Learning Outcomes Development for Informatics Engineering Students by Using Lean-Startup Model

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***Abstract*— Informatics Engineering (IE) students must have a comprehensive competency to innovate a product through learning. This purpose can be combined with Lean Startup model. This study describes the implementation of Lean Startup in learning outcomes development for IE students. There are six activities to implement Lean Startup to obtain the learning outcomes, such as defining overall competency, distributing supporting competency, arranging supporting courses, learning design, learning evaluation, and learning assessment. The case study conducted in the Information Technology Department of State Polytechnic of Jember shows that all courses in one semester could support the students to innovate a product as their learning evaluation. This is indicated by the number of increasing products as learning outcomes in the past four years. The assessment result also presents that most of the customers contributing to the learning process were satisfied with their learning results and it is also described by the number of MoU with the customers that were significantly increased. The conclusion of this study confirms that the Lean Startup model will stimulate the IE students to collaborate for customers on a new product in every semester.**

Keywords— informatics engineering, learning outcomes, and lean startup.

I. Introduction

Student-centered learning is built on four core values; an interaction between student and teachers, knowledge, collaboration with students, and responses to change [1]. Four core values can be implemented in Informatic Engineering (IE) program by designing learning with comprehensive activities and adaptive goals. To make the IE students more adaptive, the learning design and outcomes can follow the software industry. In the software industry, the developers are the programmer, but it is the IE students who are the learning developer [2]. Therefore, it can be assumed that IE learning design can be modeled as software development processes.

There are four fundamental concepts of software development processes, such as product, customer, and developer. Based on the learning perspective, the IE students can be a developer, the product is the learning outcomes in one semester, and the customers are the learning customer that can assess learning result. Hence, the main idea is to design an IE learning that follows the software development process that has been used in the software industry. To achieve that the above goal, the researchers also used Lean Startup model as a learning design for the IE students. The reason why the researchers used software development rather than educational approach/design is that this study tried to closely adapt the Lean Startup model with the software industry the most.

The main idea is to make the IE students as a startup team and to give the challenge to sell a software product or/and have a stakeholder as their learning partnership for an Entrepreneurship Education (EE) learning evaluation since EE often becomes a team-based challenge, such as creating a new venture or solving a startup problem [3]. The materials of Teaching Lean Startup include course objectives, learning by doing, team formation, monitoring, and grading. [4]. The Challenge Based Startup Learning refers to a framework that combines Challenge Based Learning, lean startup, customer development, and software development techniques [5]. One model can be used to speed up the process of creating a software product so that it can be immediately tested by the user or the representation of the target market is Lean Startup.

In this paper, the researchers proposed a Lean-Startup Model in the process of developing learning outcomes in every semester. The case study of this study was conducted in the Fourth Diploma of the Informatics Engineering Program at State Polytechnic of Jember.

II. Proposed Framework

The Lean-Startup Framework is one of the most popular contributions in practitioner-oriented literature [6]. This study seeks to generate new insights into how new ventures are started by describing the five main building blocks of the Lean-Startup Model (business model, validated learning/customer development, minimum viable products, perseverance vs. pivoting, and market-opportunity navigation), enriching the framework with existing research findings, and proposing promising research opportunities in a way that reduces the academic-practitioner divide [7].

There are six activities in implementing Lean Startup for IE students to obtain the learning outcomes in every semester. It can be found specifically in the fourth step, in which the previous step is the preparation to design a curriculum to have a product in every semester. The fifth and sixth step is to measure the learning outcomes after the Lean Startup was implemented in learning design. The proposed framework is presented in Figure 1.

1) Defining overall competency

The first step for implementing Lean Startup in learning outcomes design is defining overall competency. In the case of Informatics Engineering (IE) Study Program of State Polytechnic of Jember, the researchers focused on software engineers as overall competency because most of the IE areas are covered with that terminology and most of the industrial requirement is suitable for it.

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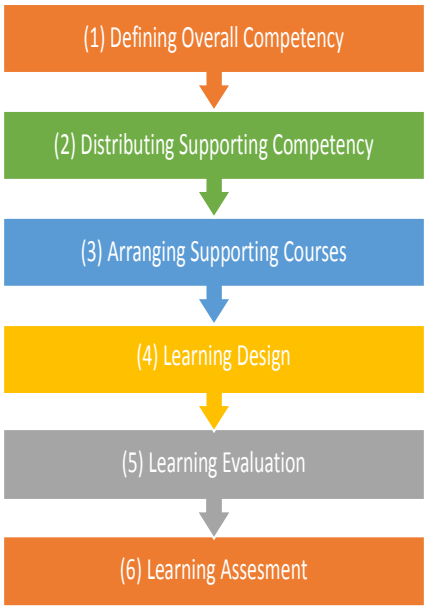

Fig 1. Proposed Framework Activities

TABLE I DISTRIBUTING SUPPORTING COMPETENCY RESULTS

Semester	Key Concept	Product	Platform/Tools
I.	Basic of Information System (IS)	GUI	Microsoft Access
II.	Object-Oriented Programming (OOP)	Dekstop	Java and Netbeans
III.	Web-based programming	Web	PHP and Code Igniter
IV.	Mobile Programming	Android	Java and REST API
V.	Internet of Things (IoT)	IoT System	Arduino or Raspberry
VI.	Artificial Intelligence (AI)	AI system	Matlab or Python
VII.	Work in industry	based on industrial needs	
VIII.	Mini thesis	based on research topics	

2) Distributing supporting competency

The second step for implementing Lean Startup in learning outcomes design is distributing supporting competency. It can be done by mapping some key concepts, products, and tools that will teach for each semester. The researchers chose six key concepts with six products and tools provided in each semester, such as basic information system, object-oriented programming, web-based programming, mobile programming, Internet of Things, and Artificial Intelligence. The researchers assumed that the six supporting competencies are the learning outcomes for each semester. The distribution of supporting competency can be seen in Table 1.

TABLE II AN EXAMPLE OF ARRANGING SUPPORTING COMPETENCY IN THIRD SEMESTER

Learning Outcomes	Supporting Courses	Credits	Role in Software Development
Web-based Programming *Course name:* Web-based information system workshop **8 Credits.**	Human-computer interaction	2	Front End
	Analysis and Design Algorithm	2	Backend
	Database management	2	Database Administrator
	Information systems modelling	2	System Analyst
	Software Testing	2	Quality Assurance
Total of credit in one semester: 18			

3) Arranging supporting courses

The third step for implementing Lean Startup in learning outcomes design is arranging supporting courses. It can be performed by deriving each supporting competency in each semester with the supporting courses, e.g., in the case of web-based programming in the third semester, the researchers assumed that the students need some supporting courses to have web-based information system, such as human-computer interaction, analysis, and design algorithm, database management, information system modeling, and software testing. It should be noted that each supporting course will have specific competency and role in a software development project, although all supporting courses must be taken for all IE students. The result of arranging supporting courses is assumed as a curriculum structure. The example of arranging supporting courses is presented in Table 2.

4) Learning Design

The Lean-Startup design used in the research location tried to combine how to drive a startup, how to steer, when to turn, and when to preserve and grow a business with a maximum acceleration into the curriculum. By using the Lean-Startup approach, the campus can create order, not being chaos by providing tools to test a major vision continuously as presented in a diagram in Figure 2 [9]. Ideas are one of the main parts to create something simple yet crucial for people, thus the researchers tried to make a collaboration in need of the industry based on the recent curriculum. Based on the code aspect, the researchers tried to change the definition code into how to build a curriculum framework that another client can easily use. Students are as human resources that should create one that is ready to use after passing all the packages of the curriculum. After the students graduated, the researchers evaluated to get some data to measure their satisfaction. This cycle is learned many times, thus the best framework for the curriculum can be obtained.

Fig 2. Learning Design with Lean Startup Model

The main step of implementing Lean Startup for IE students relies on learning design. Although this has already been done in the business class [4], the researchers tried to implement it on the IE students' context. There are three loops activities in the Lean Startup development that the researchers followed; build, measure, and learn [7]. The researchers then modified loops to accommodate the learning activities by combining some sub-activities in addition to it. On the first activity (learning), the researchers motivated the IE students to arrange a team based on the role in software development and to have some customer development activities [8]. After the team and customers that gathered, the next sub-activity is to gather the product ideas. The second activity is to build a Minimum Viable Product (MVP) performed by the IE students that can be tested by customers on the next activities. The result of product measurement activities can be customer product responded by incremental development of a product. The learning design using Lean Startup implementation is presented in Figure 2.

5) Learning Evaluation

There are two steps of learning outcomes measurement, the first step is learning evaluation by internal expert judgment. Each lecturer in supporting the course will join the IE students' team for presenting their product. The lecturer will give scores based on the course theory implemented in their product development. The lecturer also gives some recommendations to make the IE product more perfect before doing the external assessment.

6) Learning Assesment

The next step is an external learning assessment by organizing an IE product exhibition (TIF exhibition) in the research location. Besides, the researchers invited all the contributed customers to have the product assessment. At the last step, the researchers made a business matching session to attract the customers to buy or have the following Memorandum of Understanding (MoU) with IE products. The team that had the product sold or the MoU with customers would become the extra score in EE course as a reward.

III. Results and Discussions

A. Learning Evaluation

The implementation of learning evaluation of the IE program has two forms; lecture (supporting courses) and workshop. The former is the process of delivering theoretical materials by a lecturer in class. The learning method used is student-oriented (student center) to be able to encourage the students to have critical thinking, sense of exploration, creativity, and experiment by utilizing various learning resources.

The second form of learning from the IE program is a workshop which is a project-based practicum activity integrated from a combination of several courses (theory) in the same semester. Through this Workshop, the IE program focuses on the process of developing projects or IT products according to the level of each semester.

Evaluation of supporting courses in the form of a workshop in the IE program is technically carried out jointly at one time at the end of the semester of learning workshop courses. In the initial learning planning process, each of the supporting course and workshop team has a discussion to determine the product projects to be achieved at the end of the semester. Therefore, the tasks in theoretical courses are related tasks with workshop subjects following the agreed product projects in the learning implementation process. There are five theoretical courses and one workshop course in semester third, for example, as presented in Table II.

Based on Table II, the Web-based Information System Workshop has one major task in the form of software products. This workshop course is supported by several courses, such as information system modeling, human interaction, and computer, etc. At the end of this semester, the third-semester students will produce a software product, where the product completion process is supported by all courses taken in the third semester. At the time of evaluating the software product, there will be at least one expert lecturer as the representative from each team of subjects in the third semester to assess the software products. This should be achieved since every task in each subject has been agreed at the beginning of the learning plan.

B. TIF Exhibition

The exhibition activity of the IE program is one form of a forum for students to show the results of lecture products to the wider community. This activity aims to build cooperation and networking with the business and industry and is expected to bring benefits to the development of the digital economy and entrepreneurship.

This exhibition was first held in 2017 and continued to be annually held. The documentation of the implementation in 2017 is presented in Figure 3. The exhibition was held after semester 1,3, and 5 lectures ended. The participants of the exhibition were students of the IE program semester 1, 3, and 5. The description of the exhibition was begun with the opening by the representatives of the IE program and guests of customers, then during the exhibition, the assessment would be conducted to have the best application categories and the most favorite stands. The winners will be announced at the end of the exhibition. This competition is a form of reward from the IE program to the students who have done the learning process. The number of exhibitors has increased and the consistency of the number each year is presented in Figure 3.

Fig 3. The First Exhibition In 2017

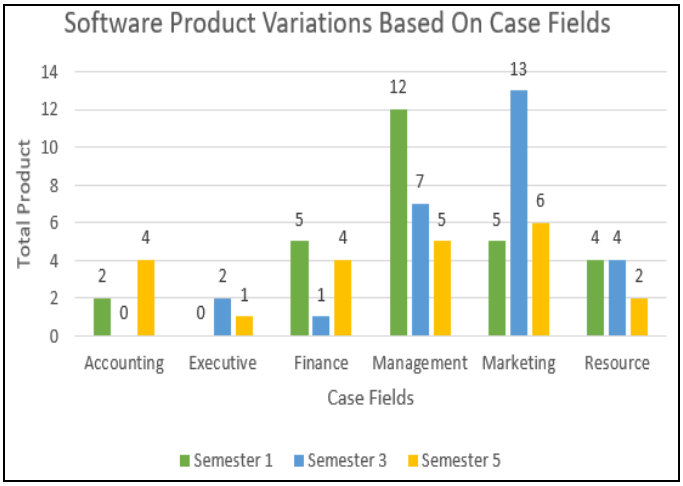

Fig 5. Software Product Variations Based On Case Fields

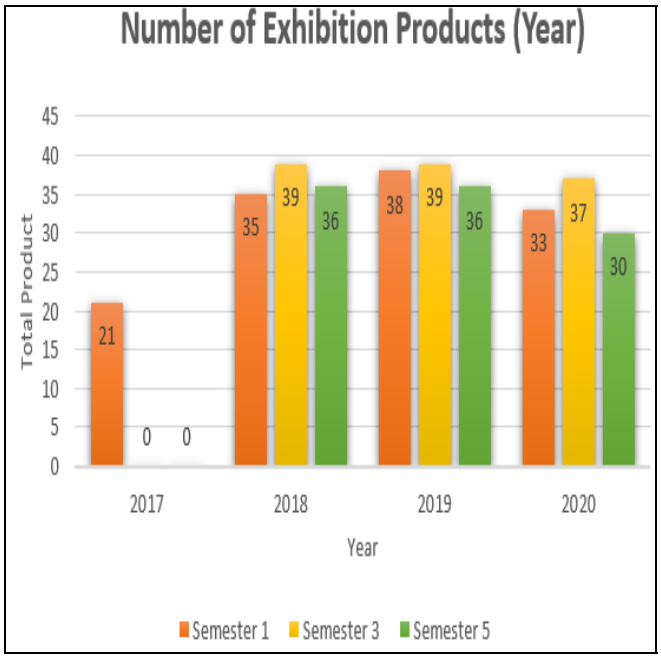

Fig 4. Number of Exhibition Product

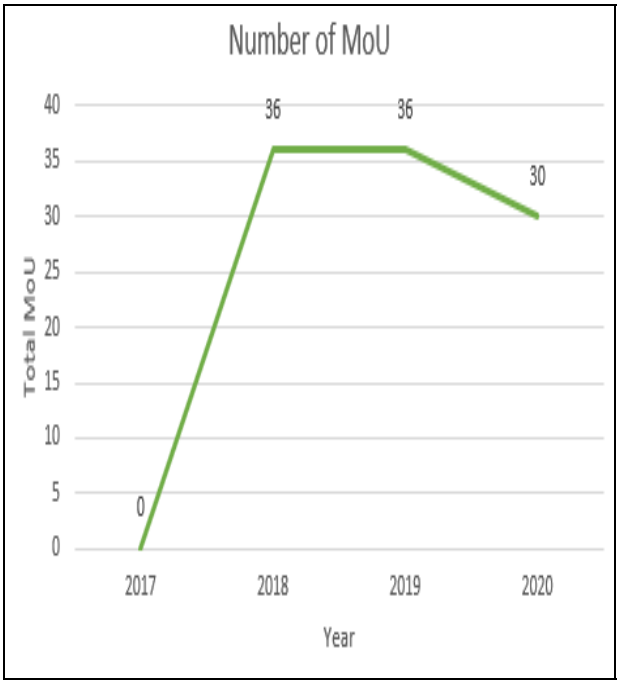

Fig 6. Number of MoU

Based on Figure 4, the participants of the exhibition products in 2017 came from the-first semester students only. The exhibitors also came from the third and the fifth-semester students in the following year to date. The students' products were the results of lectures from the workshop course project. The workshop course is one of the founding subjects in the IE program, which during the learning process, uses project-based learning methods. Figure 4 shows the average number of products displayed annually (i.e. around 30-40).

The products that are annually displayed consist of several variations of the software products. Based on the platform, the types of developed products consist of desktop-based software, web-based software, and mobile-based software. GUI is software developed by the first-semester students which are a product of the Information Systems Basic Workshop course. Web-based software was developed by the third-semester students that are the product of the Web-Based Information Systems Workshop and Software Development course. The average mobile-based software was developed by the fifth-semester students because the mobile application course is in the even semester (i.e. fourth semester) which is a product of the Information Systems Project course, but the students are free to choose desktop, web, and mobile platforms in this Information System Project course. Therefore, the software products displayed by the fifth-semester students include desktop, web, or mobile-based software.

In addition to variations in platform-based software products, the variations of software products developed by students also solve the problems in many fields, such as accounting, executive, finance, management, marketing, and resources. This indicates that the Informatics Engineering is one of the important fields whose existence can support the needs of other fields. The variations of software products displayed at the 2020 exhibition based on the fields are presented in Figure 5.

This routine activity always invites customers to attend the exhibitions of student products. This is routinely performed to measure the quality of products that have been developed in terms of the actual product users. In the process of product completion, the students conduct the requirements analysis stage directly to the user, so through this exhibition, the developed products are expected to be directly assessed by the users according to the requirements analysis stage at the beginning, thus the synchronization and learning achievements are achieved.

In addition to seeing and providing input on the developed products that have, the presence of customers in the exhibition is also expected to be continued by buying or ordering the products. Figure 6 shows the number of MoUs that the students get every year. The MoUs are the beginning of software products developed by the students, which can be sold and used by the customers.

Figure 6 shows that there was an increase in the number of MoUs with customers from 2017 to 2019 and remained consistent with an average of 30 MoUs in 2020. This is one indicator the IE students are ready to collaborate with when they graduate later. This is following the objectives of vocational education, such as preparing skillful graduates to be able to work based on their respective fields.

C. Learning Assessment

The product exhibition of information technology program is one form of evaluation of products that have been produced by students. The output of this product evaluation is in the form of an MoU with customers because the products are developed from the customers' problems.

The customers appreciate the exhibition activities that have been going on from 2017 to 2020 because some creative ideas from the students can provide great benefits to solve the problems existing in the world of business and industry. Some evaluations are given by contributors from the world of business and industry, complete product documentation, and improving product quality so that the products can truly have marketability according to the existing industry standard.

According to the customers, the products produced by students in terms of system functionality were running well and the errors/bugs had been resolved well, but the products still had weaknesses in the User Interface/User Experience (UI/UX) appearance, so it needs to be improved again. Such feedbacks are expected to be an input for the Informatics Engineering study program to improve and enhance the learning process in courses related to UI/UX.

Also, the evaluation of the exhibition throughout the years is the need for uniformity of formats related to the MoU document with the customers. The Informatics Engineering study program has not yet made a standard for MoU document to date. Figure 7 and Figure 8. show the MoU documents that had been made so far.

SURAT PERJANJIAN KERJA ANTARA
SDN BADEAN 1 BONDOWOSO DENGAN BIKEA TECHNOCRAFT TENTANG PEMBUATAN APLIKASI SISTEM INFORMASI MANAJEMEN (SIM) SDN BADEAN 1 BONDOWOSO

Nomor : 02/XII/Bikea/2019

Pada hari Rabu, 18 Desember 2019 bertempat di SDN BADEAN 1 BONDOWOSO, para pihak yang bertanda tangan di bawah ini:

I. Nama : Siti Agustinah, M.Pd
Alamat : Jl. Letnan Jendral S Parman No.10 Badean, Kec. Bondowoso, Kab. Bondowoso, Jawa Timur 68214
Jabatan : Kepala SDN BADEAN 1 BONDOWOSO
NIP : 19660827 199111 2 001

Dalam hal ini bertindak untuk dan atas nama SDN Badean 1 Bondowoso selanjutnya disebut PIHAK PERTAMA.

II. Nama : Rendhy Pratama Putra
Alamat : Jl. K. H. Wahid Hasyim No. 41, Bondowoso (Politeknik Negeri Jember)
Jabatan : OWNER BIKEA TEKNOCRAFT
NIK : 3511192805970001

Dalam hal ini bertindak untuk dan atas nama Tim Pengembang Aplikasi (Bikea Technocraft), selanjutnya disebut PIHAK KEDUA.

PIHAK PERTAMA dan **PIHAK KEDUA** secara bersama-sama disebut sebagai PARA PIHAK sepakat untuk menandatangani dan melaksanakan Perjanjian Kerjasama Pembuatan Aplikasi Absensi dengan ketentuan dan syarat-syarat sebagai berikut :

PASAL 11
LAIN-LAIN

Hal-hal lain yang ada hubungannya dengan perjanjian ini dan belum cukup diatur dalam pasal-pasal dari surat perjanjian ini akan ditentukan lebih lanjut oleh kedua belah pihak secara musyawarah dan mufakat dan dituangkan dalam Surat Perjanjian Tambahan/ Addendum dan merupakan bagian yang tidak terpisahkan dari Perjanjian ini.

PASAL 12
PENUTUP

1. Surat Perjanjian ini dinyatakan sah dan mengikat kedua belah pihak dan mulai berlaku setelah ditandatangani oleh kedua belah pihak
2. Surat Perjanjian ini dibuat 2 (dua) rangkap masing-masing bermaterai cukup dan mempunyai kekuatan hukum yang sama.

Bondowoso, 18 Desember 2019

PIHAK PERTAMA,
Siti Agustinah, M.Pd
Kepala SDN Badean 1 Bondowoso

PIHAK KEDUA,
Rendhy Pratama Putra
Owner Bikea Technocraft

Fig 7. Example of MoU-1

a. Pembayaran Pertama (UangMuka)

Dilakukan pada saat penandatanganan perjanjian kontrak atau maksimal 2 minggu setelahnya dengan 30% dari total nilai kontrak yaitu senilai Rp.1.050.000

b. Pembayaran kedua (Pelunasan)

Dilakukan dengan sisa dari pembayaran yaitu 70%dari total nilai pembayaran dan diterima oleh Pihak Pertama dari Pihak Kedua pada saat penyerahan hasil cetak terakhir pada tanggal 09 Januari 2020 atau maksimal 2 minggu setelahnya yakni senilai 2.400.000-.

PASAL VI
ForceMajeure

Yang dimaksud dengan Force Majeure atau keadaan memaksa adalah suatu hal atau kejadian yang menimpa salah satu pihak dalam perjanjian yang terjadi di luar kemampuan manusia seperti : bencana alam, meninggal dunia, tindakan pemerintah di bidang keuangan, situasi keamanan yang tidak mengizinkan, dan hal-hal lain yang disepakati oleh kedua belah pihak.

Apabila terjadi hal-hal yang dimaksudkan dalam pasal 6 (enam) ayat 1 (satu), maka para pihak yang terkait dalam perjanjian ini akan segera melakukan perundingan untuk menyelesaikan, penyelesaian selanjutnya yang dilakukan paling lambat 14 (empat belas) hari setelah kejadian.

Apabila terjadi hal-hal yang dimaksudkan dalam pasal 2 (dua), maka para pihak yang terkait dalam perjanjian ini akan segera melakukan perundingan untuk menyelesaikannya, penyelesaian selanjutnya yang dilakukan paling lambat 14 (empat belas) hari setelah kejadian.

PASAL VII
PenyelesaianMasalah

Apabila terjadi perselisihan dan ketidak puasan dari Pihak Pertama dan Pihak Kedua sehubungan dengan pelaksanaan dari perjanjian kerjasama ini, maka Pihak Pertama dan Pihak Kedua akan menyelesaikan dengan jalan musyawarah dan mufakat dan akan diusahakan jalan terbaik untuk menyelesaikannya.

- Kategori
- Laporan
- Pegawai
- User
- Bukti Pembayaran

2. Admin
- Login
- Dashboard
- Produk
- Bukti Pembayaran

B. Front End
1. Customer
- Dashboard
- Kategori Produk
- Detail Produk
- Keranjang
- Pembayaran
- Upload bukti pembayaran
- Chat Seller

C. Hosting dan Domain.
D. Maintenance dari kesalahan sistem bersifat life time.
E. Training Admin dan Owner sebanyak 3x

PASAL II
JangkaWaktuKerjasama

Perjanjian kerjasama ini telah dilakukan dan diterima untuk jangka waktu dari tanggal 12 Desember 2019 sampai dengan 12 Januari 2020 dan mulai bekerja dasar hukumnya terhitung sejak ditandatanganinya perjanjian ini.

PASAL III
Kewajiban - kewajiban PihakPertama

1. Pihak Pertama bersedia melaporkan kegiatan dalam tahap pembuatan, dan melaporkan setiap ada problem yang dialami.

Scanned with CamScanner

Fig 8. Example of MoU-2

IV. CONCLUSSIONS AND FUTURE WORK

The implementation of Agile and Lean Startup in learning outcomes is already presented in this study. There are six activities to implement Lean Startup to obtain learning outcomes. The preparation activities are conducted to develop the learning outcomes by defining overall competencies, distributing supporting competency, and arranging supporting courses. The main activities are to implement the Lean Startup model in learning design by collaborating with the customers. Also, the last activities are learning outcomes measurement, including learning evaluation (internal expert judgment) and learning assessment with the customers.

The result is students could collaborate with the customers to produce a software product as their learning assessment. The number of software products as learning outcomes has increased in the past four years. The customers also felt satisfied with the learning results indicated by the number of MoUs produced every year. It confirms that the Lean Startup model will stimulate the IE students to elaborate on a new product for customers in every semester.

In future work, Lean Startup can become a model for IE students to obtain their learning outcomes by producing some products as a learning evaluation and assessment. The further investigation must be conducted to measure the correlation between entrepreneurship education

(EE) skills and the implementation of the Lean Startup model for IE students.

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