A Proposed of Lean Six Sigma Framework for Higher Education Institution (LSSF - for HEdu) To Improve Effectiveness and Efficiency of Higher Education in Indonesia

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Abstract

Improvement of the effectiveness and efficiency of Higher education institutions (HEI) are required to alter the teaching and learning process, research, and community service. HEI are also improve student abilities and focus on customers requirement. HEI must redesign business processes to reduce the administrative overhead and improve the services delivered to students, industry partners, faculty, and researchers. As a result, HEI should increase all its resources by using various quality improvement methods. Currently, universities in America, Europe, and Australia adopted several frameworks. Universities can carry out accreditation using these frameworks. Accreditation is comparing specific criteria with established standards. For this reason, HEI must have a framework for improving its quality. Lean Six Sigma (LSS) approach is one of the frameworks for improvements.
LSS is a business strategy and methodology that increases process improvement, resulting in enhanced customer satisfaction and improved processes. Lean Manufacturing (LM) is a manufacturing concept to produce products efficiently by reducing waste. The Six Sigma methodology is a disciplined and structured approach to improving process performance and achieving high levels of quality. Many service industries, including at HEI, implemented Lean Six Sigma (LSS),i.e., the integration of Lean Manufacturing and Six Sigma. So far, the adaptation of LSS has been only partial and has focused on reducing waste rather than a holistic approach. There are not many studies that discuss LSS comprehensively, develop models and carry out cost evaluations. This paper proposes the Lean Six Sigma Framework for Higher Education (LSSF - for HEdu) comprehensively. The framework hopefully can increase the effectiveness and efficiency of the HEI so that it can satisfy all customers and reduce costs

Keywords:
Lean Six Sigma, LSSF - for HEdu, effectiveness, efficiency, HEI.

1. Introduction

Higher Education Institution (HEI) was greatly influenced by the Industrial Revolution 4.0. Digitalization affects all aspects of teaching, research, knowledge transfer, and administrative activities (Dräger et al., 2017). HEI must improve and develop teaching and learning strategies, improve student competency and focus on customers, and increase all resource utilization (Davidson et al., 2020; Svensson et al., 2015; Wawan et al., 2018). Currently, universities in America, Europe, and Australia adopt several frameworks. Universities can carry out accreditation using these frameworks. Accreditation is comparing specific criteria with established standards. Accreditation systems widely used include the Accreditation Board for Engineering and Technology (ABET), Association to Advance Collegiate Schools of Business (AACSB), European Quality Improvement System (EQUIS), ASEAN University Network-

Quality Assurance (AUN-QA), and Japan Accreditation Board for Engineering Education (JABEE). The framework has no specific methodology for continuous improvement (Davidson et al., 2020). HEI must improve its business processes systematically. Lean Six Sigma is a methodology for improving business processes systematically (Svensson et al., 2015). The American Society for Quality (ASQ) stated many advantages of implementing LSS at HEI, i.e., meeting accreditation requirements, making improvements, encouraging collaboration between organizations, knowing customer desires, identifying and reducing costs (Simons, 2013).

The concept of quality continues to evolve and results in several methodologies. Total Quality Management (TQM) is a quality management system that improves companies such as Texas Instruments, Xerox, IBM, and Motorola. Furthermore, there are several quality development models, i.e., Malcolm Baldrige Award, European Foundation for Quality Management, the Deming Prize Criteria, and Kaizen quality development models (Sunder M & Antony, 2018). Kaizen is a gradual and continuous improvement. Lean is a quality improvement philosophy that fosters a CI culture in an organization. The Lean concept developed in Japan after World War II. Japanese manufacturers realized that they could not make the significant investments required to rebuild the destroyed facilities (Bhamu & Sangwan, 2014). Lean Manufacturing (LM) is a well-known and widely used approach in companies because of its ability to increase process efficiency and productivity (Bittencourt et al., 2019).

LM implementation began in the automotive industry, followed by other industries, including textiles, construction, food, medical, electricity and electronics, ceramic industry, plywood, furniture, slippers, shell, and the service industry (Alifiya & Singgih, 2019; Bakkali et al., 2017; Bhamu & Sangwan, 2014; Hardiningtyas et al., 2011; Mulyana & Angka, 2014). LM has also been implemented well in HEI (A. C. Alves et al., 2016; Balzer, 2010). Lean Manufacturing in HEI is an adaptation of Lean Thinking to HEI, both in administrative and academic activities (Vukadinovic et al., 2017). The Technical School in Morocco improves quality, reduces waste and costs, and shortens time through the implementation of LM (Bakkali et al., 2017). Other several other studies have shown the contribution of LM implementation in universities. Some benefits of LM implementation are accelerating the administration process, increase student satisfaction, and design curricula (Bârsan & Codrea, 2019; Emiliani, 2004; Koromyslova et al., 2019; Kumar et al., 2016; Sremcev et al., 2018).

Six Sigma methodology is a disciplined and structured approach to improve process performance and achieve high-quality levels. Lean Manufacturing and Six Sigma, referred to as the Lean Six Sigma (LSS), are complementary methods that have been widely used in companies. Lean Six Sigma (LSS) is a methodology that focuses on eliminating waste and defects by using Six Sigma to achieve customer satisfaction related to quality, delivery speed, and cost and generating financial benefits (Salah et al., 2010). Opportunities for improvement in HEI using LSS can be carried out in several activities, especially teaching, service administration, new student registration processes, marketing, and research (Hess & Benjamin, 2015). There have been several implementation LSS in HEI. Vats & Sujata (2015) reported that the implementation of LSS reduces waste in the teaching and learning process. Svensson et al. (2015) stated that LSS increases efficiency at King Abdullah University of Science and Technology.

Meanwhile, Allameh Tabatabai University in Tehran, Iran, increase student satisfaction levels, reducing the waiting time for consultations by 15 percent and increasing the number of applicants by 5 percent (Haerizadeh & Sunder M, 2019). Another benefit of implementing LSS in HEI is being an enabler to meet accreditation requirements (Sunder M & Mahalingam, 2018). The LSS approach in HEI can be applied to improve teaching methods, administrative processes, improve the quality of HEI and add value that can continuously increase customer/student satisfaction (Cudney et al., 2018). However, much of the research focused on implementing LSS to reduce waste rather than a holistic approach (Hines & Lethbridge, 2008). HEI requires an integrated method to increase business process efficiency and effectiveness. This paper proposes a conceptual framework of Lean Six Sigma for HEI. The framework will be developed in a comprehensive way to manage teaching process, research and community services.

2. Literature Review

2.1 Lean Manufacturing

The basic principle of Lean Manufacturing (LM) is Lean Thinking. Lean Thinking consists of 5 principles: specify the value, identify value streams, create flow, pull system, and pursue perfection (James P Womack & Jones, 2003). LM implementation benefits include reducing lead time, improving productivity, and reducing WIP (Patel & Patange, 2017). Waste in manufacture consist of (J P Womack & Jones, 1997):

a. Transportation. Unnecessary transport of parts under production.
b. Inventory. Stacks of parts waiting to be completed or finished products waiting to be shipped.
c. Motion. Unnecessary movement of people working on products.

d. Waiting. Unnecessary waiting by people to begin the next step
e. Over-Processing the product with extra steps.
f. Over-Production of products not needed.
g. Defects in the product.

2.2 Lean Six Sigma (*LSS*) in HEI

Lean and Six Sigma have a complementary relationship that is widely accepted today, and more companies are establishing Lean Six Sigma (LSS) programs (Salah & Rahim, 2019). The term LSS was introduced around 2000. LSS is widely used in the industry (Antony et al., 2017). Snee (2010) defined LSS as a business strategy and methodology that increased process performance resulting in enhanced customer satisfaction and improved bottom-line results by improving quality, speed and cost. The LSS methodology helps to improve capabilities within the organization, reduce production costs and improve quality. LSS has become a widely used strategy for continuous improvement in the manufacturing industry (automotive, heavy equipment, small industry, construction, textiles), process industry (paper, sugar, food industry), and service industries (health, finance, education, military, insurance, retail) (Shokri, 2017; M. Singh & Rathi, 2019). Although initially, LM came from the manufacturing industry, it has been implemented successfully in various industries, including HEI (Balzer, 2010). For more than 15 years, LSS has demonstrated its potential for realizing improvements in the delivery of higher education and its supporting services. Examples of improvement noted in the literature include (Balzer et al., 2016):

- reducing student waiting time at counseling centers from an average of 21 days to 0 days without adding staff
- reduce the response time of prospective students from 3 weeks to 1 hour.
- reduced the time to repair campus facilities from an average of 24 working days to an average of less than three working days, where 80 percent of repairs were completed on the same day as requested.
- half the administrative process for recruiting new staff, reducing hiring time from 22 to 8 weeks.
- more than $ 27.2 B in financial savings at US public universities over four years.

The role of LSS in HEI includes several aspects, both operational and managerial aspects. The number of articles related to the implementation, concept, and study of literature at HEI (Figure 1). Figure 1shows LSS research in PT has been started in 2006 and continues to increase in number until now. This shows that LSS is needed in PT and needs to be continuously developed.

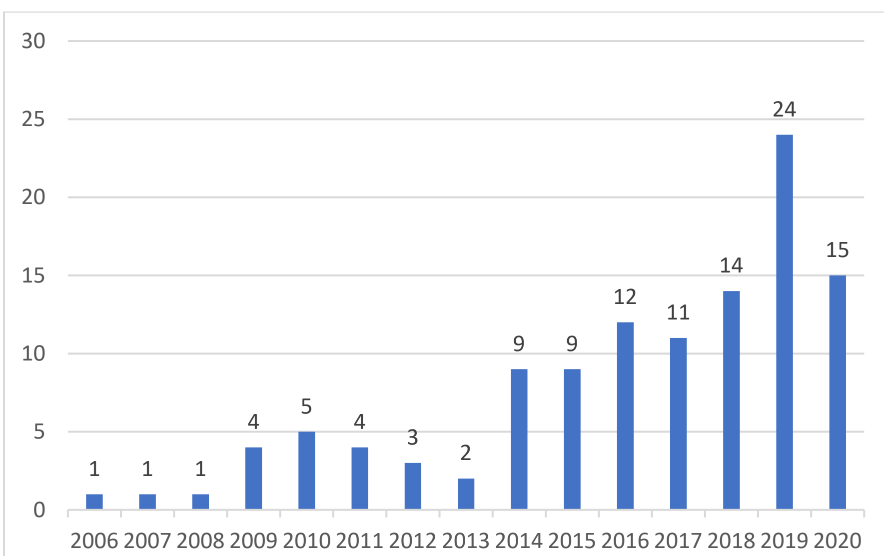

Figure 1. Number of LSS article in HEI
(Source: Scopus Database, retrieved 30-12-2020)

3. Proposed Framework

This article discusses the Lean Six Sigma Framework for Higher Education Institution (LSSF - For HEdu) to improve the effectiveness and efficiency. The framework consists of 4 stages, namely:

a. Identification and Prioritize of Waste.
b. Identification of Critical Success Factors (CSF) and Analysis of its Relationship.
c. Identification Voice of HEI stakeholders.
d. Development of improvement project selection.

Figure 2 shows the proposed framework.

3.1. Identification and Prioritize of Waste Framework

Kang & Manyonge (2014) identified the types of waste and classified them into three perspectives: students, research, and employees. Meanwhile, according to Sunder (2016), some examples of waste are as follows:

a. Uncoordinated teaching so that students do not pass the test.
b. Graduates who cannot get a job and cannot learn for life.
c. Class schedules that make it difficult for students to graduate.
d. Course does not contribute to customer value.
e. Miss planning in teaching schedule that causes students/lecturers to change rooms or locations.
f. Poor planning of materials and facilities required does not match both cost and quality.
g. Lecturers and students wait because of activities that are not on time.
h. Curricula design and supporting activities that are not under the needs of students and industry.

To develop LSS in HEI, it is necessary to identify the type of waste. Hussain & Malik (2016) argued that to develop LM successfully, waste must be identified and prioritized to eliminate. Waste in each HEI should be different both in type and impact on performance so that continuous efforts are needed to find and reduce waste. Unlike in manufacturing, waste in HEI is not clearly defined, and there is still no agreement (Kazancoglu & Ozkan-Ozen, 2019). Hartanti et al. (2020), in their study, classified waste in HEI in to nine types, i.e., overproduction, over-processing, waiting, motion, transportation, inventory, defect, people, and information. Douglas et al. (2015) and Kazancoglu & Ozkan-Ozen (2019) used semi-structured interviews and brainstorming with academic staff to identify waste. Due to a lack of definition, it is necessary to involve HEI leaders, faculty members and staff, and LSS experts in identifying waste.

The process for identifying waste is not accessible due to overlapping processes and interrelatedness between waste. Rawabdeh (2005) proposed assessing seven types of waste in the manufacturing industry using the Waste Relationship Matrix (WRM). WRM was used to determine the relationship between 7 wastes and determine their ranking. Another researcher, El-namrouty & Abushaaban (2013), also used WRM to assess waste. Pessôa et al., (2009) identified ten types of waste in a product development system and ranked the waste using the Waste Net. The other methods were used to prioritize waste in manufacture are *Quality Function Deployment* (QFD) (Rawabdeh, 2011), *Weighted Average* (Arunagiri & Gnanavelbabu, 2014), *Failure Mode Effect Analysis* (FMEA)(Souza & Carpinetti, 2014), *Fuzzy Analytical Hierarchy Process* (AHP) (Arunagiri & Gnanavelbabu, 2016), questionnaire (Aka et al., 2019), *Decision Making Trial and Evaluation Laboratory* (DEMATEL) (Gupta et al., 2019) dan *Modified Failure Mode Effect Analysis* (FMEA) (Sutrisno et al., 2020). Hussain et al. (2016) and Hussain & Malik (2016) used AHP, and Bharsakade et al. (2021) used AHP in the healthcare industry. Regarding HEI, the rating of waste by using Fuzzy DEMATEL (Kazancoglu & Ozkan-Ozen, 2019) and AHP (Klein et al., 2021).

3.2. Identification of Critical Success Factors (CSF) and Readiness of Lean Six Sigma (LSS) Framework.

Laureani & Antony (2012) surveyed to determine the critical success factors for LSS in various industries. The survey results show that 19 factors determine the success of LSS, namely management commitment, organizational culture, the relationship between LSS and business strategy, leadership, communication, the relationship between LSS and customers, concern, selection of LSS staff, database approach, selection of improvement projects, review of LSS projects. LSS staff resources, training, technical LSS, project management skills, finance, organizational infrastructure, expansion of the LSS to the supply chain, and linkage of the LSS to the reward system. Antony (2014) identified the readiness factors of 7 universities in the United Kingdom consisting of leadership and vision, management commitment and resources, linking LSS to the university's strategy, customer focus, and selecting the right people. By knowing the level of readiness to develop LSS (Lean Six Sigma Readiness/LESIRE), organizations can identify obstacles in developing LSS. Bayou & de Korvin (2008) measured the leanness of two automotive industries using fuzzy logic. Meanwhile, Vinodh & Chintha (2011) dan Vinodh & Vimal (2012) measured the leanness index and score. Wong et al. (2014) conducted an integrated leanness level (index) measurement, which includes three aspects (quality, cost, and on-time delivery). In addition to identifying CSFs, determining relationships between factors is also essential (Swarnakar et al., 2019, 2020; Yadav & Desai, 2017). The relationship between factors in a system is very complex, and it is difficult to determine the influence between factors (Swarnakar et al., 2020). Some researchers investigated the relation and interaction of CSF in the manufacturing industry. The method that is widely used to analyze the relationship between factors and categorize factors is the integration between Interpretive Structural Modeling (ISM) and Fuzzy Matrices 'Impacts Croise's Multiplication Applique'ea'un Classement (Fuzzy MICMAC) (Ben Ruben et al., 2018; Cherrafi et al., 2017; Malek & Desai, 2019; Raval et al., 2018; Swarnakar et al., 2019; Yadav & Desai, 2017). However, the limitations of ISM are (i) only describes the variables that are directly related (ii) does not explain the reasons for the relationship between variables. Total Interpretive Structural Modeling (TISM) can overcome these limitations by identifying and interpreting direct and indirect relationships between variables. By interpreting the relationship, directly and indirectly, TISM can be more easily applied in real life (Sushil, 2012). According to Sushil (2012), TISM only considers the interactions between existing variables. To consider the possibility of other interactions, TISM can be developed into Fuzzy TISM.

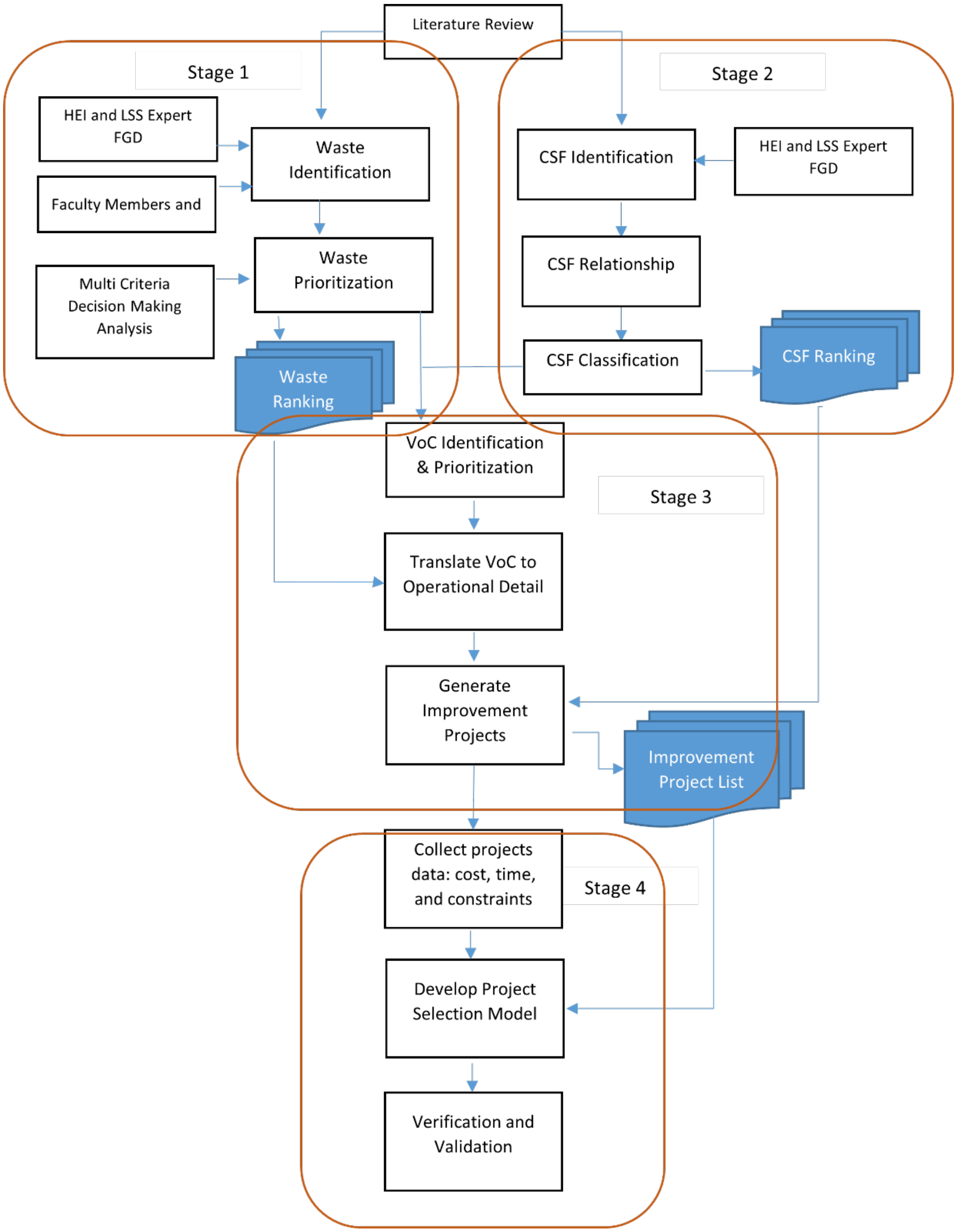

Figure 2. Proposed Framework of LSS in HEI

3.3. Voices of Customer in HEI.

In the competition era, an organization, including HEI, must improve quality. In facing competition, HEI ought to adopt a customer-oriented approach (Wulandari & Jager, 2018). HEI that adopt customer-oriented will understand and assess stakeholders' perceptions about education to find out their needs. The question that often arises in education, especially HEI, is who the stakeholders are? (Pereira & Silva, 2003). Reavill (1998) identified twelve stakeholders HEI, namely owners, student families, university leaders and employees, suppliers, high schools, other universities, industry, state, government, taxpayers, and professional organizations. Based on a study conducted by Pereira & Silva (2003), HEI customers consist of students, owners, lecturers, family, community/government, and employees. Of course, every stakeholder has their own desires that may be the same or different. HEI that can fulfill the desires of stakeholders can be said to have good quality. Like an industry, HEI must also focus on the desires of its stakeholders. The question now is not how important quality is but how to organize a qualified HEI. Most of the articles indicated that students as customers of HEI (H. Alves & Raposo, 2007; Brkanlić et al., 2020; Campos et al., 2018; Cavallone et al., 2020; Clemes et al., 2007; Elliott & Healy, 2001; Hwarng & Teo, 2001; Koris & Nokelainen, 2015; Mark, 2013; Santini et al., 2017; Skea, 2017, 2019; Wiers-Jenssen et al., 2002; Wulandari & Jager, 2018; Zineldin et al., 2011). Some other articles did not merely consider students as the customer. Chen et al.(2006) developed a satisfaction measurement model of faculty members. Gonzalez et al. (2011) used employees as customers in designing curriculum. Sandmaung & Khang (2013) determined quality indicators from students, faculty members, university leaders, and staff perspectives.

To find out the Voice of Customer (VoC) and determine the priority of VoC, the KANO method can be used. KANO model was able to identify product attributes that meet customer desires (Sharif Ullah & Tamaki, 2011; Suef et al., 2014, 2017). Several articles show the effectiveness of KANO in identifying VoC HEI. Sahney (2011) uses the KANO method to determine priorities for improving HEI services in India. Mcdowall (2016) conducted research to determine quality attributes and measure student satisfaction using the KANO method. Hamzah et al. (2018) used the KANO method to classify the quality attributes of HI in Indonesia. In its use, KANO also integrated with other methods such as Quality Function Deployment (Hamzah et al., 2018; Sahney, 2011) and Importance Performance Analysis(Ku & Shang, 2020).

3.4. LSS Project Selection Model in HEI.

One of the critical factors for the success or failure of LSS development is determining improvement projects (Albliwi et al., 2014; Laureani & Antony, 2012; Sreedharan V et al., 2019). The improvement project is a process improvement project. A process improvement project is defined as a systematic approach to improving organizational performance, which consists of activities, tools, techniques, and technology, as well as implementing a series of improvement projects. In determining project selection, there are several criteria: the customer perspective, financial perspective, conformity with business strategy objectives, employee perspective, availability of resources, time, and risk. The model for determining the LSS project is grouped into 3, namely the unstructured peer review/ scoring/ranking model, Multiple Criteria Decision Making (MCDM) model, and mathematical programming (Padhy, 2017).

Researchers most widely use the Multiple Criteria Decision Making (MCDM) model to select improvement projects. One of the methods used is the Analytical Network Process (ANP). Some researchers use ANP or combine it with other methods, for example, Meade & Presley (2002) combining it with AHP, Büyüközkan & Öztürkcan (2010) integrating with Decision-Making Trial and Evaluation Laboratory (DEMATEL) and Vinodh & Swarnakar (2015) using an approach based on Fuzzy DEMATEL, ANP, and TOPSIS. Meanwhile, Abdel-Basset et al. (2019) integrated the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) with DEMATEL to determine project priorities.

4. Conclusion

In this article, we have proposed an integrated LSS framework in HEI. The proposed framework is integrated, starting from identifying waste to determining the improvement project. Lean Six Sigma is a fundamental concept in the development of this framework. This framework helps HEI management to increase the efficiency and effectiveness of HEIs. This framework is unique in that HEI customers are different from other manufacturing or service industries. HEI customers consist of students, lecturers, staff, government, industry. In this framework, the Voice of the customer considered are lecturers, students, administrative staff, and industry. The method of developing LSS in HEI uses some MCDM methods. Some examples of MCDM methods are AHP, ANP, TOPSIS, DEMATEL, MICMAC.

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