easily understand the problem and can apply it in their professional life later.
3. New information is acquired through self-directed learning; In the process of solving problems, it is possible for students not to know and understand all the prerequisite knowledge, so students try to find themselves through the source, either from books or other information.
4. Learning occurs in small groups; In order for scientific interaction and exchange of ideas to occur in an effort to build knowledge collaboratively, PBL is carried out in small groups. The group created demands clear division of tasks and clear goal setting.
5. Teachers act as facilitators; In implementing PBL, lecturers only act as facilitators. However, even though the lecturer must always monitor the progress of student activities and encourage students to achieve the targets to be achieved.

According to Arends (2008), there are 5 steps in implementing PBL, namely (1) orienting students to problems; (2) organizing students to research; (3) assist independent and group investigations; (4) develop and present the work; (5) analyze and evaluate the problem solving process, the problems used in PBL are the problems faced in the real world. Although individual abilities are required for each student, in the learning process in PBL students learn in groups to understand the problems at hand. Then students learn individually to obtain additional information related to problem-solving. The role of the lecturer in PBL is as a facilitator in the learning process.

3. Teaching and Learning Methodology

3.1 Supply Chain Management Course

Supply Chain Management (SCM), which course code is TI-83542, is a course for industrial engineering students with the main purpose is to ensure that the students understand the integrated system that involves business processes ranging from suppliers to consumers in the supply of products. Students are required to understand the integration of key business processes from end user through original suppliers that provide products, services, and information that add value for customers and other stakeholders.

Initially, the competencies expected to be achieved by students were identified to satisfy the Learning Outcomes (LO) for Industrial Engineering Undergraduate Degree Program. The expected competencies for the students after participating in SCM course are the following:

- a. Students understand the concept of supply chain (SC) development and the problem is based on the level of decision (strategic, tactical, operational) in the 4 (four) cycles of the main activities, namely: customer order, distribution, manufacturing, and procurement.
 - b. 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.
 - c. Students understand basic concepts and SC system management methods in the information technology era and market uncertainty.
 - d. Students are able to develop and design an SC 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 ranging from suppliers to consumers in providing products efficiently and effectively for the entire system.

LO for Industrial Engineering Undergraduate Degree Program is shown in Table 1. The relevant LO identified for the SCM course are LO3 and LO5. Detailed descriptions of each relevant LO are shown in Table 2.

Table 1. Learning Outcomes (LO) for Industrial Engineering Undergraduate Degree 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 workgroup

Table 2. Detailed descriptions of relevant LO for SCM 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
LO5	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

3.2 Problem-Based Learning Cycle

Yusof et al. (2012) have developed a PBL framework for an engineering class at a university. The PBL model is shown in Figure 1. The PBL process can be divided into 3 main phases. Phase 1 consists of meeting the problem, problem identification, and analysis. In Phase 2, students do self-directed learning, peer teaching, reporting, synthesis, and application. At this stage, the facilitator must ensure that the coverage of the problem is sufficient, and probes students on the accuracy and validity of the information obtained. This can be an iterative process, where students may need to re-evaluate the analysis of the problem, pursue further learning, reporting, and peer teaching. Upon solving the problem, the students enter the Third Phase, where they do solution presentation and reflection. Later, we adopted this framework to be implemented in the SCM course to enhance students' problem-solving skill.

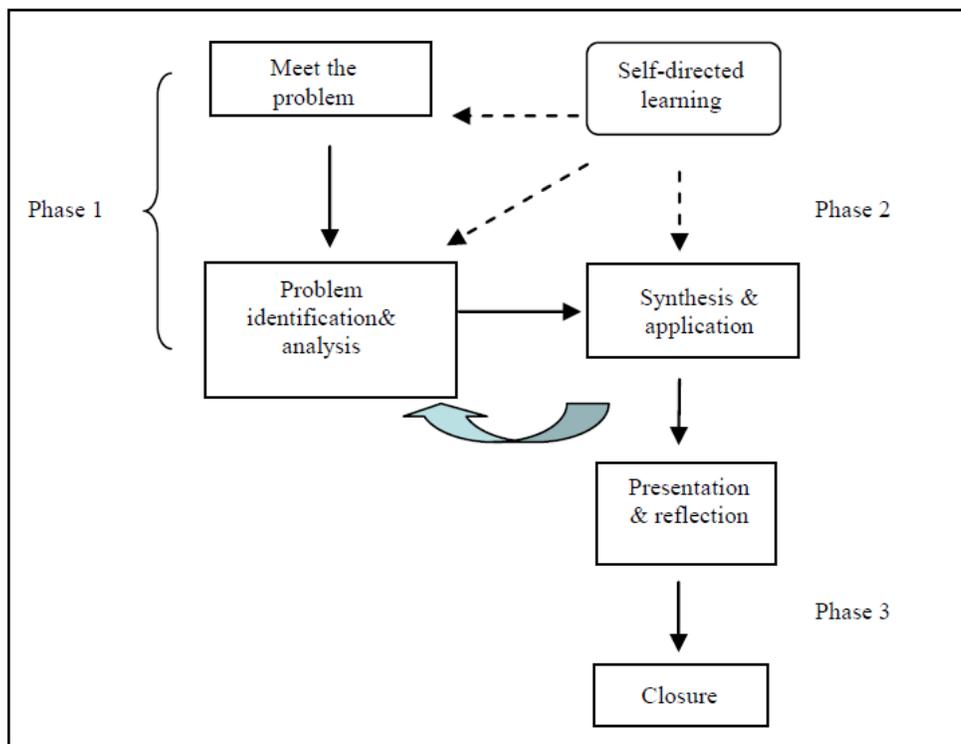


Figure 1. Problem-Based Learning Cycle

3.3 Problem-Based Learning in Supply Chain Management Course

In this paper, we describe the process and results of applying the PBL method to the supply chain management (SCM) course held by the Department of Industrial Engineering at Universitas Sebelas Maret (UNS). We initiated this project since the 2016/2017 academic year. SCM courses are held in a 16 week period for one semester. From a total of 12 students who took this course, they were divided into 6 groups. In the first 2 weeks, the lecturer delivered introductory material about SCM and students were asked to do a literature review of SCM.

In the next 2 weeks, material about the newspaper supply chain was introduced to students. The following week, each group was asked to choose 6 topics that had been provided and students were asked to present a resume about the theory related to the topic chosen. The topics chosen were procurement, production-distribution, customer order cycle, supply chain coordination, distribution, and supply chain risk management.

Then students were given 3 weeks to conduct surveys and observations in the field. Students observe problems in a newspaper producing industry. The students were assigned to follow the real activities in the supply chain processes, identify problems using 5W+1H (What, Who, Where, Why, When and How), and discuss alternative solutions with the problem's owner before the proposed improvements. The methods used by students during the survey were in-depth interviews with stakeholders involved in newspaper making and direct observation of the newspaper production process. In this 3-week face-to-face lecture, students submitted reports on the activities and progress that had been made to the lecturer then discuss them for the sake of further observation.

The following week, each group presented the findings and problems from the survey results and proposed a method for problem-solving. In this case, the lecturer has a role to provide opinions and input on the proposed method. At this stage, 2 students who choose the same topic are required to give different proposals. Here, students analyzed the existing problems and make alternative improvements to give recommendations to problem's owner and then evaluate them. The consultation process between lecturers and students last for the next 2 weeks.

Then students were given 3 weeks to write scientific articles based on case studies that have been carried out according to their respective topics. At week 15, students presented the results of their case studies to the newspaper industry to obtain feedback on the proposed alternative improvements. In the last week, there was an evaluation of SCM courses by lecturers to students. Figure 2 shows the PBL timeline which was implemented to this SCM course.

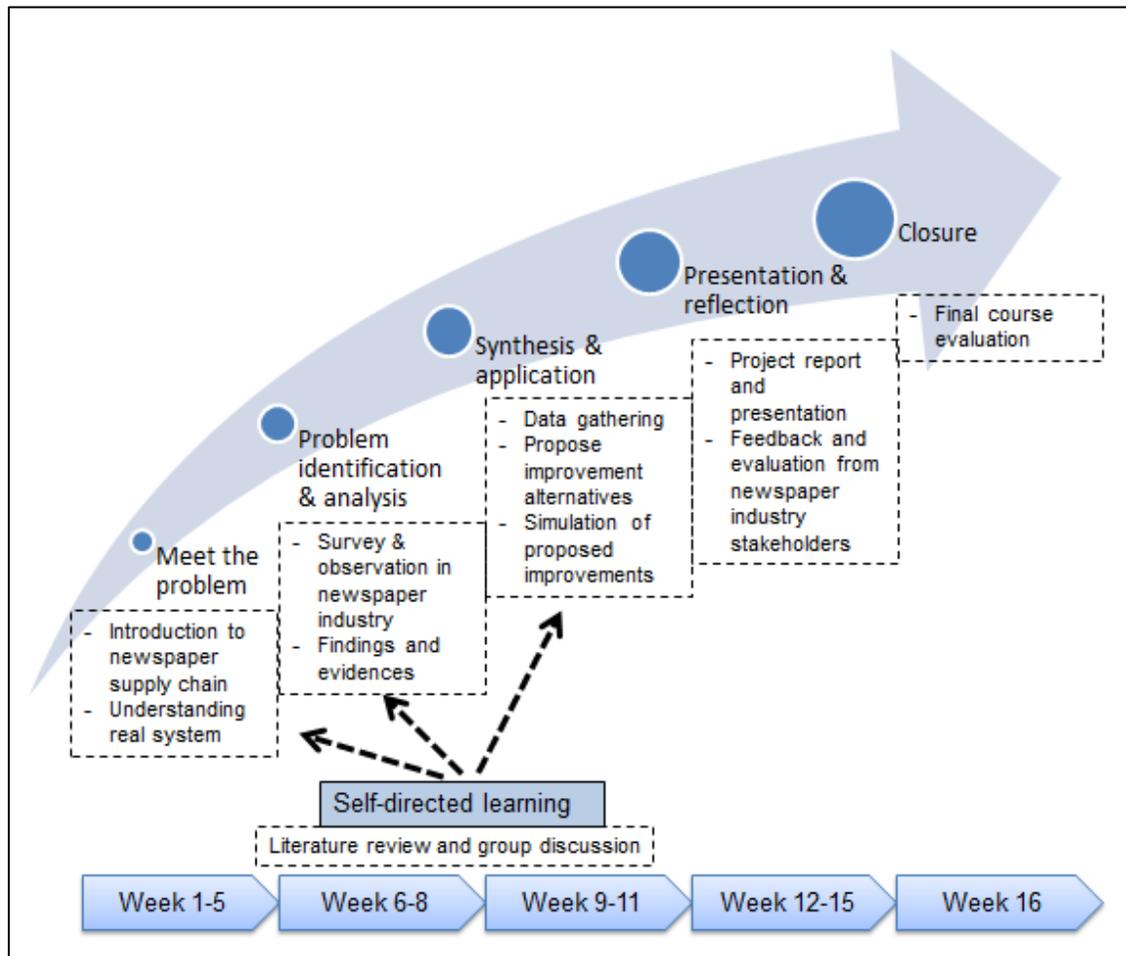


Figure 2. Problem-Based Learning Approach in SCM Course

In order to get a clearer picture, here we presented the newspaper supply chain cycle by adopting the green supply chain concept, which is shown in Figure 3. In this supply chain, it is important to integrate environmental thinking

into supply chain management, including product design, material sourcing, and selection, manufacturing process, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life.

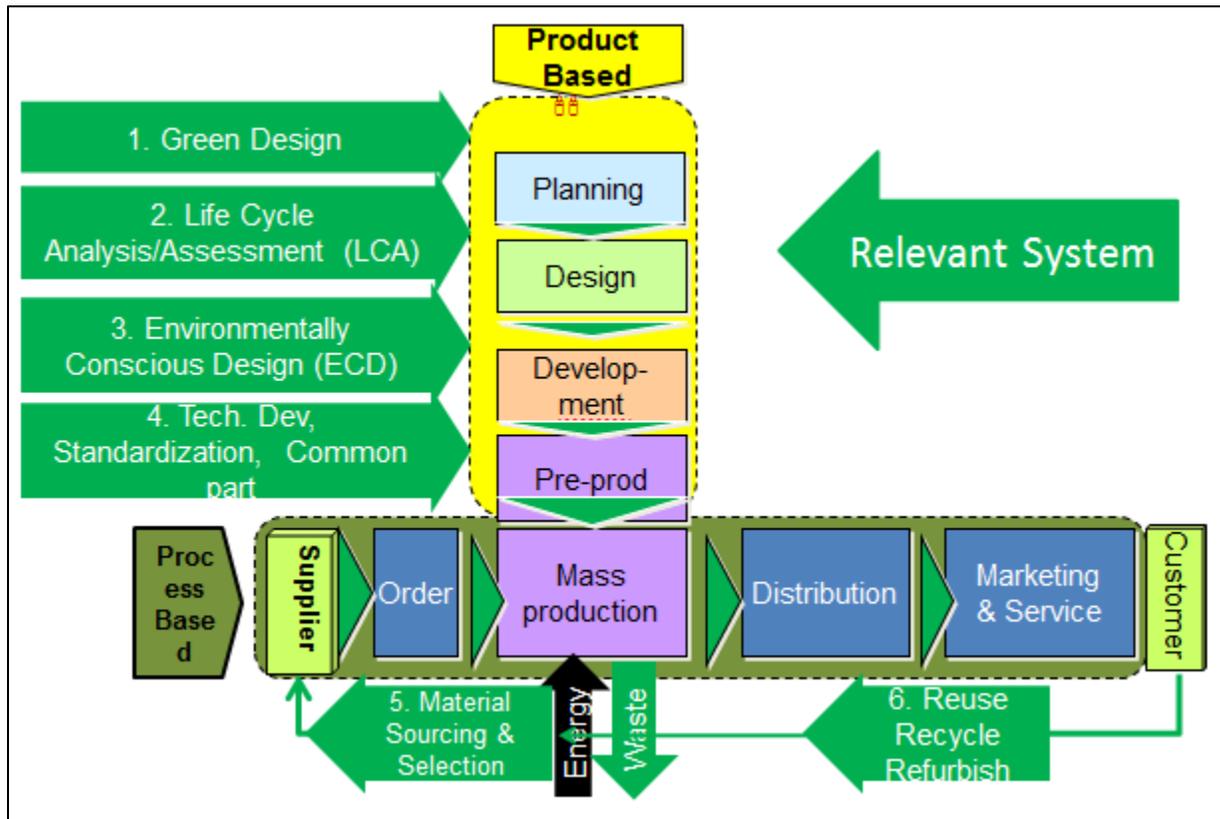


Figure 3. Green Supply Chain Cycle in General

Based on this model, it is known that there are 4 main cycles in the supply chain, namely customer order cycle, distribution cycle, manufacturing cycle, and procurement cycle. Regarding the PBL approach, students were assigned to observe the real activities in each cycle and then did the problem definition, synthesize the findings and collected data in order to propose recommendations to solve the problems. Table 3 shows the project outcomes, highlighting the papers resulted from students' article writing activities based on the case study. Based on the table, it can be known the SCM cycle and the level of problem-solving decision in which each paper is categorized.

Table 3. The project outcomes, highlighting the papers resulted from students' article writing activities based on the case study

No.	Paper title	SCM cycle				Level of decision		
		Customer order	Distribution	Manufacturing	Procurement	Strategic	Tactical	Operational
1	Sales forecasting newspaper with ARIMA: A case study	√				√		
2	Order Optimization for Perishable Products: Case Study	√				√		
3	Solving Capacitated Vehicle Routing Problem Using Sweep Algorithm For Determining Newspaper Distribution Routes: Case Study		√					√

4	Optimization of Distribution Channel Vehicle Routing Problem with Time Windows using Differential Evolution Algorithm A Case Study in Newspaper Industry		√					√
5	The Integration of Production-Distribution on Newspapers Supply Chain for Cost Minimization using Analytic Models: Case Study		√	√			√	√
6	Multi Times Direct Shipment Method for Synchronizing Production and Distribution Planning Newspapers: A Case Study		√	√			√	√
7	Supply chain risk management in newspaper company: House of risk approach	√	√	√	√	√		
8	Supply Chain Risk Management of Newspaper Industry: A Quantitative Study	√	√	√	√	√		
9	Supply Chain Coordination with Revenue Sharing Contracts: Case Study of Newspaper Industry	√	√	√	√	√		
10	Supply Chain Collaboration Optimization based on the Agreement of Relations between Suppliers and Network Design Problems	√	√	√	√	√		
11	Supply Chain Coordination Mechanism with Buyback Contract: Case Study in Newspaper Industry	√	√	√	√	√		
12	Multi-Objective Optimization Model for Multi Inventory Planning of Supplier Using ABC Method: Case Study				√		√	

4. Discussion

In this section, we discuss the benefits of PBL approach in teaching and learning process for the SCM course. The teaching and learning process using PBL approach that was carried out during the SCM course able to encourage and train the students to develop critical thinking, to actively participate in the classroom/meetings and to be effective team members. In engineering education, apart from producing engineers who possess in-depth technical knowledge, it is also important for the engineers to be able to work effectively as a team member. Team working requires skills such as organizing meetings; negotiating, discussing and arguing; solving problems creatively; willingness to give ideas and opinions; leadership; communication (listening, talking and visual presentation) and others relevant skills (Andersen, 2003). Team working played an important role in the overall success of projects. The learning process also enhanced the students' skills to interact and communicate orally with each other. The student's awareness of newspaper supply chain issues was at the same time improved by having the PBL activities. Newspaper sustainability awareness was enhanced through the PBL approach, whereby students were actively involved in gathering relevant information and data from a survey and observations in solving the problems. Furthermore, students' problem-solving skill was enhanced through the understanding of a real system, problem synthesis, and simulation of proposed improvements.

5. Conclusion

This study illustrates the applications of problem-based learning in a Supply Chain Management (SCM) course for Industrial Engineering Students. An active methodology for teaching and collaborative learning was proposed through case studies in the newspaper industry. Problem-based learning approach was used in the course to improve students' capabilities, including problem identification and analysis, data collection and analysis, proposed improvements and recommendation and its simulation. A team project report was presented to show how to design, improve, and install of integrated systems has been developed in a semester of SCM Courses. Particularly, this study was implemented successfully in an undergraduate course of SCM.

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