A mixed-methods investigation of evidence-based Lean Thinking practice to Kaizen academic processes for Private Higher Education Institutes in Singapore

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Abstract

This study aims to bridge the gap by investigating, exploring, and proposing evidence-based Lean Thinking practice in the Course Planning and Delivery Process (CP&DP) in Singapore Private Higher Educations Institutes (SPHEIs). There is no such evidence about the current level of Lean Thinking practice in SPHEIs. Starting from the gap that the bibliometric analysis and literature review highlights, the research study focuses on (a) the current level of Lean Thinking evidence practice in SPHEIs for CP&DP; (b) the relationship between Lean Thinking versus CP&DP; (c) the current Lean Thinking practice that influences Key Performance Indicators (KPI) in SPHEIs; (d) how SPHEIs deploy Lean Thinking practice to improve academic processes.

The goal of bibliometric techniques is to assist the public and private Higher Education Institutes (HEIs) understand the importance of Lean Thinking in adding value to customers ("students") while reducing waste in administrative and academic processes. A total of a hundred and thirty-three papers found in the Scopus database published between 2003 to 2020 were identified through bibliometric analysis. The survey identified a hundred and sixty authors from forty-one countries in a hundred and thirty-three papers. However, only two articles on Six Sigma and Lean management connect to Singapore. Thus, there appears to be a gap in the recent literature concerning Lean Thinking practice in SPHEIs.

The literature review revealed the critical Lean Thinking in Higher Education themes: administration and operation process; curriculum design and delivery process; teaching and learning process; leadership and sustainability; quality and performance. The study also looked at evidence-based practice in Higher Education, such as the source of evidence and common misconceptions, before moving on to evidence-based Lean Thinking practice. However, there has been insignificant literature about the use of Lean Thinking in Higher Education. Hence, the theoretical framework of the literature review, knowledge gap analysis, and conceptual framework of the research study has been developed and discussed.

The research philosophy of this study was epistemology pragmatism. A cross-sectional survey collected more facts about the context of the Lean Thinking practice in the SPHEIs. An empirical study was conducted, using triangulation embedded mixed-method, which combined quantitative and qualitative data, to address the research gap. The study is limited to two

SPHEIs from the twenty-seven target institutions during the COVID-19 lockdown in Singapore since April 2020.

Using five Lean Principles, four Lean Wastes, and eight Lean Tools, the questionnaire survey presented and investigated: the level of Lean Thinking evidence practice, level of Lean Tools competency, level of Lean Thinking relationship, and level of KPI. The first null hypothesis sought to learn the current level of evidence for Lean Thinking practice in SPHEIs. It indicated positive acceptance among the respondents as to the evidence-based practices of the various attribute, a highly positive significance test results. The second null hypothesis investigated the relationship between dependent and independent variables, and it demonstrated that Lean Thinking has correlated to CP&DP. The third null hypothesis was to understand the current Lean Thinking practice level in SPHEIs that could significantly influence KPI. The results of the inter-relationship between Lean Thinking practice in CP&DP versus KPI, Lean Tools competency versus KPI and Lean Thinking relationship versus KPI demonstrated a highly significant influence on one another. Thus, these three null hypotheses were rejected. Finally, qualitative data on how SPHEIs used the Lean Thinking practice in the CP&DP were analysed and addressed to understand the quantitative findings better as evidence-based strategies. This research does have limitations, and this has not impacted the study. Moreover, similar future research can be carried out in private Higher Education Institutes (HEIs) or public universities in other countries by extending more variables in the CP&DP.

Finally, the researcher discussed the realisation of research aim and objectives, quality of research, the contribution to theory, knowledge, and professional practice. Theoretical implications impact the researcher's value in the study, and it could come from the additional variables the researcher added to the original view. Next, the contribution to the knowledge that 33% (1 out of 3) of internal wastage comes from three activities or processes: (a) Do the right things wrong; (b) Do the wrong things; (c) Do the wrong things wrong. However, if the activities are doing the right things the first time and all the time, it contributes or adds a 67% value (100% - 33%) to increase the revenue stream. The professional practice has twelve steps with fifteen components of Lean Thinking Kaizen Academic Process Canvas form a complete "big picture" of "T" shape or foundation and "U" shape or methodology components from problem to solution. The self-explanation canvas helps SPHEIs restructure, adopts highly effective strategic planning, gives high value-added through innovation, and stays competitive by improving educational processes.

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Firstly, I express my heartfelt gratitude to my supervising guide, Prof Amin Hosseinian Far, Deputy Head of Subject and an Associate Professor in the Department of Business Systems and Operations, the Faculty of Business and Law at the University of Northampton, for the constant support during the entire period of research work. I especially thank him for the guidance, constant encouragement, understanding, care and empathy.

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Abbreviations

AD	Administrators
CP&DP	Course Planning and Delivery Process
CPE	Committee for Private Education
CSFs	Critical Success Factors
CTQ	Critical to Quality
DMAIC	Define Measure Analyse Improve Control
EDPs	External Degree Programmes
HEIs	Higher Education Institutes
IRT	Item Response Theory
KPI	Key Performance Indicators
KS	Kolmogorov-Smirnova
LE	Lecturers
LSS	Lean Six Sigma
MOE	Ministry of Education
MOH	Ministry of Manpower
PDCA	Plan Do Check Act
PEIs	Private Education Institutes
PHEIs	Private Higher Education Institutes
PICO	Population Intervention Comparison Outcome
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QFD	Quality Function Deployment
RDB	Research Degree Board
REC	Research Ethics Committee
SME	Small Medium Enterprise
SPHEIs	Singapore Private Higher Education Institutes
SSG	Skills Future Singapore
ST	Students
TPS	Toyota Production System
TQM	Total Quality Management
VOC	Voice of Customers
WDA	Workforce Development Agency

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Chapter 1 – Introduction

1 Introduction

1.1 Background

The authors James P. Womack and Daniel T. Jones have published two books. The first book was *Lean Thinking: Banish Waste and Create Wealth in Your Corporation,* initially published in 1996, was then revised and updated in 2003 (Womack and Jones, 2003). The second book, *The Machine That Changed the World* in 2007, focused on Lean production - Toyota's secret weapon in the global car wars that revolutionized world industry (Womack *et al.*, 2007). According to the authors, "*Lean Thinking has five principles: specific value by product, identify value stream for each product, make value flow without disruptions, let customer pull value from the producer, and pursue perfection.*" In other words, Lean Thinking is "*The right people continuously searching for the simplest and smoothest process to meet customer needs*".

Technological and commercial changes in the world have forced Higher Education Institutes (HEIs) to face new challenges and issues such as rising costs, declining completion rates, growing privatisation of public colleges or universities, and innovative curriculum (Allaire, 2018). Womack and Jones (2003)'s Lean ideas are the single most powerful tool available for creating value and eliminating waste in any organisation and are fully supported by Douglas *et al.* (2015); Mostafa *et al.* (2015), and Thangarajoo and Smith (2015). Balzer (2016) claimed that academic processes include teaching and learning, research and development, curriculum design and delivery, course planning and delivery. Lean was to improve administrative and academic processes has a substantial and quantifiable impact for an entire institution, including department and unit level, and achieved effective improvement (Balzer, 2010; 2020). According to Emiliani (2015), the essential concepts of the Lean are "Respect for People" and "Continuous Improvement" that organised for the education approach. Tatikonda (2007) said that if universities manage the academic processes well, they serve as the foundation for the HEIs' long-term performance.

Lean and Six Sigma has become the most common corporate strategies for deploying continuous improvement in manufacturing and service, including government organisations, banking finance, healthcare and education institutes in both public and service sectors (Raja Sreedharan and Raju, 2016). Six Sigma, Lean Six Sigma, Lean/Lean

Thinking have been widely used for Higher Education across different countries (Coowar *et al.*, 2006; Thirkell and Ashman, 2014; Jahan and Doggett, 2015; Lu *et al.*, 2017; Sremcev *et al.*, 2018; Singh, M. and Rathi, 2019). The majority of completed studies based in universities in the United States, the United Kingdom, and India showed significant benefits in Higher Education. However, there is no such evidence about the current level of Lean Thinking practice in Private Higher Educations Institutes (PHEIs) in Singapore.

Singapore Private Higher Education Institutes (SPHEIs) operate in a highly competitive Small Medium Enterprise (SME) business environment (Lo, 2014). Therefore, this research explores SPHEIs that have directly or indirectly implemented Lean Thinking. Do SPHEIs lack Lean Thinking practice in the academic processes, which could be a source of competitive advantage? Can SPHEIs deliver value-added services and cost reduction in a Lean Thinking environment? Can SPHEIs bring better education more efficiently and effectively if they implement Lean Thinking practice? Therefore, the researcher carried out the bibliometric analysis (See Chapter 2) to find papers that could answer the questions raised about the current level of Lean Thinking adoption with SPHEIs. However, only two articles on Six Sigma and Lean management connect to Singapore (See Chapter 2, Section 2.3.4). Ho *et al.* (2006) showed that the Six Sigma framework provides an excellent platform for infusing statistical education into the engineering curriculum with some fundamental issues and challenges. Tay, H.L., Low (2017) applied Lean management principles to provide a holistic view of the process transformations in using digital innovation in the Higher Education context. Thus, there appears to be a gap in the recent literature concerning Lean Thinking practice in the SPHEIs.

The researcher conducted an empirical study to address this gap in the literature, using triangulation embedded mixed-method, a cross-sectional survey to collect more facts about the Lean Thinking practice in the SPHEIs context. This study aims to bridge this gap to investigate how SPHEIs use Lean Thinking practice in Course Planning and Delivery Process (CP&DP), which are at the heart of any academic institute, either directly or indirectly, to achieve student learning development and satisfaction. This chapter introduces the background to the study, outlines the critical research gaps to be examined and lays down the structure of subsequent chapters.

1.2 Committee for Private Education

Workforce Singapore, formerly known as the Singapore Workforce Development Agency (WDA), is a statutory board of the Ministry of Manpower (MOM) of Singapore. The Committee for Private Education (CPE), formerly the Council for Private Education, is a Skills Future Singapore (SSG) agency that was previously a statutory board under the Ministry of Education (MOE) of Singapore. CPE restructured Singapore WDA and Council for Private Education to form SSG on 3 October 2016. The SSG Board has currently appointed the CPE to conduct its functions and powers relating to private education under the Private Education Act. A team of dedicated SSG staff members supported CPE, who work to regulate the sector, provide services, carry out consumer education and facilitate capability development efforts to uplift standards in the local private education industry (CPE, 2020). While private schools must register with the CPE, this is not an endorsement or accreditation of the school. The organisations, employers and individuals must distinguish between the several school qualifications for acceptance and recognition.

There are 301 Private Education Institutes (PEIs) in Singapore updated in Dec 2020 (PEIs, 2020) that offer full-time and part-time courses/programmes with certification awarded by local PEI and foreign institutes as shown below:

- Tuition, Preparatory, Foundation, Certificate[1]
- Diploma, Advanced Diploma, Higher Diploma[2]
- Bachelor
- Graduate Diploma, Post-Graduate Diploma, Specialist Diploma[3]
- Graduate Certificate, Post-Graduate Certificate[4]
- Master, Doctorate

[1] "**Preparatory** relates to or engaged in study or training that serves as preparation for advanced education. **Foundation** is a course either in a wide range of subjects or in one subject at a basic level, preparing students for more advanced study. **Certificate** is vocational and technical certificates programs are focused on a specific skill and are usually offered at community colleges or technical and vocational schools."

[2] "**Diplomas** focus on a specific skill or field, like technical or vocational certificates, without the general education coursework required by a degree. **Advanced Diploma** is one given to students who complete a set of courses based on their desired field of study. **Higher Diploma** is an academic award by a University, College, other Tertiary Institutions, or Post-Secondary Institutions."

[3] "**Graduate diploma** is an academic or vocational qualification often taken after a bachelor's degree although sometimes only a foundation degree is required. **Postgraduate diploma** is a postgraduate academic qualification taken after a bachelor's degree. **Specialist Diploma** is designed to enable existing diploma or degree holders to deepen their knowledge and skills and develop specialisations within their trained discipline areas."

[4] "**Graduate certificate** is designed with working professionals in mind, helping these learners acquire knowledge and skills essential for their workplace. **Postgraduate certificate** is an educational credential that provides students advanced skills in a specific area of specialisation."

The CPE conducted an annual PEIs Graduate Employment Survey (GES) for graduates from full-time bachelor's level External Degree Programmes (EDPs) in Singapore to study the employment outcomes of recent PHEIs graduates. The PEI GES aims to help prospective students in making well-informed educational decisions. PEIs that provide EDPs are obligated to participate in the survey (PEIs Survey, 2020).

CPE surveyed a total of 40 PEIs, of which 27 (See Appendix 1, Annex D) had graduated from full-time bachelor's level EDPs shown in *Table 1.1*. About 10,200 individuals completed full-time bachelor's EDPs at PEIs between May 2017 and April 2018, and 39.5% responded to the PEIs GES survey. Of this group, this press release focuses on the employment outcomes of about 2,800 respondents from eleven (11) PEIs (See *Table 1.2*) who are economically active[5] fresh graduates and excludes working adults undergoing part-time degree programmes and fresh graduates who are not economically active. These twenty-seven (27) PEIs were the target institutes for this study, also known as the target population.

Table 1.1 - List of PEIs who participated in PEIs GES 2017/18 (PEIs Survey, 2020)

List of Private Education Institutes in Singapore			
1.	Air Transport Training College	15.	Nanyang Institutes of Management
2.	Amity Global Institute	16.	Ngee Ann Academy
3.	Auston Institute of Management	17.	Parkway College of Nursing and Allied Health
4.	Curtin Education Centre	18.	PSB Academy
5.	Dimensions International College	19.	Raffles College of Higher Education
6.	East Asia Institute of Management	20.	S P Jain School of Global Management
7.	ERC Institute	21.	SAA Global Education Centre
8.	First Media Design School	22.	SDH Institute
9.	FTMS Global Academy	23.	Singapore College of Traditional Chinese Medicine
10.	Informatics Academy	24.	Singapore Institute of Management
11.	ITC School of Laws	25.	Singapore Raffles Music College
12.	James Cook University	26.	TEG International College
13.	Kaplan Higher Education Academy	27.	TMC Academy
14.	Management Development Institute of Singapore		

The CPE has released the results of the PEIs GES 2017/18. The job findings for the 2017/18 cohort were similar to the 2016/17 cohort, according to media released on April 10, 2019 (SSG, 2020). Compared with the 2016/2017 cohort, graduates from SPHEIs in the 2017/18 cohort had slightly higher employment rates and the same median gross monthly income (See Appendix 1, Annex B) (SSG, 2020). *Table 1.2* shows that the overall employment rate for the 2017/18 cohort ranged from 42.1% to 90.9 % across

[5] "**Economically active** graduates are those who are working, or not working but actively looking and available for a job."

eleven (11) PEIs (See Appendix 1, Annex C) with ten or more respondents (PEIs Survey, 2020). Therefore, eleven (11) PEIs were contacted via email in Feb 2020 and invited to participate in this research to explore they have directly or indirectly implemented Lean Thinking.

Table 1.2 - PEIs Graduate Employment Survey (PEIs Survey, 2020)

S/No	Private Higher Education Institutes (PHEIs)	Overall Employee Rate	Response Rate[6]	No of Respondents[7]
1	Parkway College of Nursing and Allied Health	90.9%	81%	11
2	Ngee Ann Academy	85.4%	66%	41
3	Singapore Institute of Management	84.7%	45%	1,799
4	Kaplan Higher Education Academy	78.3%	44%	452
5	Curtin Education Centre	78.1%	34%	50
6	James Cook University	75.3%	27%	81
7	ERC Institute	65.9%	27%	44
8	PSB Academy	65.1%	39%	146
9	Management Development Institute of Singapore	64.7%	23%	68
10	Air Transport Training College	65.2%	73%	23
11	Raffles College of Higher Education	42.1%	14%	19
			Total	2,734

1.3 Problem Statement

To remain competitive and fully benefit from the increasing demand for private education, SPHEIs, like any other business, must better understand their students' needs and desires, as well as what they prefer (Chia, 2012). According to the author, the factors that influence students in the selection of a SPHEIs are: "academic reputation/recognition; campus location; ranking of the institution; quality of faculty; friends attending the same institution; family influence; financial cost; employment prospects; earning potential; and safety/security concerns." On the other hand, Khoo *et al.* (2017) found that "service quality, customer satisfaction, behavioural intentions", which educational management also can use as a guide.

Higher education supports knowledge and learning and is the gateway to good jobs and prosperous life for many people (Ramaley, 2014). Higher Education has become an increasingly important component of becoming globally competitive (Kent, 2017).

[6] "Response Rate refers to the percentage of graduates from full-time degree programmes in PEIs who responded to the survey."
[7] "Results of PEIs based on a small sample size of fewer than 30 full-time fresh PEIs degree graduates may not be representative of the institution's graduate employment outcomes."

Customers' ("student") expectations constantly change, making it difficult for SPHEIs to retain their competitive position. These challenges require SPHEIs to rethink what it means to Higher Education in today's world (Lo, 2014). If SPHEIs have the right set of Lean Thinking practices in Higher Education, they can connect, track, monitor, analyse, measure, and expand their strategy, marketing, and operations.

The bar graph below indicates the breakdown of SPHEI complaints from CPE between 2016 to 2018, as shown in *Figure 1.1* (PEIs Statistics, 2020).

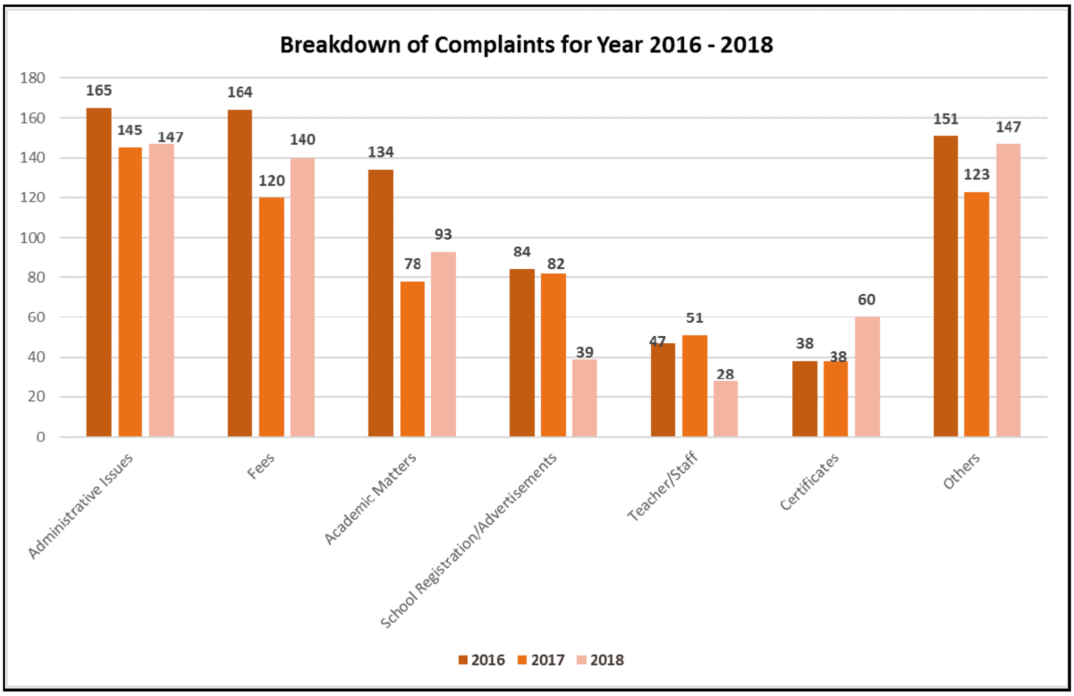

Figure 1.1 - Complaints for the Year 2016 to 2018 (PEIs Statistics, 2020)

Administrative Issues[8] has remained the top feedback category for SPHEI students over three consecutive years. Between 2017 and 2018, complaints increased in all feedback categories (*Fees*[9], *Academic Matters*[10], *Certificates*[11], *Others*[12]) except *Teacher/Staff*[13]

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[8] "**Administrative Issues:** Relocation of school premises, school facilities, scheduling, request to view examination papers, admission and withdrawal processes, deferment and disciplinary policies, issues related to the management of examinations."

[9] "**Fees**: Fees increase, the refund due to course withdrawal, disputes on a payment schedule or outstanding fees."

[10] "**Academic Matters**: Disputes on progression pathway, disputes on different exemptions given to students based on their qualifications, disputes on marks received for examinations and assignments, problems with industry attachment provided by school."

[11] "**Certificates:** Recognition of certificates/courses, delay in receiving certificates/transcripts."

[12] "**Others:** Issues with course fee insurance coverage, problems related to student visas, issues related to closure of schools such as disruption of studies, difficulties in contacting the private school."

[13] "**Teacher/Staff:** Alleged favouritism and bias towards other students, teaching quality of teachers, service standards of school administrative staff."

*a*nd *School Registrations/Advertisements*[14]. Notably, complaints about *Certificates* increased by 60%. The absolute number of complaints has remained constant, despite a significant decrease (41%) in the total volume of feedback or queries received over the last three years. In 2018, four out of every ten cases received by CPE were complaints against SPHEIs (PEIs Statistics, 2020).

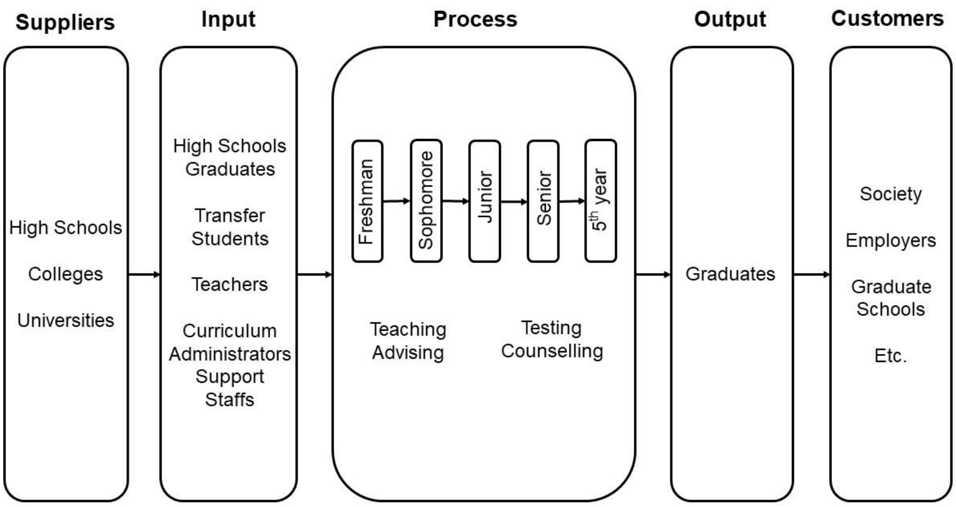
The life cycle of a butterfly consists of the egg, caterpillar, pupa, and butterfly. Each stage of transformation takes on a completely new and unrecognisable form from the earlier stages. When a caterpillar loses its earlier form and transforms into a butterfly, this does not imply that the caterpillar stage was terrible. It is simply a natural and significant process that occurs in a life of learning and discovering. Kent (2017) said Singapore has gone from a developing nation, with low educational enrolment and completion, to becoming the premier education system in Asia. The shifting mindsets and attitudes on education in the culture are essential as policymaking. However, SPHEIs operate in a highly competitive SME business environment (Lo, 2014) and have spent a long time in the pupa stage, encased and contained within the traditional business world. Standard SME business paradigm shifts focus on problem-solving, quality enhancement, revenue generation, lowest cost, and driving profitable growth in market share. SPHEIs have set up methods to generate savings, focus on cost reduction and quality improvements for student satisfaction. However, SPHEIs have seen declining revenue and market share for many years (Lo, 2014). Education must make changes and improvements (Kent, 2017). Therefore, transforming the traditional SMEs into Lean SMEs is not an easy task (Yadav *et al.*, 2019).

According to Balzer (2016; 2010; 2020), Lean Higher Education is a powerful strategy supported by Lean Thinking. Lean Thinking is strategic planning that includes vision and values, alignment and leadership, aligned people and thinking, execution, and transformation. SPHEI strategic planning intertwines with marketing, operational decisions, and other issues. SPHEIs must transform to become more efficient and effective, and therefore it is necessary to investigate whether Lean Thinking can improve academic processes and change SPHEIs.

[14] "**School Registrations/Advertisements:** Misleading advertisements by schools, complaints on unregistered institutions."

1.4 Research Rationale

In manufacturing processes, raw materials and work-in-processes move from one work centre to another. The finished units are graded and sorted as either acceptable or defective. Tatikonda (2007) said that education and manufacturing processes are similar. The raw material is the knowledge students bring to class; work in progress would be considered the student at the different stages of degree completion. The result of the educational process is graduates with knowledge and skills. They go through a sequence of lessons in which lecturers offer value by imparting new skills and expertise - the general education process as illustrated in *Figure 1.2*. Smith (2015) supported Tatikonda's (2007) framework of the education process.



Source: Adapted from Tatikonda (2007)

Figure 1.2 - Framework of the Education Process

Tatikonda (2007) claimed that the quality of graduates in University of Wisconsin-Oshkosh, United States, decided by the background of incoming students, the input of lecturers, "the curriculum, course contents, teaching pedagogy, and assessment methods." According to Emiliani (2016), academic processes also included improving courses or programs, academic advising, standard, assessment, and integrity. Qayyum and Manarvi (2017) argued that teaching, learning, researching, knowledge transfer, and engagement procedures are the core educational processes at HEIs.

Students and employers are the primary customers of SPHEIs. Students enrolled in the reputation SPHEIs and studied the EDPs, from the United Kingdom, and Australia's universities offered a two to four-year process. They are groomed into professionals slightly early in Singapore, which is generalisable from the five-year study of the United States programme. Employers hire graduates of private Higher Education for the quality of their knowledge and skills. SPHEIs recognise the significance of developing the best education process to gain a competitive advantage.

1.5 Motivating Factors

There are a couple of factors motivating this research study. Firstly, SPHEIs are often small and face financial, enrolment and other problems related to their size. Furthermore, SPHEIs are independent and autonomous; and subject to various external controls. They oversee their funding, and the consequences of poor financial management are immediate and severe. Third, the education market is inherently flawed. It is challenging to predict employment trends and even more challenging to ensure that institutional programmes are relevant to these trends (Lo, 2014). SPHEIs face unique challenges and responsibilities because of their rapid growth and increased importance in the global Higher Education system. Shook (2020) claimed that Lean Thinking maximises customer value while minimising time, resources, energy, and effort. Lean Thinking practice assists the SPHEIs in becoming both innovative and competitive, allowing them to become sustainable (Shook, 2020). The study contributes to the Lean Thinking Kaizen Academic Process Canvas (See Chapter 6) guideline for SPHEIs. The statistical study data contribute to developing a guideline for the CPE to use as a benchmark.

1.6 Research Context

According to Tatikonda (2007), the four critical features of any course are content (*what to teach*), pedagogy (*how to teach*), organisation (*how topics present*), and assessment (*how to evaluate student learning*) in the educational process shown in *Table 1.2*.

Table 1.3 - Four Critical Features of any Course (Tatikonda, 2007)

Features	Methodology and Method
Course Content	Applying Quality Function Deployment (QFD) to design.
Course Pedagogy	Streamlining teaching with Cell Layout.
Course Organisation	Streamlining teaching with Topic Families.
Course Assessment	Applying the Balanced Scorecard for Student Learning.

Teachers who select and incorporate these features into their courses significantly impact what and how well students learn. Tatikonda (2007) used the Lean Principles to design, teach, and deliver accounting courses. Tılfarlıoğlu and Anwer (2017) agreed and supported Tatikonda (2007) by incorporating the Lean Principles and four critical features in English language teaching and learning. Similarly, Emiliani (2004) designed and delivered a graduate business leadership course using the Lean Principles. Emiliani (2005) also showed how to improve degree programs in graduate business school with Kaizen. Pusca and Northwood (2016) added three components of course content, instructional methods and assessment methods when applying the Lean Principles in an Engineering Design course. Dinis-Carvalho and Fernandes (2017) emphasised the importance of the planning process, including three components of learning outcome, teaching strategies and assessment methods, when making use of the Lean Principles in teaching and learning.

Six Sigma, Lean Six Sigma, Lean/Lean Thinking have been widely used for Higher Education across different countries (Coowar *et al.*, 2006; Thirkell and Ashman, 2014; Jahan and Doggett, 2015; Lu *et al.*, 2017; Sremcev *et al.*, 2018; Singh, M. and Rathi, 2019). However, the level of Lean Thinking practice in SPHEIs is unknown. The researcher developed these research questions to understand better how SPHEIs use Lean Thinking in academic processes, either directly or indirectly. *Figure 1.3* shows that the researcher narrowed the research further to investigate the use of Lean Thinking in CP&DP, one of the Kaizen academic processes, to analyse the current Key Performance Indicators (KPI) and explore the findings of the research questions.

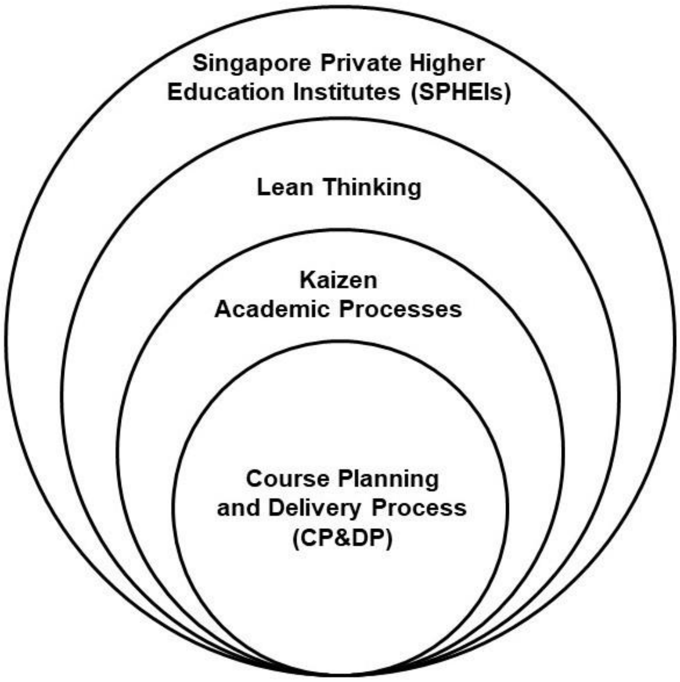


Figure 1.3 - Formulate Research Questions and Scope (Source: Author)

In this study, it is critical to look into the current level of evidence-based Lean Thinking practice, using Lean Principles, Lean Wastes and Lean Tools, in a specific aspect of CP&DP and the current KPI in SPHEIs in *Figure 1.4*.

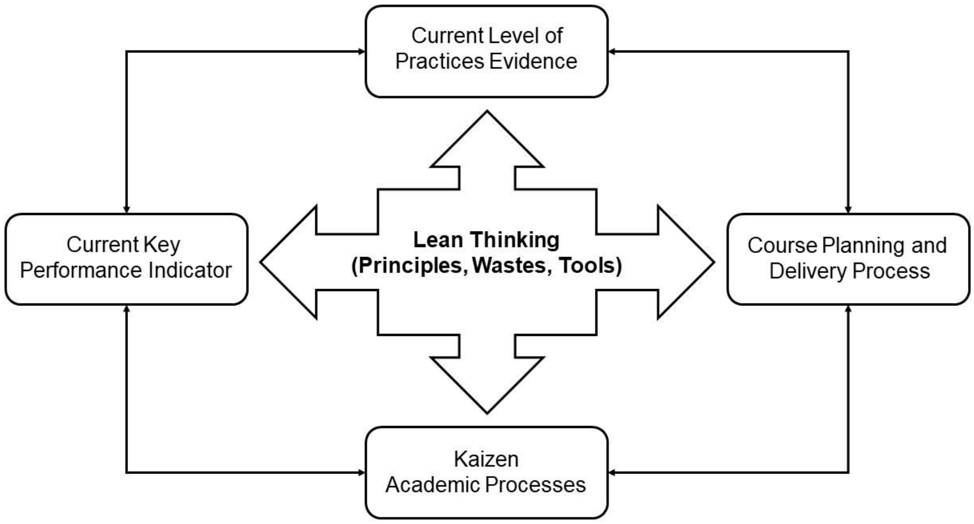


Figure 1.4 - Research Context (Source: Author)

Lean Principles are "*Identify Value*, *Value Stream*, *Create Flow*, *Establish Pull* and *Pursue Perfection*" (Womack and Jones, 2003; Womack *et al.*, 2007). Lean Wastes in Higher Education are "*People Wastes*, *Process Wastes*, *Information Wastes* and *Assets*

Wastes" (Balzer, 2010; 2020). Some of the standard Lean Tools are *Hoshin Kanri, 5S, PDCA, Poka-Yoke, Muda (Waste), Muri (Overburden), Mura (Unevenness)* and *Value Stream Mapping* (Womack and Jones, 2003; Womack *et al.*, 2007) (See Chapter 3).

Lean Thinking is not a new concept (Womack and Jones, 2003; Womack et al., 2007), but SPHEIs have yet to fully explore and adopt Lean Thinking (Toh, 2012). Evidence-based practice is a systematic approach to synthesising and generalising relevant data findings from research studies that support the impact of an outcome and its application (Jones, 2018). This study aims to bridge this gap by investigating, exploring, and proposing how evidence-based Lean Thinking practice in CP&DP, which are at the heart of any academic institute, can achieve student learning development and satisfaction.

1.7 Research Aim

A mixed-methods research study investigates the evidence-based Lean Thinking practice to improve CP&DP for PHEIs in Singapore.

1.8 Research Objectives

From the issues in the problem statement and reasons in the research rationale, the researcher pursues the following objectives to achieve the research aim.

RO1: To access the current level of Lean Thinking evidence practice in SPHEIs for the CP&DP.

RO2: To interpret the relationship between Lean Thinking versus CP&DP.

RO3: To understand the current Lean Thinking practice that influences KPI in SPHEIs.

RO4: To understand how SPEHIs deploy Lean Thinking practice to improve academic processes.

1.9 Research Questions

The researcher posed the following research questions as the literature review presented in Chapter 3.

RQ1: WHAT is the current level of Lean Thinking evidence practice in SPHEIs for the CP&DP?

The first step in this research is to find the current level of Lean Thinking evidence practice in SPHEIs for the CP&DP. The CP&DP classifies into six categories: course resources, course contents, course pedagogy, course assessment, course evaluation and course refinement. Lean Tools competency has Hoshin Kanri, 5S, PDCA, Poka-Yoke, Muda (Waste), Muri (Overburden), Mura (Unevenness) and Value Stream Mapping. Both results address the first null hypothesis ($H01_{null}$), the current Lean Thinking evidence-practice level in SPHEIs for CP&DP.

RQ2: WHAT is the relationship between Lean Thinking versus the CP&DP?

This question addresses the most critical aspect of the study. The purpose of this study is to look at the significant influence and correlation between independent variables (Lean Principle and Wastes) and dependent variables (course resources, contents, pedagogy, assessment, evaluation, and refinement). To investigate the second null hypothesis ($H02_{null}$), how SPHEIs practice Lean Thinking directly or indirectly.

RQ3: HOW does current Lean Thinking practice influence KPI in SPHEIs?

The third research question investigates the current Lean Thinking practice that influences the KPI in SPEHIs. The significant influence and correlation between Lean Thinking evidence practice in the CP&DP versus KPI, Lean Tools competency versus KPI, and Lean Thinking relationship versus KPI. The results address the third null hypothesis ($H03_{null}$).

RQ4: HOW do SPEHIs deploy Lean Thinking practice to improve academic processes?

The final research question investigates how SPHEIs use Lean Thinking practice to improve academic processes. The purpose of collecting more qualitative facts is to interpret, understand, and answer the quantitative research questions more resounding.

1.10 Research Hypotheses

Figure 1.5 depicts the interdependence of the hypotheses of Lean Thinking versus Course Planning and Delivery Process. There are three (3) hypotheses. The first null hypothesis ($H01_{null}$) seeks to learn the current level of evidence for Lean Thinking practice in SPHEIs. The second null hypothesis ($H02_{null}$) investigates the relationship between dependent variables (course resources, course contents, course pedagogy, course assessment, course evaluation and course refinement) and independent variables (Lean principles, wastes and tools). The third null hypothesis ($H03_{null}$) is to understand the current Lean Thinking practice level in SPHEIs that can significantly influence KPI. These hypotheses are associated with the research questions (RQs). The RQs align with the research objectives (ROs), and the ROs answer the research aim.

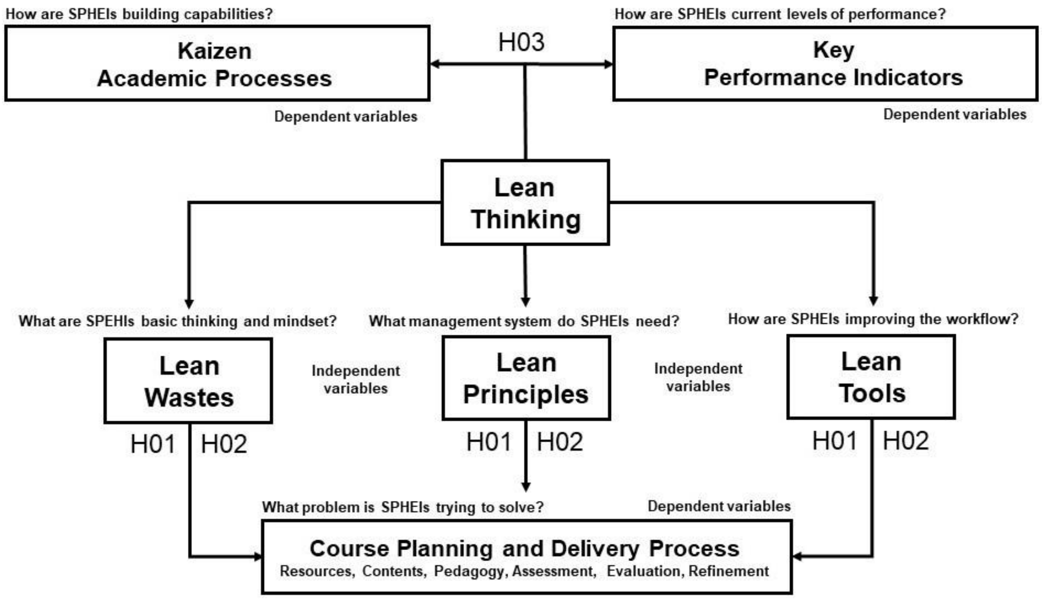


Figure 1.5 - Research Hypotheses (Source: Author)

Hypothesis 1 (RQ1, RO1)

$H01_{(Null)}$: There is **NO** evidence showing SPHEIs deploy Lean Thinking practice in the CP&DP.

One sub hypothesis (See Chapter 5):

$H01\text{-}1_{(Null)}$: The distribution of <attribute> is the same across categories of Group.

Hypothesis 2 (RQ2, RO2)

$H02_{(Null)}$: There is **NO** correlated evidence between Lean Thinking versus CP&DP.

One sub hypothesis (See Chapter 5):

$H02\text{-}1_{(Null)}$: The distribution of <attribute> is the same across categories of Group.

Hypothesis 3 (RQ3, RO3)

$H03_{(Null)}$: There is **NO** evidence showing the current Lean Thinking practice can influence KPI in SPHEIs.

One sub hypothesis (See Chapter 5):

$H03\text{-}1_{(Null)}$: The distribution of <attribute> is the same across categories of Group.

It is essential to conduct the normality test of the collected dataset to decide whether to use a parametric or nonparametric approach. According to Tsagris and Pandis (2021), the Kolmogorov-Smirnov and the Shapiro-Wilk tests are frequently used to test normality. Hence, both tests were adopted using SPSS for normality testing, and further detailed analysis is provided in Chapter 5.

1.11 Research Scope

Figure 1.6 illustrates how the researcher executes the research activities. The researcher started with bibliometric analysis (Chapter 2), followed by literature review, presented the theoretical framework of the literature review, identified the knowledge gap analysis and created the conceptual framework of the research study (Chapter 3). Stakeholder evidence is “the values and concerns of people who may be affected by the decision” (Jones, 2018). The researcher used triangulation embedded mixed-method, a cross-sectional survey (Chapter 4) to collect more facts about the Lean Thinking practice in CP&DP for SPHEIs (Chapter 5). The total population size of twenty-seven SPHEIs was about 10,000 students in this study. According to Taherdoost (2018a), targeting to collect 370 samples out of 10,000 populations with a 95% confidence level and a 5% margin of error would be sufficient. The details on sampling are provided in Chapter 4, Section 4.10.5. However, 303 of the student respondents from the two participating SPHIEIs have contributed 82% return compared to 370 samples (Chapter 5, Section 5.6). Furthermore, the study has collected data from two homogenous SPHEIs out of twenty-seven target institutions because they share similar or identical characteristics.

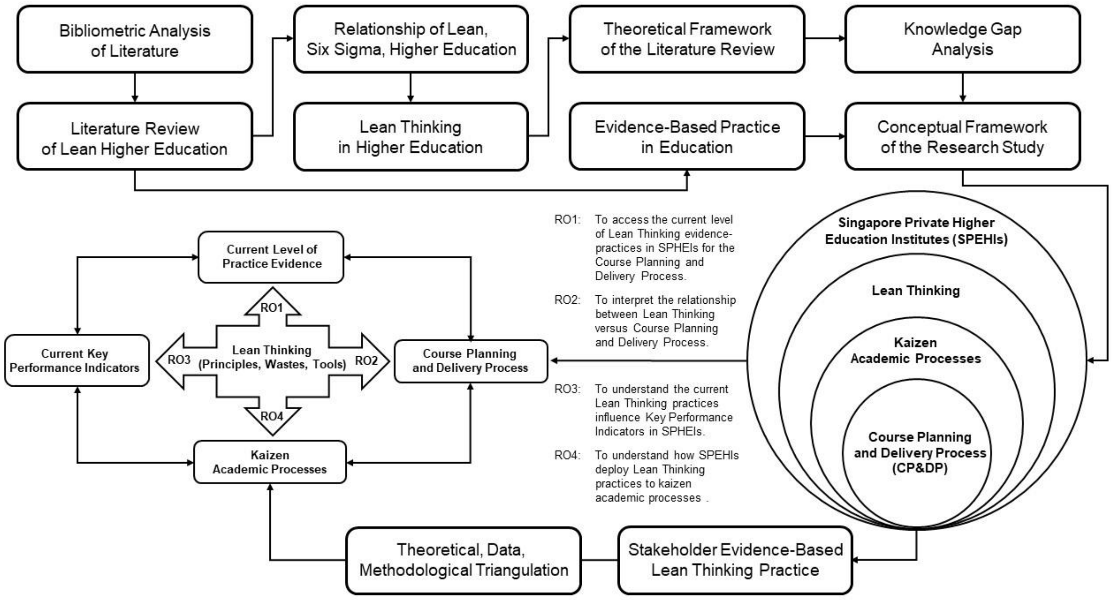


Figure 1.6 - Research Scope (Source: Author)

1.12 Research Process

Table 1.4 summarises research designs, methods, data collection and analysis for this project. The researcher contacted the eleven (11) SPHEIs, who had a high employment rate ranging from 42.1% to 90.9 %, via email in Feb 2020 and invited them to participate in the survey. However, only two (2) SPHEIs agreed to take part in the research survey before the Singapore COVID19 lockdown ("circuit breaker") in April 2020. Hence, the researcher decided on these two (2) SPHEIs as the sampling frame for this study.

Table 1.4 - Design, Methods, Data Collection and Analysis (Source: Author)

Research Process	Description
Type	The study is descriptive according to the nature of the study.
Target Population	27 SPHEIs had graduated from full-time bachelor's level EDPs.
Sampling Frame	11 SPHEIs had a high employment rate and invited them to participate in the survey. However, only 2 SPHEIs were accepted.
Sampling Unit and Method	Stratified Sampling: Faculties and Programmes.
Sample Size	Respondents: Administrators, Lecturers and Students.
Sampling Plan	To use an online survey (formerly BOS) to collect data.
Select the Sample	To target an adequate survey rate and the item response rate.
Methods	Embedded Mixed-Methods [QUAN(qual)].
Triangulation Type	Theoretical, Data, Methodological Triangulation.
Data Analysis	Analyse and interpret both quantitative and qualitative data.
Analysis Technique	SPSS for descriptive and statistical analysis (QUAN). Nvivo/Excel for code and theme analysis (qual).

Stratified sampling is "where the population divides into strata (or subgroups), and a random sample takes from each subgroup. A subgroup is a natural set of items" (Taherdoost, 2018a). The strata or sub-groups should be different, and the data should not overlap. Stratified sampling is "often used where there is a great deal of variation within a population. Its purpose is to ensure that every stratum represents adequately" (Taherdoost, 2018a). The main reason to create strata is to make the sampling strategy more efficient.

A stratified sampling strategy was created for each SPHEI by separating the population into non-overlapping groups. Then a simple random sample was selected from each stratum (See Chapter 4, Section 4.10.4). Each SPHEIs had three Faculties (School of Business, School of Engineering and School of Life Science), each faculty had three Programme Types (Bachelor, Master and Doctorate). Hence, stratified sampling was applied in the selected Faculties and Programme Types. Stratified random sampling helps to ensure that the sample reflects different subgroups or strata. The Head of Faculty were allowed to randomly select the Programme Types for this study and do an online survey to collect the data from three respondents (Administrators, Lecturers and Students). The target was to have an adequate survey rate and the item response rate for this study. The researcher did not find any missing data from the online survey.

1.13 Measurable Variables

This mixed-methods study looks at the evidence-based Lean Thinking practice to improve CP&DP for SPHEIs. The researcher collected quantitative and qualitative data in parallel to identify the relationship between independent variables (Lean Principle, Wastes and Tools) and dependent variables (course resources, course contents, course pedagogy, course assessment, course evaluation and course refinement). Quantitative data was analysed statistics to demonstrate that the concept theory of Lean Thinking can positively improve CP&DP for SPHEIs. The qualitative data suggested that Lean Thinking has a significant impact and influence on the CP&DP for SPHEIs, which results in the independent-dependent variable relationships. The purpose of collecting both quantitative and qualitative data is better to understand the quantitative results at a deeper level using qualitative data. Both methods are essential in answering the research questions.

1.14 Research Methodology

According to Dudovskiy (2011), a research philosophy can be viewed in two ways: epistemology and ontology. Epistemology is how one knows what one knows, and ontology is how one sees reality in this world (Creswell and Guetterman, 2019). Positivism depends on quantifiable observations that lend themselves to statistical analysis. Interpretivism integrates human interest into a study and involves researchers interpreting elements of the study. Interpretivism studies usually focus on meaning and may use multiple methods to show different aspects of the issues such as interviews and observations. Pragmatism recognises different methods of interpreting and no single point of view can ever give the entire picture. Pragmatics can combine both positivism and interpretivism, in place within the scope of single research according to the nature of the research question (Dudovskiy, 2011; Alan Bryman, 2015; Quinlan, Christina, Zikmund, 2015; Zikmund, William, Quinlan, Christina, Carr, Jon, Griffin, Mitch, Babin, 2019) (See Chapter 4). The research philosophy of this study was epistemology pragmatism.

1.15 Research Method

1.15.1 Mixed-Methods Research

The researcher has adopted an embedded mixed-method design [QUAN(qual)] (Creswell, 2015) to collect and analyse both quantitative and qualitative data shown in *Figure 1.7*. In embedded mixed-method design, mixing occurs in parallel, either concurrently or over time, by administering questionnaires requiring quantitative and qualitative responses (Creswell, 2015). The data gathered both quantitatively and qualitatively simultaneously, separately analysed, and then compared and related (See Chapter 4).

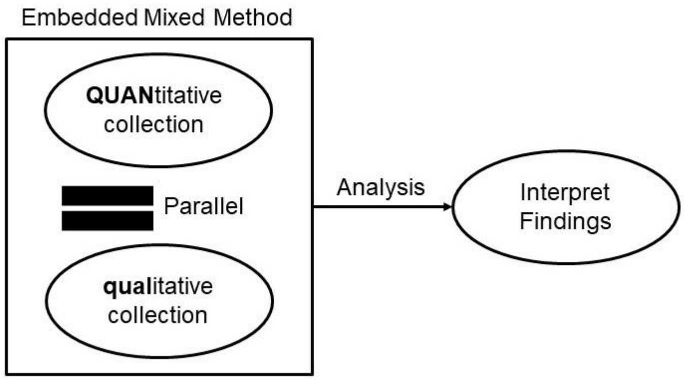


Figure 1.7 - Embedded Mixed-Methods Design (Source: Author)

Data for this study was gathered using quantitative (self-administered survey questionnaires) and qualitative (self-administered open-structure questions) methods. Both quantitative and qualitative methods were critical in answering the research questions and developing the Lean Thinking Kaizen Academic Process Canvas (See Chapter 6). The collection of online survey data began in June 2020 and took several months due to the COVID19 lockdown ("circuit breaker") in Singapore since April 2020.

1.15.2 Triangulation Approach

The triangulation approach (Carter *et al.*, 2014; Heale and Forbes, 2013) used in this study summarises in *Table 1.5* (See Chapter 4).

Table 1.5 - Triangulation Mixed-Methods Approach (Source: Author)

Type	As applied in this study
Theoretical Triangulation	To investigate Lean Thinking evidence-based practice related to CP&DP.
Data Triangulation	To collect primary data from two (2) SPHEIs. To use an online survey (formerly BOS) to collect data.
Methodological Triangulation	To collect quantitative data via a self-administered Likert scale questionnaire. To collect qualitative data via a self-administered open-structure question.

- **Theoretical Triangulation**

  The researcher adopted the theoretical triangulation (Carter *et al.*, 2014; Heale and Forbes, 2013) mixed-methods research design for CP&DP, conducted surveys on Administrators (AD), Lecturers (LE) and Students (ST) from selected SPHEIs, shown in *Figure 1.8* (See Chapter 4).

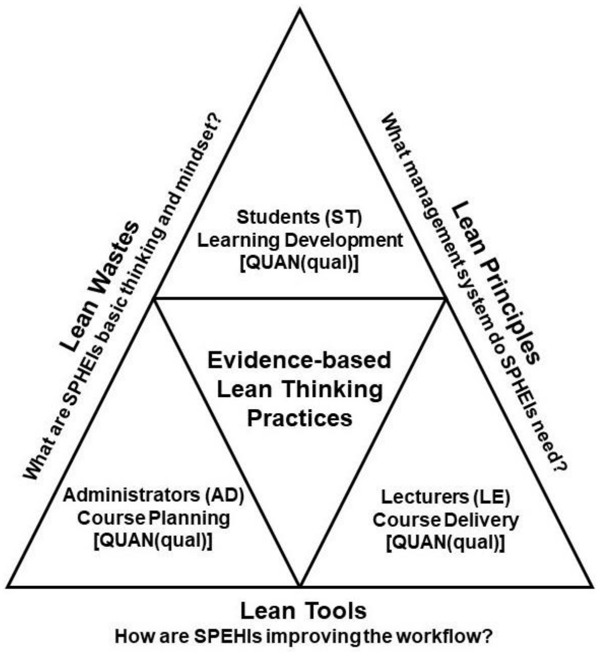


Figure 1.8 - Theoretical Triangulation Mixed-Methods Design (Source: Author)

- **Data Triangulation**

  The researcher used an online survey (formerly BOS) recommended by the university to collect the data. The quantitative format was a self-administered Likert scale questionnaire, and the qualitative structure was through self-administered open-structure questions (See Chapter 4).

  The researcher collected data from two (2) SPHEIs. Since each SPHEI had three (3) datasets (Administrators, Lecturers and Students), there was a total of six (6) datasets shown in *Table 1.6*. Datasets were combined and analysed as cross-case. To understand the reaction of student learning development, merging the AD and LE datasets were critical to investigate evidence-based Lean Thinking practice in the CP&DP (See Chapter 4).

Table 1.6 - Data Triangulation Mixed-Methods Datasets (Source: Author)

Process Flow	Triangulation Data	SPHEIs-A	SPHEIs-B	Combined Dataset
Input	Administrators (AD) Course Planning	Dataset A1	Dataset B1	Dataset A1+ B1+ A2 + B2
Process	Lecturers (LE) Course Delivery	Dataset A2	Dataset B2	
Output	Students (ST) Learning Development	Dataset A3	Dataset B3	Dataset A3 + B3

- **Methodological Triangulation**

  The methodological triangulation mixed-methods survey has two formats. The quantitative format is a self-administered Likert scale questionnaire, and the qualitative structure is self-administered open-structure questions. There was a total of nine (9) survey questionnaires and five (5) open-structure questions. Each survey question breaks down into five to seven attributes asked in the self-administered Likert scale questionnaires format. The dependent attributes correspond to independent variables of five (5) Lean Principles and four (4) Lean Wastes (See Chapter 4).

The researcher used SPSS to process numerical data to analyse and interpret quantitative data. Using NVivo or Microsoft Excel to process code and theme analysis to manipulate qualitative data, then present graphs and charts (See Chapter 5).

1.15.3 Validity and Reliability

Taherdoost (2018b) claimed that the extent to which a concept is accurately measured in a quantitative investigation is known as validity. Validity refers to the ability of a test or instrument to measure what it claims to be measured accurately. The content validity is the matching of questionnaires and the question content. The author said content validity is “the degree to which the measurement covers all dimensions of the definition under consideration” and is “the matching between questionnaires and the content of the questions”. Furthermore, the author explained that construct validity is “the adherence of a measure to current theory and understanding of the principle measured” and is “one technique to determine the validity of a test and shows that the test is measuring the construct it claims to be assessing” (See Chapter 4).

Taherdoost (2018b) stated that the consistency of a measure is related to reliability. Reliability measured the stability or consistency of test scores. Internal reliability, often known as internal consistency, is how well a test measures what the researchers want to measure. The Cronbach's alpha test estimates reliability because an exact reliability calculation is impossible. The most widely used test for determining the internal consistency of survey questionnaires with more than two responses is Cronbach's alpha. Cronbach's alpha is a number that ranges from 0 to 1. It considers acceptable to have a reliable score of 0.7 or higher (See Chapter 4).

1.16 Significance of Research

1.16.1 Professional Practice and Novelty

This study is the first to look into evidence-based Lean Thinking practice in Kaizen academic processes. The second contribution is the mixed-method study of Lean Principles, Lean Wastes and Lean Tools to improve CP&DP as one of the educational processes. Third, this is the first time research was conducted on selected SPHEIs, whereas most previous studies universities were in the United Kingdom, the United States and India. The study also contributes to the Lean Thinking Kaizen Academic Process Canvas (See Chapter 6) guideline for SPHEIs to transform, adopt a highly effective strategy planning, provide high value-added through innovation and stay competitive. Finally, the statistical study data contribute to developing a guideline for the CPE to use as a benchmark.

1.16.2 Academic Practice

The mixed-methods design study focuses on applying evidence-based Lean Thinking practice to improve CP&DP for SPHEIs. The purpose of collecting both quantitative and qualitative data is better to understand the quantitative results at a deeper level using qualitative data. Both methods were critical in answering the research questions and developing the Lean Thinking Kaizen Academic Process Canvas (See Chapter 6). Next, use the triangulation mixed-method to collect data from selected SPHEIs to ensure the method is valid and reliable.

1.17 Ethical Considerations

The ethics application form has been submitted to the Research Degree Board (RDB) for approval before data collection began. The privacy of participants is taken care of through the research process. The survey informed participants that the survey results would be used for research purposes only, and this survey is entirely voluntary that they can refuse to answer any questions at any time for any reason. All responses responded to the questionnaire will remain anonymous. The Research Ethics Committee (REC) has approved the ethical application:

- Application ID: ETH1920-0022 date 18 Nov 2019 (See Chapter 4)
- Application ID: ETH1819-0068 dated 22 May 2019 (See Chapter 4)

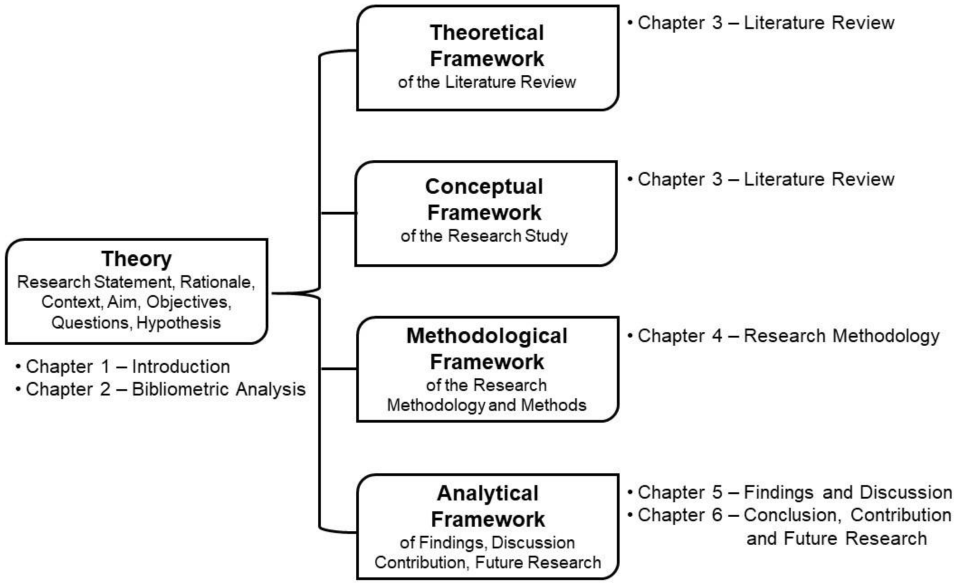
1.18 Structure of the Thesis

William G. Zikmund *et al.* (2019) developed the four frameworks approach as a simple guide for the researcher to develop the research project that links to the thesis structure, as shown in *Figure 1.9*.

This thesis has been divided and structured into chapters as follows:

- *Chapter 1 – Introduction*

  This chapter introduces the study by outlining the background, problem statement, research rationale, motivating factors, research context, research aim, objectives, questions, hypotheses, research scope and research process. The research methodology and method, the study's significance, and ethical considerations have also been presented.



Source: Adapted from William G. Zikmund *et al.* (2019)

Figure 1.9 - Structure of the Thesis

- *Chapter 2 – Bibliometric Analysis*

  Bibliometric analysis is to identify the scientific gaps and research trends from the included documents classified into the various quantitative groups. The methodology for the literature review critically identifies, appraises and synthesizes all the evidence that meet the criteria to answer the established questions for the literature review. This chapter reviews documents on the existence, adoption, implementation and application of Six Sigma, Lean Six Sigma and Lean/Lean Thinking in Higher Education. Lastly, bibliometric analysis related to the main research questions has been discussed.

- *Chapter 3 – Literature Review*

  The current literature is examined in this chapter, which leads to identifying research gaps, which leads to the formulation of the research questions for this study. The chapter looks at the relationship between Lean Thinking, Lean Six Sigma and Higher Education. The chapter examines Lean Thinking critically as an evidence-based practice for improving administrative and academic processes in Higher Education.

The review covers the application, benefits and challenges of Lean Thinking in Higher Education comprehensively.

- *Chapter 4 – Research Methodology*
  This chapter presents the research philosophy, methodology and design adopted in this research – three sections addressed in the discussion. Firstly, this research study developed the collaborative survey. Then the sampling respondents and survey administration are discussed, followed by analysis and reporting of survey data. Furthermore, the reliability and validity of this piece of research examine and ethical considerations presented. The rationale for these methodological choices explains throughout the chapter.

- *Chapter 5 – Findings and Discussion*
  This chapter presents the quantitative and qualitative results. First, it demonstrates the quantitative analysis of the current level evidence-based Lean Thinking practice in SPHEIs. Next, it examines the significant influence and correlation between Lean Thinking and the CP&DP. Third, consider the impact of current KPI on current Lean Thinking practice in SPHEIs. Finally, it presents the qualitative analysis of SPHEIs deploys Lean Thinking practice the CP&DP as an evidence-based practice. In summary, both methods were critical in answering the research questions.

- *Chapter 6 – Conclusion, Contribution and Future Research*
  This chapter discusses the realisation of research aim and objectives, research quality, the contribution of this study to theory, professional practice and knowledge. The limitation of this study, future work that will benefit other researchers in this field, are also discussed.

1.19 Chapter Summary

This chapter introduces the research background, problem statement, research rationale, motivating factors, research context, and setting out the research aim, objectives, questions, and hypotheses. An overview of the research scope, research process, research methodology, research method, and the significance of the research discussed. Finally, it presented the ethical consideration and structure of the thesis. This study investigates how SPHEIs use Lean Thinking practice in the CP&DP, either directly or indirectly, to achieve student learning development and satisfaction.

Chapter 2 – Bibliometric Analysis

2 Bibliometric Analysis

2.1 Introduction

Lean is a methodology of high performance that enables organisations to focus on improvement and value (Balzer, 2010; 2020). Respect for people and continuous improvement is the foundation of Lean (Emiliani, 2015). It has a long history in manufacturing, more recently in the service environments, health care, and the general public sector (Gupta *et al.*, 2016). The application of Lean in Higher Education can transform this sector, and the number of Lean practitioners in universities is increasing (Balzer *et al.*, 2015; Balzer *et al.*, 2016). The bibliometric analysis was to identify and select appropriate literature from various journals and other disseminated research on Lean Higher Education. The researcher decided to choose Scopus offered by Elsevier because the content coverage by subject area is in Life Science, Social Science, Physical Science, Health Science and has over 75+ million records (Scopus, 2020). The researcher defined the process of searching, inclusion and exclusion criteria for articles clearly. The study adopted Scopus analysis tools to analyse the Lean Higher Education knowledge base documents by years, countries, subject areas, source and type, authors, affiliation, keywords, and citations. This study aims to consolidate the latest Lean implementation scenarios in the Higher Education industries. This analysis may assist the public and private HEIs understand the importance of Lean Thinking in adding value to customers ("students") while reducing waste in administrative and academic processes.

2.2 Documents Searching Strategy

A "systematic review" is a type of review in a specific methodology. According to Tranfield et al. (2003), "a systematic literature review is an important tool for searching, appraising and synthesising research evidence systematically". Still, there is some ambiguity surrounding the phrase "systematic literature review" because it can be used and done in several ways by researchers (Ramey and Rao, 2011; Xiao and Watson, 2019). The "systematic literature review" methodology proposed by Tranfield *et al.* (2003) was used for "objective, systematic, transparency, repeatability, and helped to avoid the potential impacts of bias in research."

Pollock and Berge (2018) defined a “systematic review” as:

> *“A systematic review aims to bring evidence together to answer a pre-defined research question. It involves identifying all primary research relevant to the defined review question, the critical appraisal of this research, and the synthesis of the findings. Systematic reviews may combine data from different research studies to produce a new integrated result or conclusion, or they may bring together different types of evidence to explore or explain the meaning.”*

Many researchers interchangeably use the phrase "systematic review" when discussing a “systematic literature review”. However, researchers can use the term “systematic literature review” to refer to a literature review that is conducted in a relatively systematic manner but does not meet the rigorous requirements of a “systematic review” (Ramey and Rao, 2011). A “systematic review” is typically conducted with experts by a group that includes a search information specialist and a statistician for meta-analysis (Pollock and Berge, 2018). However, a single person can also carry out a “systematic literature review” (Tranfield *et al.*, 2003).

Pollock and Berge (2018) described four steps in the “systematic review” process: “Plan a systematic review; write and publish protocol; finish the review; publish, disseminate and update the review”. However, several authors have presented a model for the various stages of a “systematic review” of literature (Tranfield *et al.*, 2003; Tranfield *et al.*, 2004; Jones and Gatrell, 2014; Pittaway *et al.*, 2014; Okoli, 2015). Pittaway *et al.* (2014) described three steps for undertaking a “systematic review” of the literature, whereas Okoli (2015) employed four steps. Tranfield *et al.* (2003) broke down three stages into nine phases. Tranfield *et al.* (2003) defined three stages: “systematic literature reviews”: “Planning the review; Conducting the review; Reporting and dissemination.”

Six Sigma’s DMAIC approach is to enhance processes. The five processes represented the letters in the acronym. *Define* is “to specify the problem”; *Measure* is “to quantify the problem”; *Analyse* is “to identify the cause of the problem”; *Improve* is “to implement and verify the solution”; *Control* is “to maintain the solution” (Yu and Ueng, 2012; Bargerstock and Richards, 2015; Allen *et al.*, 2015). The researcher adopted the “systematic literature review” developed by Tranfield *et al.* (2003), using Six Sigma methodologies DMAIC (“*Define – Measure – Analyse – Improve – Control”*) analysis carried out in this study shown in *Table 2.7*.

Table 2.7 - Systematic Literature Review with DMAIC (Tranfield et al., 2003)

Phase	**Description (Tranfield et al., 2003)**	**DMAIC (Niñerola *et al.*, 2021)**	**Tools / Techniques (Source: Author)**
Stage I	**“Planning the Review”**		
01	“Identification for the need for a review”	Define	Questions with PICO
02	“Preparation of a proposal for a review”	Define	Scopus Database
Stage II	**“Conducting the Review”**		
03	“Development of a review protocol”	Measure, Control	Key Phrases
04	“Identification of research”	Measure, Control	Inclusion / Exclusion
05	“Selection of studies”	Measure, Control	PRISMA
06	“Study quality assessment”	Measure, Control	Documents Included
07	“Data extraction and monitoring ”	Analysis	Categories Classified
Stage III	**“Reporting and Dissemination”**		
08	“The report and recommendation”	Analysis, Improve	Bibliometric Analysis
09	“Getting evidence into the practice”	Improve, Control	Further Study Identified

STAGE I, called “Planning the Review”, corresponds to *Define* of DMAIC, comprised with “identification for the need for a review” (phase 01) was to motivate and justify in the research study, and “preparation of a proposal for a review” (phase 02) was to explain the methodology. The researcher established the literature review questions with the aid of the PICO (*Population – Intervention – Comparison – Outcome*) framework (Eriksen and Frandsen, 2018) and identified the details of the selected database for document searching.

STAGE II, called “Conducting the Review”, corresponds to *Measure, Analyse and Control* of DMAIC included phrases 03 to 07. This stage consisted of identifying, screening, and having documents from the selected database, keyphrases chosen for this purpose. The document filtering results that met all of the inclusion criteria specified in the review protocol would be categorised and incorporated into the review.

STAGE III, called “Reporting and Dissemination”, corresponds to *Analyse, Improve, and Control* of DMAIC included phrases 08 to 09 for documents and content search analysis. This stage of the systematic review of literature constituted the study’s goal and provided a summary and comment on further studies.

2.2.1 Planning the Review

Phase 01 – "Identification for the need for a review"

This phase is to identify research aims and objectives. Firstly, the "systematic literature review" aimed to classify the available literature on Lean Thinking and Higher Education. Next, it organised the research on this subject quantitatively to meet objectives. A "systematic literature review" plan is a strategy to identify the body of knowledge on Lean Thinking in Higher Education. It identified systematic search information regarding Lean Thinking practice in Higher Education, and it was to find and assess how Lean Thinking applies in Higher Education. The researcher compiled and reviewed the comprehensive findings of published documents of Six Sigma, Lean Six Sigma, and Lean/Lean Thinking in Higher Education.

This chapter aims to consider the literature review questions as follow:

LRQ1: What is the distribution of documents across the years, countries, subject areas and document types in the Lean Higher Education knowledge base?

LRQ2: What are the sources and types, authors, affiliation, keywords and citations that have the most significant influence on Lean Higher Education research?

Finding appropriate resources and searching for relevant evidence without a well-defined question can be difficult and time-consuming. To formulate the question and make the literature search easier, practitioners frequently employ a specialised framework known as PICO (Eriksen and Frandsen, 2018). PICO is an acronym that stands for Population, Intervention, Comparison and Outcome. Evidence-based models use a process for framing the PICO question, locating, assessing, evaluating, and repeating as needed (Eriksen and Frandsen, 2018). *Table 2.8* shows the keyphrases adopted in the PICO framework in this study.

Table 2.8 - Keyphrases adopted in the PICO Framework (Source: Author)

Population	**I**ntervention	**C**omparison	**O**utcome	
Higher Education	Lean Thinking	Six Sigma	Years	Sources
Public	Lean Principles	Lean Six Sigma	Countries	Authors
Private	Lean Wastes		Subject areas	Affiliation
Institutes	Lean Tools		Types	Keywords
Universities	Lean Kaizen			Citations

Phase 02 – "Preparation of a proposal for a review"

This phase is to identify relevant databases. José de Oliveira *et al.* (2019) stated as:

> *"Examples of scientific research platforms with robust databases and reasonable availability of search filters include Scopus and Web of Science (WoS). These platforms provide access to thousands of scientific articles published by publishers such as Elsevier, Springer, Emerald, Wiley and Taylor & Francis, among others. EBSCO, Crossref, and Google Scholar are other multidisciplinary platforms also used by researchers. In addition to these, there are vast numbers of platforms specific to the different fields of knowledge."*

Therefore, the selected articles were searched for from the SCOPUS scientific database. "SCOPUS is a source-neutral abstract and citation database curated by independent subject matter experts. It places powerful discovery and analytics tools in the hands of researchers, librarians, institutional research managers and funders". The researcher decided to choose Scopus offered by Elsevier because the content coverage by subject area are Life Science, Social Science, Physical Science, Health Science and has over 75+ million records (Scopus, 2020).

The researcher used the two-step approach to collect comprehensive data from the SCOPUS database. First, the researcher selected relevant keyphrases to search (See *Phase 03*). Next, the researcher conducted a content analysis of the documents to identify the appropriate documents for this analysis (See *Phase 04*).

2.2.2 Conducting the Review

Phase 03 – "Development of a review protocol"

The researcher searched the SCOPUS database electronically for documents using the keyphrases shown in *Table 2.9*. The base of journal articles gathered was refined to identify the relevant records in the available literature. Complete reading papers had a stronger correlation with the subject under review.

Table 2.9 - Keyphrases used in the SCOPUS database (Source: Author)

As applied in this study	
• Lean Thinking Higher Education	• Lean Service Higher Education
• Lean Principle Higher Education	• Lean Process Higher Education
• Lean Wastes Higher Education	• Lean Leadership Higher Education
• Lean Tools Higher Education	• Lean Sustainability Higher Education
• Lean Kaizen Higher Education	• Lean Evidence Higher Education

Phase 04 – "Identification of research"

An initial search on SCOPUS was to identify a collection of journal documents used in this study till 31 December 2020. The search criteria for articles is as shown in *Table 2.10*. Next, the titles and abstracts were reviewed to ensure that the search met the requirements. Additionally, read the documents and identify the Six Sigma, Lean Six Sigma and Lean/Lean Thinking approaches used in Higher Education.

Table 2.10 - Inclusion and Exclusion Criteria (Source: Author)

Search Criteria	Inclusion Criteria	Exclusion Criteria
Database	Scopus	Others
Period Time	Up to 31 Dec 2020	After 31 Dec 2020
Document Type	Articles, Conference Papers, Reviews, Books, Book Chapters, Editorials	-
Source Type	Journals, Conference Proceeding, Book Series, Books	Thesis, Gray Literature
Subject Area	All	-
Language	English	Other languages

Phase 05 – "Selection of studies"

The "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" is "an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses" (Moher *et al.*, 2009). The author states, "PRISMA focuses on reporting reviews evaluating randomised trials. It can also be used as a foundation for reporting systematic literature reviews of other types of research, particularly evaluations of interventions."

Silva da *et al.* (2018) used six parameters to conduct this systematic literature and bibliometric review of the research criteria: "scientific database, publication period, document type, source type, subject areas and language". The searches used the key terms and parameters "peer review" and "full text" to meet the research criteria. On the other hand, the researcher conducted the bibliometric analysis of the current literature on Six Sigma, Lean Six Sigma and Lean/Lean Thinking in Higher Education. The bibliometric analysis of this study was to analyse the documents in the Lean Higher Education knowledge base by years, countries, subject areas, types, sources, authors, affiliation, keywords and citations.

The PRISMA guidelines for conducting a systematic review of research was to guide the search process in this review (Moher *et al.*, 2009). The following keyword string creates the initial SCOPUS database of documents.

TITLE-ABS-KEY (lean AND higher AND education)

Bias is difficult to avoid entirely during the research process. A well-designed study is likely bias-free, but its elimination cannot be guaranteed. According to Pannucci and Wilkins (2010), any tendency that prevents an issue from being considered objectively is biased. Bias can occur at any stage of the research process. Keeble *et al.* (2015) claimed that surveys and epidemiological studies are well known to suffer from selection bias. There are numerous methods to reduce its effects to choose which method is best suited for their research.

Pannucci and Wilkins (2010) explained that "selection bias may occur while identifying the study population. The ideal study population is well-defined, easily accessible, dependable, and at a higher risk of developing the desired outcome". One has to choose the articles using strict criteria to avoid selection bias, and articles must be from the same general population. Since the outcome is uncertain at the time of recruitment, well-designed prospective studies help reduce selection bias.

The researcher first used the keyphrases defined in the PICO framework. The key phrases used in the SCOPUS database, and then strictly adhered to the inclusion and exclusion criteria, then selected PRISMA documents. All the documents were compiled, analysed and appraised systematically and critically within the scope of work defined. *Figure 2.10* shows that the PRISMA selection process yielded 1070 papers from academic articles until 31 December 2020.

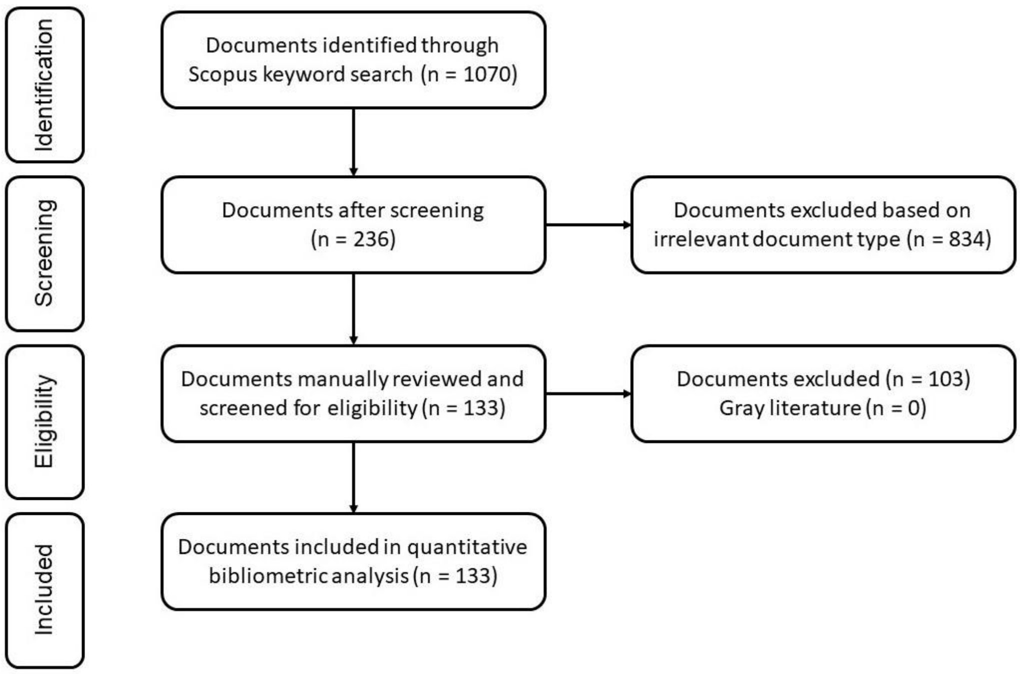


Figure 2.10 - Selection of Documents using PRISMA (Source: Author)

Phase 06 – "Study quality assessment"

The final papers were explored and related to Six Sigma, Lean Six Sigma, Lean/Lean Thinking, Principle, Wastes, Tools, Kaizen, Service, Process, Leadership, Sustainability, Evidence and Higher Education. SCOPUS filters screened out documents based on broad categories, reducing the documents to 236 shown in *Figure 2.10*.

It excluded an additional 103 documents after reviewing the titles and abstracts of articles to determine eligibility. These resulted in a final database of 133 papers for this review. Before bibliometric analysis, the supervision team checked and validated the documents to avoid selection bias. It has identified the strengths and weaknesses of journal articles to assess their usefulness and validity in a systematic process. The researcher summarised and ordered chronologically for the final documents (See Appendix 2).

Phase 07 – "Data extraction and monitoring progress"

SCOPUS assists researchers in completing common research workflows. The four main Scopus analysis tools are: analyse results; view citation overview; browse the source and compare journals; analyse author Scopus output profile (Scopus, 2020).

The SCOPUS data search results feature analysis shows a visual breakdown by years, countries, subject areas, types, journals, authors, affiliation, keywords, and citations. Researchers need to identify and support pathways to scientific projects (José de Oliveira *et al.,* 2019).

2.2.3 Reporting and Dissemination

Phase 08 – "The report and recommendations"

A total of 133 articles were found in the Scopus database between 2003 to 2020. The survey identified 160 authors from 41 countries in 133 papers. The researcher presented the record categories for bibliometric review in tables and graphs created with Excel software to prepare fundamental indicators. The extraction of bibliometric analysis indicators helped the researcher identify and study trends in various scientific domains.

Phase 09 – "Getting evidence into practice"

After identifying the bibliometric results, the researcher delivered a piece of clear and comprehensive evidence on Six Sigma, Lean Six Sigma, Lean/Lean Thinking practice in Higher Education.

2.3 Documents Analysis Strategy

2.3.1 What is Bibliometric?

The OECD Glossary of Statistical Terms defined bibliometric research (Anon, 2020) as:

"The statistical analysis of books, articles, or other publications... to measure the 'output' of individuals/research teams, institutions, and countries, to identify national and international networks, and to map the development of new (multi-disciplinary) fields of science and technology."

José de Oliveira *et al.* (2019) quoted:

"Bibliometric analysis is an indispensable statistic tool to map state of the art in a given area of scientific knowledge and identify essential information for various purposes, such as prospecting research opportunities and substantiating scientific researches… This method enables us to expand the boundaries of science scientifically by investigating and identifying relevant and avant-garde research topics."

Bibliometric methods make examining more extensive data sets easier and help researchers make funding decisions. Bibliometrics are a quantitative way of measuring the impact of the research. The procedure is straightforward, and the same method can replicate the results. Bibliometrics take relatively little time to produce, use, and be scalable (Barker, 2013).

2.3.2 Basic Law of Bibliometrics

The basic law of bibliometrics is frequently invoked. Sordan *et al.* (2020) claimed Bradford's Law which examines journal effectiveness, identifies the most prolific journals in science that address a specific subject. In addition, Lotka's Law examines the number and frequency of publications by authors on a particular topic and demonstrates that the authors have contributed to the progress of science. The authors explained Zipf's Law which examines the frequency and ranking of words in the text to comprehend the characteristics and distribution of the volume of scientific documents and to statistically analyse this publication (Sordan *et al.*, 2020). Therefore, the statistical analysis of the selected papers was presented based on these three laws.

2.3.3 Analysis of Documents by Year

All documents were arranged chronologically and grouped according to the published years. The first documents on these topics were published in 2003. Before 2012, less than four studies related to Six Sigma, Lean Six Sigma, and Lean/Lean Thinking related to Higher Education were released. After 2013, publications increased steadily, with some minor variations in 2014 and 2016. The publication of papers indicates that a significant amount of research was conducted between 2015 and 2020, as shown in *Figure 2.11*.

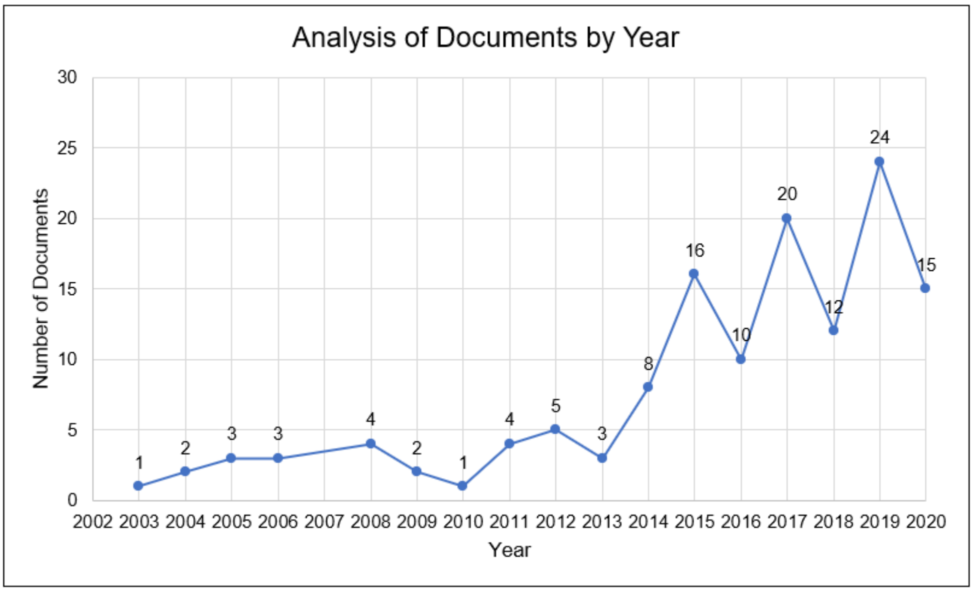


Figure 2.11 - Analysis of Documents by Year up to 31 Dec 2020 (Source: Author)

The researcher selected the highest number of published documents in 2015, 2017 and 2019, *Figure 2.11*. Next, identify the keywords adopted from the title of the documents and classify them as Management, Six Sigma, Lean Six Sigma, Lean/Lean Thinking shown in *Figure 2.12*. The number of keywords adopted for each year and group was calculated.

	Title	Year	Keywords
1	Implementation of the six sigma method in the educational process	2019	Six Sigma
2	Attributes valued by students in higher education services: a lean perspective	2019	Lean
3	How to use lean Six Sigma methodology to improve service process in higher education: A case study	2019	Lean Six Sigma
4	A lean six sigma approach for improving university campus office moves	2019	Lean Six Sigma
5	Lean Six Sigma in higher education institutes: an Irish case study	2019	Lean Six Sigma
6	Kaizen in university teaching: continuous course improvement	2019	Lean
7	Evaluating university leadership performance using Lean Six Sigma framework	2019	Lean Six Sigma
8	Lean academics: Lean implementation on campus	2019	Lean
9	Experiential learning at Lean-Thinking-Learning Space	2019	Lean Thinking
10	They teach, but do they apply?: An exploratory survey about the use of Lean thinking in Brazilian higher education institutions	2019	Lean Thinking
11	Implementing lean practices in an academic department: A case study	2019	Lean
12	Impacts of Lean Six Sigma on improving a higher education system: a case study	2019	Lean Six Sigma
13	Lean thinking for education: development and validation of an instrument	2019	Lean Thinking
14	Developing engineering curriculum: The lean way	2019	Lean
15	Role of lean leadership in the lean maturity - Second-order problem-solving relationship: A mixed methods study	2019	Lean
16	A structured review of Lean Six Sigma in various industrial sectors	2019	Lean Six Sigma
17	Systematic reviews and meta-analyses of higher education research	2019	Lean Six Sigma
18	Lean Six Sigma implementation: multiple case studies in a developing country	2019	Lean Six Sigma
19	Lean in higher education: A proposed model for lean transformation in a business school with MCDM application	2019	Lean
20	Bridging theory and practice with Lean Six Sigma capstone design projects	2019	Lean Six Sigma
21	A critical perspective on the changing patterns of Lean Six Sigma research	2019	Lean Six Sigma
22	Lean six sigma improvement of higher education student hiring processes	2019	Lean Six Sigma
23	Improving processes in a postgraduate office of a university through lean office tools	2019	Lean
24	Using 6 sigma to improve outcomes of higher education institutes	2019	Six Signa

	Title	Year	Keywords
1	Application of Lean six sigma in Indian higher education system	2017	Lean Six Sigma
2	Lean learning - Applying lean techniques to improve software engineering education	2017	Lean
3	Applying lean thinking to the structure and delivery of a kinematics course	2017	Lean Thinking
4	Leadership characteristics for Lean Six Sigma	2017	Lean Six Sigma
5	Lean utilisation for streamlining processes in the higher education sector in South Africa	2017	Lean
6	Lean higher education: Increasing the value and performance of university processes	2017	Lean
7	Lean Six Sigma for public sector organizations: is it a myth or reality?	2017	Lean Six Sigma
8	Combining lean teaching and learning with eduScrum	2017	Lean
9	Lean Six Sigma: yesterday, today and tomorrow	2017	Lean Six Sigma
10	Insights on lean gamification for higher education	2017	Lean
11	Applying lean thinking in an educational institute – an action research	2017	Lean Thinking
12	Implementing Lean Six Sigma into curriculum design and delivery – a case study in higher education	2017	Lean Six Sigma
13	Lean Six Sigma leadership in higher education institutions	2017	Lean Six Sigma
14	Lean Six Sigma for higher education	2017	Lean Six Sigma
15	Digitalization of learning resources in a HEI – a lean management perspective	2017	Lean
16	Applying lean concepts to teaching and learning in higher education: Findings from a pilot study	2017	Lean
17	Quantitative analysis of Six Sigma, Lean and Lean Six Sigma research publications in last two decades	2017	Lean Six Sigma
18	Education for lean & lean for education: A literature review	2017	Lean
19	Lean for education	2017	Lean
20	Six Sigma in education	2017	Six Sigma

	Title	Year	Keywords
1	Sustainability in higher education: A systematic review with focus on management education	2015	Management
2	Bringing Kaizen to the classroom: lessons learned in an Operations Management course	2015	Lean
3	Process integration and improvement in a higher education institution in South Africa	2015	Management
4	Improving the student academic experience through lean engineering principles	2015	Lean
5	Lean thinking for a maintenance process	2015	Lean Thinking
6	Negative side effects of lean management implementations - A causal analysis	2015	Lean
7	Critical success factors of Lean Six Sigma deployment: a current review	2015	Lean Six Sigma
8	A Lean Six Sigma program in higher education	2015	Lean Six Sigma
9	Waste identification and elimination in HEIs: the role of Lean thinking	2015	Lean Thinking
10	Lean higher education: successes, challenges, and realizing potential	2015	Lean
11	Learning from the pioneers: A multiple-case analysis of implementing Lean in higher education	2015	Lean
12	A comparative study of Lean implementation in higher and further education institutions in the UK	2015	Lean
13	A study on the students' perceptions of the applicability of lean principles at universities	2015	Lean
14	How did the publication of the book The Machine That Changed The World change management thinking? Exploring 25 years of lean literature	2015	Lean
15	Applying Lean Six Sigma within the university: Opportunities for process improvement and cultural change	2015	Lean Sx Sigma
16	Challenges in the deployment of LSS in the higher education sector: viewpoints from leading academics and practitioners	2015	Leas Six Sigma

Figure 2.12 - Keywords adopted in Documents Title (Source: Author)

Lean or *Lean Thinking* has the same theory concept (Womack and Jones, 2003; Womack *et al.*, 2007). Lean is about doing more with less, and Lean Thinking is a logical and systematic approach that focuses on creating an organisational environment that continuously seeks and eliminates waste.

Table 2.11 shows that Lean Six Sigma (38%), Lean/Lean Thinking (54%) have contributed to the higher percentage of published documents. This specific Lean/Lean Thinking trend in the number of journal papers published may continue to rise in the coming years.

Table 2.11 - Number of Documents by Year (Source: Author)

Keywords adopted in the Document Title	Year 2015	2017	2019	Total	Per cent
Management	2	-	-	2	3%
Six Sigma	-	1	2	3	5%
Lean Six Sigma	4	8	11	23	38%
Lean/Lean Thinking	10	11	11	32	54%
Total	16 (27%)	20 (33%)	24 (40%)	60	100%

2.3.4 Analysis of Documents by Country or Territory

Geographical analysis shows that Six Sigma, Lean Six Sigma, Lean/Lean Thinking and Higher Education has been reviewed in 133 documents over 15 countries. *Figure 2.13* presents the frequency of documents gathered about the country.

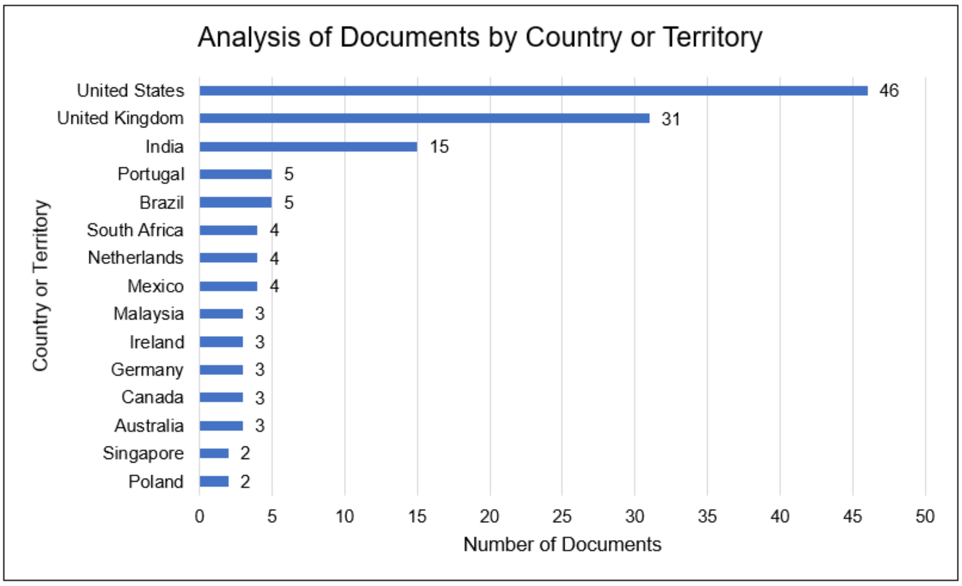


Figure 2.13 - Analysis of Documents by Country or Territory (Source: Author)

According to the findings, authors from the United States, the United Kingdom, and India conducted and published 70% of the study. There were fewer articles from developing and underdeveloped countries than developed countries like the United States and the United Kingdom. Nevertheless, developing countries such as Portugal to Mexico have made significant contributions. Another interesting fact is that there appears to be a relatively low level of research publication from Malaysia to Poland. *Table 2.12* demonstrates the numbers of documents published in the United States, the United Kingdom, and India from 2003 to 2020. The results showed that most papers were published (60%) between 2016 and 2020 as comparing those documents (40%) before 2015. The researcher found only two articles on Six Sigma and Lean management connected to Singapore (See Chapter 1). Thus, there appears to be a gap in the recent literature concerning Lean Thinking practice in the SPHEIs.

Table 2.12 - Number of Documents by Country by Year (Source: Author)

Country	**Year**				**Total**
	<= 2005	**2006 – 2010**	**2011 – 2015**	**2016 – 2020**	**(Per Cent)**
United States	6	7	12	21	46 (50%)
United Kingdom	-	1	11	19	31 (34%)
India	-	-	-	15	15 (16%)
Total	6 (7%)	8 (9%)	22 (24%)	55 (60%)	92 (100%)

2.3.5 Analysis of Documents by Documents Type

The 133 documents were published from six different document types. 65% of papers were published from *Articles*, 22% were from *Conference Papers*, 10% were from *Reviews*, and the remaining 3% were from *Book Chapters*, *Books* and *Editorials,* as shown in *Figure 2.14*.

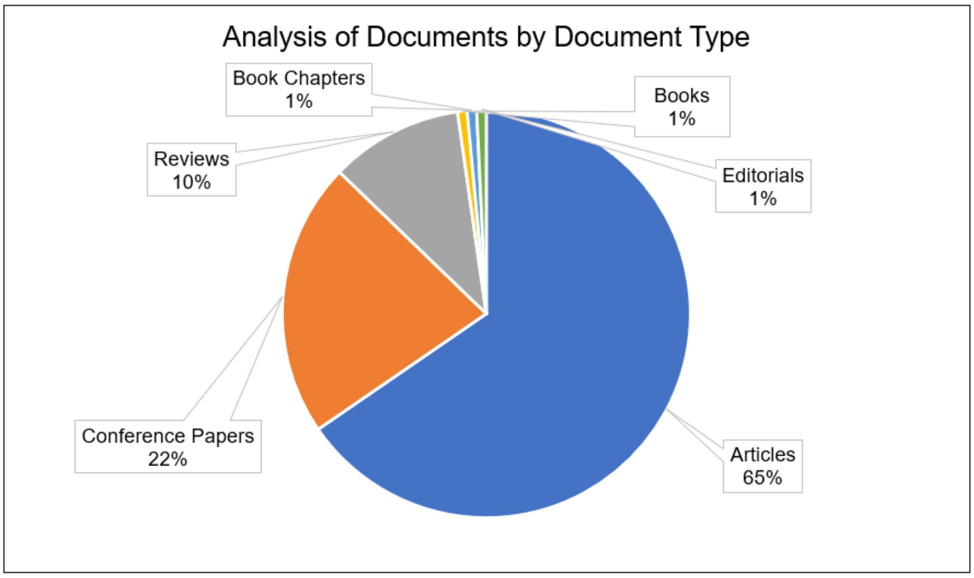


Figure 2.14 - Analysis of Documents by Document Type (Source: Author)

The number of documents published in the research area of Six Sigma, Lean Six Sigma, Lean/Lean Thinking for *Articles*, *Conference Papers* and *Reviews* as presented in *Table 2.13*. The results showed that the highest published documents for Lean/Lean Thinking contributed 55%, followed by Lean Six Sigma (34%) and finally Six Sigma (1%). The analysis shows that research on Lean/Lean Thinking in Higher Education will continue to grow in the coming years.

Table 2.13 - Number of Documents by Document Type by Research (Source: Author)

Document Type	Keywords adopted in the Document Title			Total (Per cent)
	Six Sigma	Lean Six Sigma	Lean/Lean Thinking	
Articles	9	32	46	87 (67%)
Conference Papers	4	4	21	29 (22%)
Reviews	-	8	6	14 (11%)
Total	13 (1%)	44 (34%)	73 (55%)	130 (100%)

2.3.6 Analysis of Documents by Source and Type

The published documents by the journal directly related to Six Sigma, Lean Six Sigma, Lean/Lean Thinking and Higher Education as presented in *Figure 2.15*.

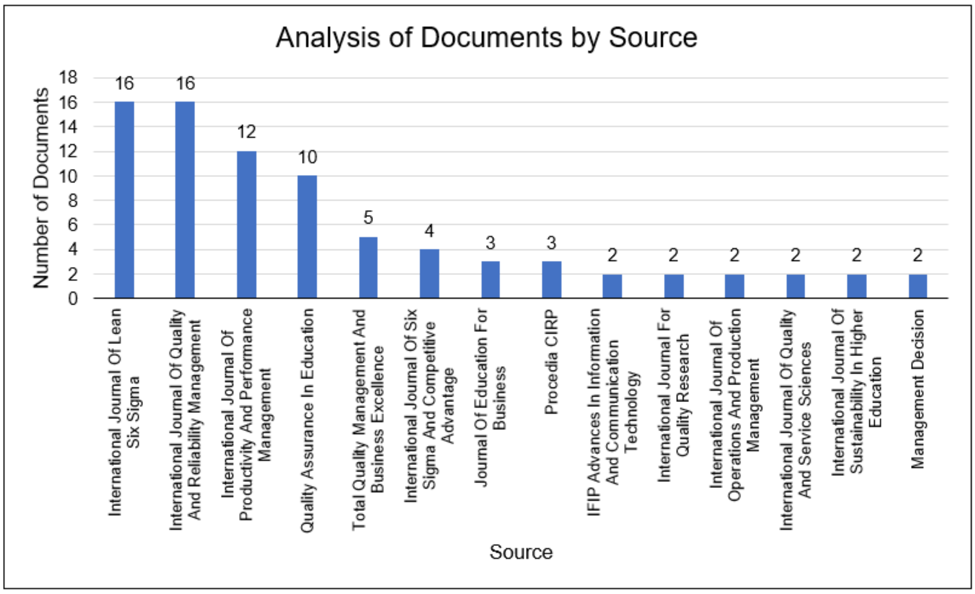


Figure 2.15 - Analysis of Documents by Source (Source: Author)

It has been noted that the "*International Journal of Lean Six Sigma", the "International Journal of Quality and Reliability Management",* the *"International Journal of Efficiency and Performance Management"* and *"Quality Assurance in Education"* are among the first four journals with the highest number of published documents. The "*International Journal of Lean Six Sigma"* and the *"International Journal of Quality and Reliability Management"* have the most papers of 32 in total. *Figure 2.16* shows the analysis of documents based on their source type. There were 103 *"Journal"* papers and 25 "*Conference Proceeding*" papers published as journal source type documents.

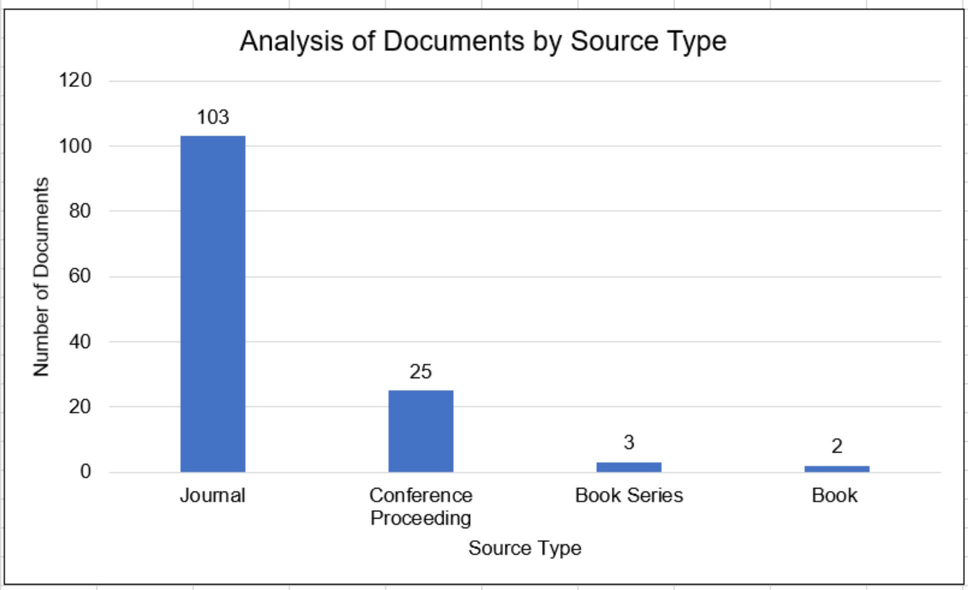


Figure 2.16 - Analysis of Documents by Source Type (Source: Author)

2.3.7 Analysis of Documents by Subject Area

The research subject areas in Six Sigma, Lean Six Sigma, Lean/Lean Thinking in Higher Education are presented in *Figure 2.17*. The most common subject areas are "*Business (Biz), Management (Mgt) and Accounting (Acc)*", which accounted for 34% of published documents. The second most popular subject area is "*Engineering*" with 22% of published documents contribution. The following area, "*Social Sciences, Decision Sciences, Computer Science*", contribute 15%, 13% and 8% of distributed documents, respectively. *Table 2.14* demonstrates the percentage of the documents distributed by subject area by year. The results show a 22% distribution between 2011 and 2015 and a 58% distribution between 2016 and 2020.

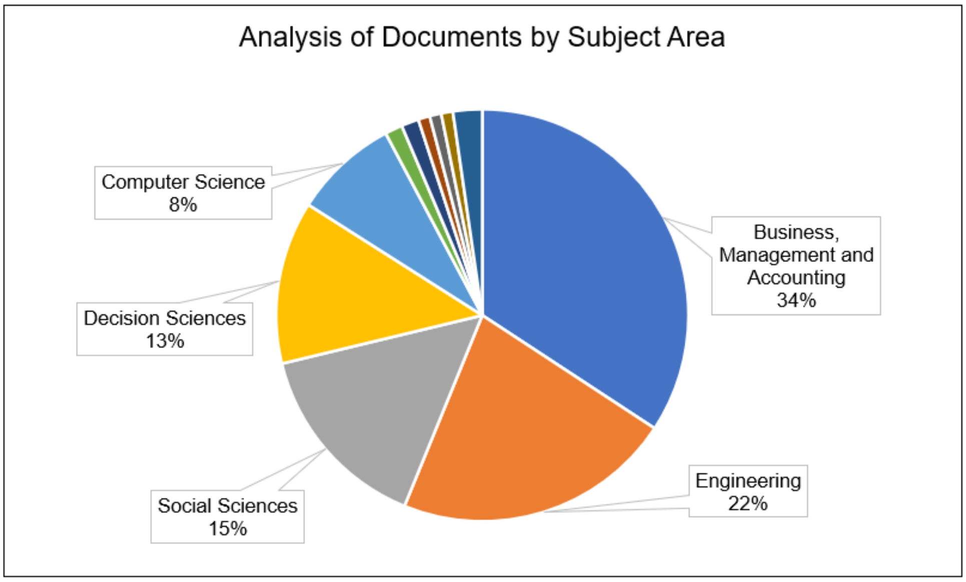


Figure 2.17 - Analysis of Documents by Subject Area (Source: Author)

Table 2.14 - Document distributed by Subject Area by Year (Source: Author)

Subject Area	Year				Total
	<= 2005	2006 – 2010	2011 – 2015	2016 – 2020	
Biz, Mgt and Acc[1]	0.5%	2.5%	9.0%	22.0%	34.0%
Engineering	-	1.0%	6.0%	15.0%	22.0%
Social Sciences	2.5%	2.5%	3.0%	7.0%	15.0%
Decision Sciences	1.0%	1.0%	2.0%	9.0%	13.0%
Computer Science	-	1.0%	2.0%	5.0%	8.0%
Total	4.0%	8.0%	22.0%	58%	92.0%

[1] Biz denoted as Business; Mgt denoted as Management; Acc denoted Accounting

The percentage of the document by subject area by research area and Six Sigma, Lean Six Sigma, Lean/Lean Thinking in Higher Education are presented in *Table 2.15*. Lean Six Sigma and Lean/Lean Thinking have a distribution of 32.5% and 49.0%, respectively.

Table 2.15 - Document Distributed by Subject Area by Research (Source: Author)

Subject Area	Keywords adopted in the Document Title			Total
	Six Sigma	Lean Six Sigma	Lean/Lean Thinking	
Biz, Mgt and Acc[1]	2.0%	17.0%	14.0%	34.0%
Engineering	2.0%	7.0%	13.0%	22.0%
Social Sciences	3.0%	2.0%	10.0%	15.0%
Decision Sciences	0.5%	6.0%	6.5%	13.0%
Computer Science	2.0%	0.5%	5.5%	8.0%
Total	9.5%	32.5%	49.0%	92.0%

[1] Biz denoted as Business; Mgt denoted as Management; Acc denoted Accounting

2.3.8 Analysis of Documents by Author

According to the study, 160 authors contributed to 133 documents on Six Sigma, Lean Six Sigma, Lean/Lean Thinking and Higher Education, with academicians conducting most research. *Figure 2.18* shows the top 25 authors actively working and publishing research on Lean Higher Education. *Antony* is the most productive author in Lean Higher Education research, with 22 documents (See *Table 2.16*), and he is followed by 24 authors (*Cudney, Emiliani, Sunder, Balzer, Comm,* etc.). Two papers were submitted by each of the 19 authors, even though several authors only contributed one document. These findings indicate that Lean Higher Education has a relatively small number of scholars who actively and consistently publish in this field.

Table 2.16 - List of Documents Published by Antony (Source: Author)

Year	Title	Cited by
2020	"A systematic review of Lean and Six Sigma approaches in Higher Education"	10
2020	"Lean Six Sigma for reducing student dropouts in Higher Education–an exploratory study"	7
2020	"Lean Six Sigma and social performance: A review and synthesis of current evidence"	0
2019	"How to use Lean Six Sigma methodology to improve service process in Higher Education: A case study"	1
2019	"A critical perspective on the changing patterns of Lean Six Sigma research"	5
2018	"A conceptual Lean Six Sigma framework for quality excellence in Higher Education institutions"	29
2018	"Lean Six Sigma journey in a UK Higher Education institute: a case study"	19
2017	"Leadership characteristics for Lean Six Sigma"	37
2017	"Lean Six Sigma for public sector organisations: is it a myth or reality? "	28
2017	"Lean Six Sigma: yesterday, today and tomorrow"	62
2017	"Implementing Lean Six Sigma into curriculum design and delivery – a case study in Higher Education"	19
2017	"Lean Six Sigma leadership in Higher Education institutions"	25
2017	"Lean Six Sigma for Higher Education"	11
2016	"Academic leadership and Lean Six Sigma: A novel approach to systematic literature review using design of experiments"	6
2016	"Lean six sigma journey in a UK Higher Education Institute: Challenges, projects, and key lessons learned"	3
2015	"A Lean Six Sigma program in Higher Education"	60
2015	"Waste identification and elimination in HEIs: the role of Lean thinking"	51
2015	"A comparative study of Lean implementation in higher and further education institutions in the UK"	25
2015	"Challenges in the deployment of LSS in the Higher Education sector: viewpoints from leading academics and practitioners"	25
2014	"Readiness factors for the Lean Six Sigma journey in the Higher Education sector"	101
2014	"Critical failure factors of lean Six Sigma: A systematic literature review"	188
2012	"Lean Six Sigma for Higher Education institutions (HEIs): Challenges, barriers, success factors, tools/techniques"	128

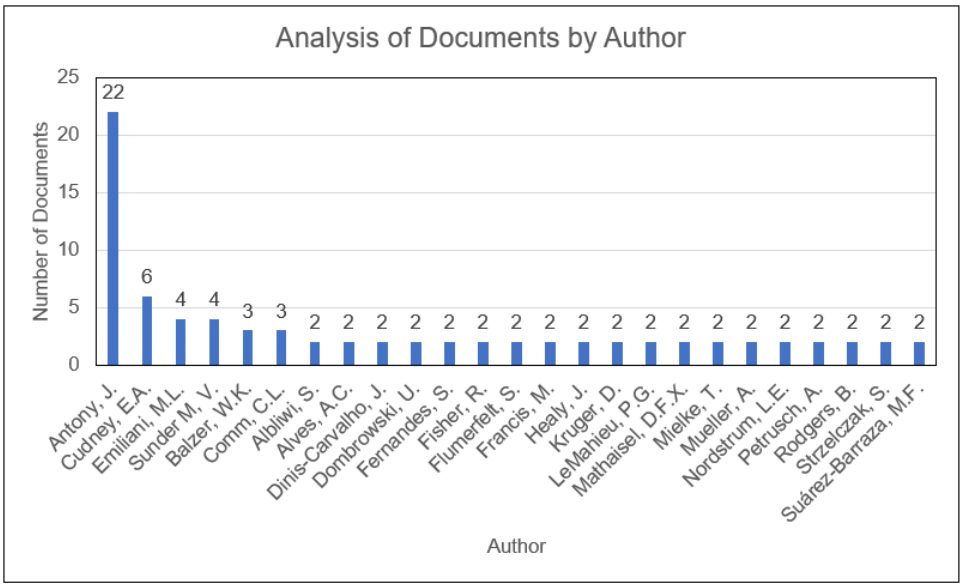


Figure 2.18 - Analysis of Documents by Author (Source: Author)

2.3.9 Analysis of Documents by Affiliation

Affiliated authors represent 226 institutions in the 133 documents on Six Sigma, Lean Six Sigma, Lean/Lean Thinking, and Higher Education analysed in this study. *Figure 2.19* lists the universities that appear to be the most engaged in this field of research. The contribution of universities to the publication of papers ranges from one and nineteen. It has been noted that "*Heriot-Watt University (Edinburgh Campus)*" has contributed the most documents, with 19 publications. Six universities, with 4 to 6 papers, namely "*Missouri University of Science and Technology*", "*Indian Institute of Technology Madras*", "*Universidade do Minho*", "*Rensselaer at Hartford Campus*", "*Oakland University*", *the* "*University of Strathclyde*", follow closely. Besides, nine universities contributed three documents, and 16 universities contributed two documents. Also, one paper was contributed by 119 universities (not listed). This analysis provides information about leading universities, "*Heriot-Watt University (Edinburgh Campus)*" one of them, working on different issues of Six Sigma, Lean Six Sigma, Lean/Lean Thinking and Higher Education as shown in *Table 2.17*.

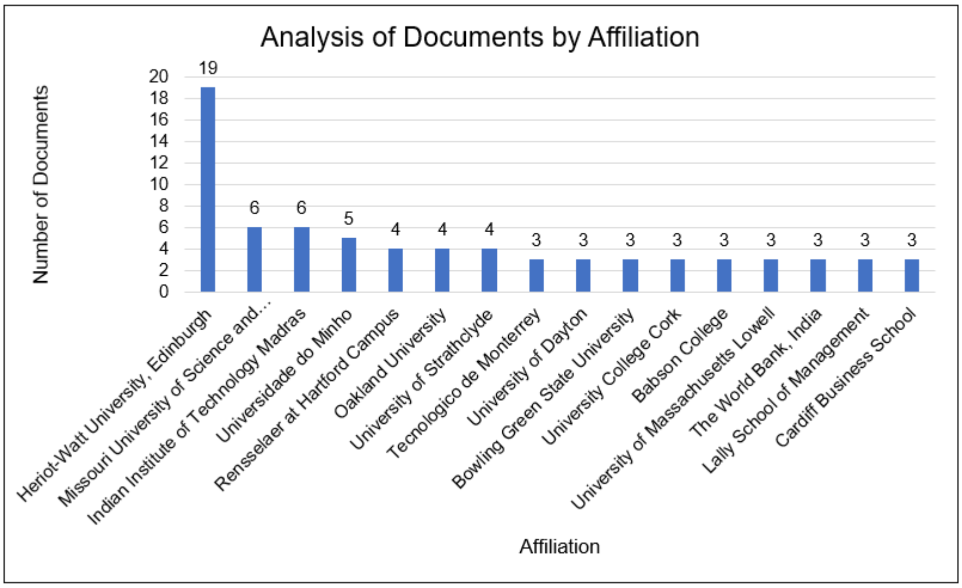


Figure 2.19 - Analysis of Documents by Affiliation (Source: Author)

Table 2.17 - List of Documents by Heriot-Watt University (Source: Author)

Year	Title	Authors
2020	"A systematic review of Lean and Six Sigma approaches in Higher Education"	"Cudney E.A., Venuthurumilli S.S.J., Materla T., Antony J. "
2020	"Lean Six Sigma for reducing student dropouts in Higher Education– an exploratory study"	"Gupta S.K., Antony J., Lacher F., Douglas J. "
2020	"Lean Six Sigma and social performance: A review and synthesis of current evidence"	"Sony M., Naik S., Antony J. "
2019	"How to use lean Six Sigma methodology to improve service process in Higher Education: A case study"	"Li N., Laux C.M., Antony J. "
2019	"A critical perspective on the changing patterns of Lean Six Sigma research"	"Rodgers B., Antony J., Gupta S. "
2018	"A conceptual Lean Six Sigma framework for quality excellence in Higher Education institutions"	"Sunder M V., Antony J. "
2018	"Lean Six Sigma journey in a UK Higher Education institute: a case study"	"Antony J., Ghadge A., Ashby S.A., Cudney E.A. "
2017	"Leadership characteristics for Lean Six Sigma"	"Laureani A., Antony J. "
2017	"Lean Six Sigma for public sector organisations: is it a myth or reality? "	"Antony J., Rodgers B., Cudney E.A. "
2017	"Implementing Lean Six Sigma into curriculum design and delivery – a case study in Higher Education"	"Thomas A., Antony J., Haven-Tang C., Francis M., Fisher R. "
2017	"Lean Six Sigma leadership in Higher Education institutions"	"Lu J., Laux C., Antony J. "
2017	"Lean Six Sigma for Higher Education"	"Antony J. "
2016	"Academic leadership and Lean Six Sigma: A novel approach to systematic literature review using design of experiments"	"Anthony S., Antony J. "
2016	"Lean six sigma journey in a UK Higher Education Institute: Challenges, projects, and key lessons learned"	"Antony J., Cudney E.A. "
2015	"A Lean Six Sigma program in Higher Education"	"Svensson C., Antony J., Ba-Essa M., Bakhsh M., Albliwi S. "
2015	"Waste identification and elimination in HEIs: the role of Lean thinking"	"Douglas J.A., Antony J., Douglas A. "
2015	"A comparative study of Lean implementation in higher and further education institutions in the UK"	"Thomas A.J., Antony J., Francis M., Fisher R. "
2015	"Challenges in the deployment of LSS in the Higher Education sector: viewpoints from leading academics and practitioners"	"Antony J. "
2014	"Critical failure factors of lean Six Sigma: A systematic literature review"	"Albliwi S., Antony J., Lim S.A.H., van der Wiele T. "

2.3.10 Analysis of Documents by Keywords

The analysis of documents by keywords is shown in *Figure 2.20*. The primary keywords used in the papers are *Higher Education (48 counts)*, *Lean/Lean Thinking (37 counts), Lean Six Sigma (32 counts)* and *Six Sigma (32 counts)*. The keyword *Lean/Lean Thinking* has the second-highest count in the documents. The number of papers by keyword distributed by years is shown in *Table 2.18*. The findings revealed that the research for Six Sigma, Lean Six Sigma, Lean/Lean Thinking and Higher Education rose from 2016 to 2020.

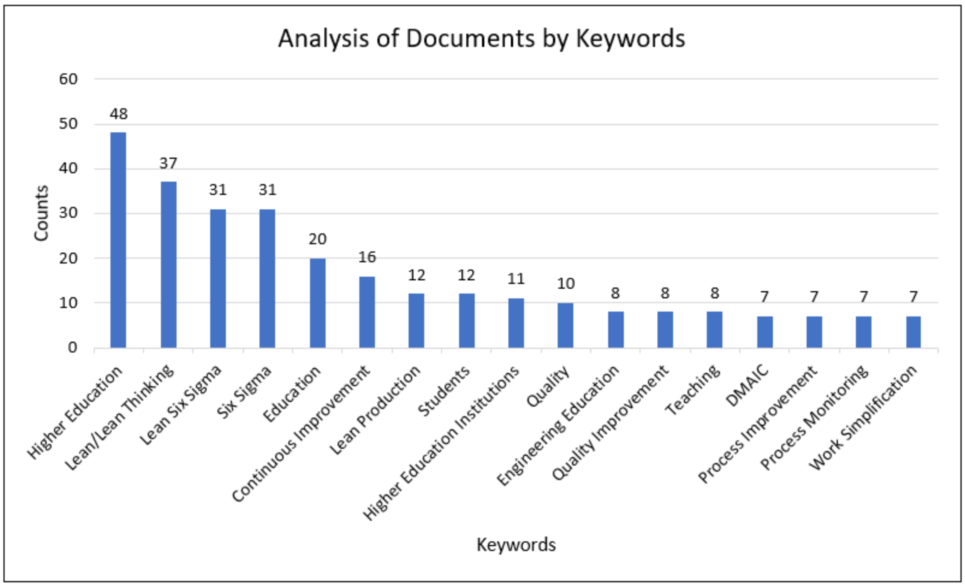


Figure 2.20 - Analysis of Documents by Keywords (Source: Author)

Table 2.18 - Number of Document by Keywords by Year (Source: Author)

Keywords	Year				Total	Per cent
	<= 2005	2006 – 2010	2011 – 2015	2016 – 2020		
Higher Education	2	2	13	29	48	33%
Six Sigma	-	4	5	22	31	21%
Lean Six Sigma	-	-	6	26	31	21%
Lean/Lean Thinking	-	2	11	24	37	25%
Total	2 (1.5%)	8 (5.5%)	35 (24%)	101 (69%)	147	100%

2.3.11 Analysis of Documents by Citation

It is a citation overview for a subset set of 133 documents, as shown in *Table 2.19*. Albliwi *et al.* (2014) are the authors with the highest number of 185 citations. Figueiró and Raufflet (2015) published the most relevant article: "*Sustainability in Higher Education: A systematic review with a focus on management education*", with the second-highest number of 136 citations. The third-highest number of citations goes to Antony *et al.* (2012) have 127 citations for their article: "*Lean Six Sigma for Higher Education institutions (HEIs): Challenges, barriers, success factors, tools/techniques*".

Table 2.19 - Analysis of Document by Citation (Source: Author)

Authors	Journal Title	<2017	2017	2018	2019	2020	Total
"Albliwi S., Antony J., Lim S.A.H., van der Wiele T."	"Critical failure factors of lean Six Sigma: A systematic literature review"	15	21	35	61	53	185
"Figueiro P.S., Raufflet E. "	"Sustainability in Higher Education: A systematic review with a focus on management education"	7	29	32	34	34	136
"Antony J., Krishan N., Cullen D., Kumar M. "	"Lean Six Sigma for Higher Education institutions (HEIs): Challenges, barriers, success factors, tools/techniques"	29	11	22	32	33	127
"Antony J. "	"Readiness factors for the Lean Six Sigma journey in the Higher Education sector"	16	10	16	31	29	102
"Comm C.L., Mathaisel D.F.X. "	"A case study in applying lean sustainability concepts to universities"	45	8	8	13	12	86
"Emiliani M.L. "	"Improving business school courses by applying lean principles and practices"	40	10	7	15	12	84
"Suarez-Barraza M.F., Smith T., Dahlgaard-Park S.M. "	"Lean service: A literature analysis and classification"	32	7	16	12	12	79
"Emiliani M.L. "	"Using kaizen to improve graduate business school degree programs"	33	8	9	15	13	78
"Gupta S., Sharma M., Sunder M V. "	"Lean services: a systematic review"	0	3	18	31	22	74
"Dombrowski U., Mielke T. "	"Lean leadership -15 rules for a sustainable lean implementation"	16	13	12	16	14	71
"Hines P., Lethbridge S. "	"New development: Creating a lean university"	38	3	7	14	8	70
"Dombrowski U., Mielke T. "	"Lean Leadership - Fundamental principles and their application"	19	10	10	18	12	69
"Yadav G., Desai T.N. "	"Lean Six Sigma: a categorised review of the literature"	1	3	9	30	23	66
"Antony J., Snee R., Hoerl R. "	"Lean Six Sigma: yesterday, today and tomorrow"	0	0	6	21	33	60
"Raja Sreedharan V., Raju R. "	"A systematic literature review of Lean Six Sigma in different industries"	0	1	16	14	28	59
"Svensson C., Antony J., Ba-Essa M., Bakhsh M., Albliwi S. "	"A Lean Six Sigma program in Higher Education"	2	4	14	20	19	59
"Samuel D., Found P., Williams S.J. "	"How did the publication of the book The Machine That Changed The World change management thinking? Exploring 25 years of lean literature"	6	14	9	18	13	60
"Danese P., Manfe V., Romano P. "	"A Systematic Literature Review on Recent Lean Research: State-of-the-art and Future Directions"	0	0	3	21	29	53
"Sunder V.M., Ganesh L.S., Marathe R.R. "	"A morphological analysis of research literature on Lean Six Sigma for services"	0	0	2	23	30	55
"Jenicke L.O., Kumar A., Holmes M.C. "	"A framework for applying six sigma improvement methodology in an academic environment"	30	6	3	4	10	53
"Maleyeff J. "	"Exploration of internal service systems using lean principles"	37	3	3	4	4	51
"Douglas J.A., Antony J., Douglas A. "	"Waste identification and elimination in HEIs: the role of Lean thinking"	2	5	12	14	17	50
"Abu Bakar F.A., Subari K., Mohd Daril M.A. "	"Critical success factors of Lean Six Sigma deployment: a current review"	0	2	11	15	18	46
"Comm C.L., Mathaisel D.F.X. "	"Less is more: A framework for a sustainable university"	24	8	5	7	3	47

Authors	Journal Title	<2017	2017	2018	2019	2020	Total
“Vijaya Sunder M. ”	“Lean Six Sigma in Higher Education institutions”	1	3	9	14	13	40
“Laureani A., Antony J. ”	“Leadership characteristics for Lean Six Sigma”	0	1	12	11	12	36
“Doman M.S. ”	“A new lean paradigm in Higher Education: A case study”	13	5	4	9	7	38
“Comm C.L., Mathaisel D.F.X. ”	“An exploratory study of best lean sustainability practices in Higher Education”	17	1	5	8	6	37
“Thirkell E., Ashman I. ”	“Lean towards learning: connecting Lean Thinking and human resource management in UK Higher Education”	6	3	3	16	6	34
“Mostafa S., Lee S.-H., Dumrak J., Chileshe N., Soltan H. ”	“Lean thinking for a maintenance process”	1	4	5	9	14	33
“Balzer W.K., Brodke M.H., Thomas Kizhakethalackal E. ”	“Lean Higher Education: successes, challenges, and realising potential”	1	2	3	14	11	31
“Emiliani M.L. ”	“Is management education beneficial to society? ”	26	2	0	3	0	31

2.4 Chapter Summary

This chapter presented a bibliometric analysis of Lean Higher Education and the research agenda. The researcher has clearly defined the process of searching, inclusion and exclusion criteria for articles. The study adopted Scopus analysis tools to analyse the Lean Higher Education knowledge base documents by years, countries, subject areas, source and type, authors, affiliation, keywords, and citations. A total of 133 papers found in the Scopus database published between 2003 to 2020 were studied. The survey identified 160 authors from 41 countries and 133 journals. The bibliometric techniques is to optimise the process of literature selection. The research uncovered the most cited articles and the presence of keywords in the titles and abstracts of the publications.

Regarding the bibliometric rules, the researcher identified the following observations in the current study:

- Bradford’s law enabled the identification of the most critical periodicals that represent the heart of the research. They are the “*International Journal of Lean Six Sigma”,* the *“International Journal of Quality and Reliability Management”,* the *“International Journal of Productivity and Performance Management”,* and “*Quality Assurance in Education”*.
- Lotka’s law revealed that 25 authors actively engaged in conducting and publishing research related to Lean Higher Education.
- A simplified method of Zipf’s law was used to analyse the frequency of the keywords. The highlighted keywords are associated with Lean Higher Education approaches.

Two literature review questions are proposed in this study. These questions have been grouped and analysed as follow:

LRQ1: What is the distribution of documents across the years, countries, subject area, and document types in the Lean Higher Education knowledge base?

- **Documents by Years**
  Provided a quantitative analysis of Lean Higher Education publications in 2015, 2017 and 2019, indicating an increasing emphasis on Lean Six Sigma (38%) and Lean/Lean Thinking (58%) in Higher Education. This specific Lean/Lean Thinking trend in the number of journal papers published may continue to rise in the coming years.
- **Documents by Countries**
  The most research contribution was from the United States (50%), the United Kingdom (34%), and India (16%) up to 2020. There was less research in this area from developing and underdeveloped countries. The researcher found two papers about Six Sigma and Lean management published in Singapore (See *Figure 2.13*). Ho *et al.* (2006) showed that the Six Sigma framework provides an excellent platform for infusing statistical education into the engineering curriculum with some fundamental issues and challenges. Tay, H.L., Low (2017) applied Lean management principles to provide a holistic view of the process transformations in using digital innovation in the Higher Education context. Thus, there appears to be a gap in the recent literature concerning Lean Thinking practice in the SPHEIs, and it shows a link to the main RQs (See Chapter 1).
- **Documents by Subject Area**
  The most common subject area was *Business, Management and Accounting* (34%) and *Engineering* (22%) with published documents contribution. Lean Six Sigma and Lean/Lean Thinking have a distribution of 32.5% and 49.0%, respectively, by subject area.
- **Documents by Document Type**
  The most common document types were *Articles* (67%) and *Conference Papers* (22%). The results showed that the highest published documents were for Lean/Lean Thinking (55%) and Lean Six Sigma (34%). The analysis shows that research on Lean/Lean Thinking in Higher Education will continue to grow in the coming years.

LRQ2: What are the sources and types, authors, affiliation, keywords, and citations that have the most significant influence on Lean Higher Education research?

- **Documents by Source and Type**

  The "*International Journal of Lean Six Sigma"* and *"International Journal of Quality and Reliability Management" have* the highest number of published documents. There were 103 "*Journal"* papers and 25 "*Conference Proceeding*" papers published as journal source type documents.

- **Documents by Authors**

  The top 25 authors have actively conducted and published research on Lean Higher Education. *Antony* is the most productive author in Lean Higher Education research, with 22 documents, and he is followed by 24 authors (*Cudney, Emiliani, Sunder, Balzer, Comm and others*). These findings indicate that Lean Higher Education has a relatively small number of scholars who actively and consistently publish in this field.

- **Documents by Affiliation**

  It noted that *Heriot-Watt University (Edinburgh Campus)* had contributed the most documents of the 226 institutions working on different issues of Six Sigma, Lean Six Sigma, Lean/Lean Thinking, and Higher Education.

- **Documents by Keywords**

  The primary keywords used in the documents are *Higher Education*, *Lean/Lean Thinking, Lean Six Sigma* and *Six Sigma*. The keyword *Lean/Lean Thinking* has been used many times in the documents. The findings revealed that the research for Six Sigma, Lean Six Sigma, Lean/Lean Thinking and Higher Education has risen from 2016 to 2020.

- **Documents by Citations**

  Albliwi *et al.* (2014) are the authors with the highest number of 185 citations for their article" "Critical failure factors of lean Six Sigma: A systematic literature review".

The goal of bibliometric techniques is to assist the public and private Higher Education Institutes (HEIs) understand the importance of Lean Thinking in adding value to customers ("students") while reducing waste in administrative and academic processes. The bibliometric analysis also provided background information on trends, key topics, active research, and informed other study activities in this thesis. The LRQ1 provided the distribution of documents in the Lean Higher Education knowledge base, whereas LRQ2 observed the most significant influence on Lean Higher Education research. Both LRQs may not have a direct relationship to RQs, and however, a reasonable correlation between RQ1 and RQ2 and the first two LRQs. The first two research questions focused on “what”, whereas RQ3 and RQ4 asked about “how”. The bibliometric analysis contributes to identifying “what” research focus areas and concepts are present within the field of Lean Higher Education.

The use of bibliometric analysis was appropriate for the scope of this study, and the literature reviews have identified several key trends of published documents. As a practical contribution, the findings revealed that Six Sigma, Lean Six Sigma, Lean/Lean Thinking, and Higher Education are the most significant areas. The researcher found two papers about Six Sigma and Lean management published in Singapore. On the other hand, the research findings were published primarily in publications related to Higher Education, rather than in the Lean journal, which reflects a growing interest of researchers in Higher Education, rather than just the current Lean practitioners and researchers.

The limitations involved analysing the results, selecting a specific database, and a particular search equation in a bibliometric study. On the other hand, the researcher did not evaluate the content quality of the chosen articles but instead conducted a descriptive-quantitative analysis of the works related to Lean Higher Education that was present in Scopus. Other sources relevant to the research were not investigated because the search for publications was restricted to the Scopus database. As a suggestion for future research, it is suggested that this work be expanded to include other databases and bibliometric analysis of other Higher Education activities.

Chapter 3 – Literature Review

3 Literature Review

3.1 Introduction

Lean is now a well-known term that refers to process improvement, waste elimination and cost reduction. Lean is defined as a continuous improvement strategy to increase customer value by reducing waste in all business processes and products (Douglas *et al.*, 2015). Lean is based on two concepts: respect for people and continuous improvement (Emiliani, 2015), and it has five principles: "Identify Value; Map the Value Stream; Create Flow; Establish Pull and Seek Perfection" (Thangarajoo and Smith, 2015). *Identify Value* is defined as something that a customer is willing to pay for anything. It is also something that the customer needs and thus expects products or services from the provider of product and service (Balzer, 2010; Thangarajoo and Smith, 2015; Balzer, 2020). *Waste* means any activity or feature that does not value the customer's products or services. Lean focuses on reducing waste (Kang and Manyonge, 2014; Balzer, 2010; Li *et al.*, 2019; Balzer, 2020). This chapter presents a thorough review of significant themes in the literature on Lean and Higher Education (See *Figure 3.21*). The origin and gradual evolution of Lean are explained. The foundation of Lean is then explored in greater depth by studying how Lean can apply to the service operation, particularly in the education sector (Balzer, 2010; 2020). Following that, a theoretical framework of the literature review guides the specific research gap presented. Finally, the research gap regarding Lean Thinking practice to improve CP&DP for SPHEIs is discussed to determine the dissertation's empirical focus.

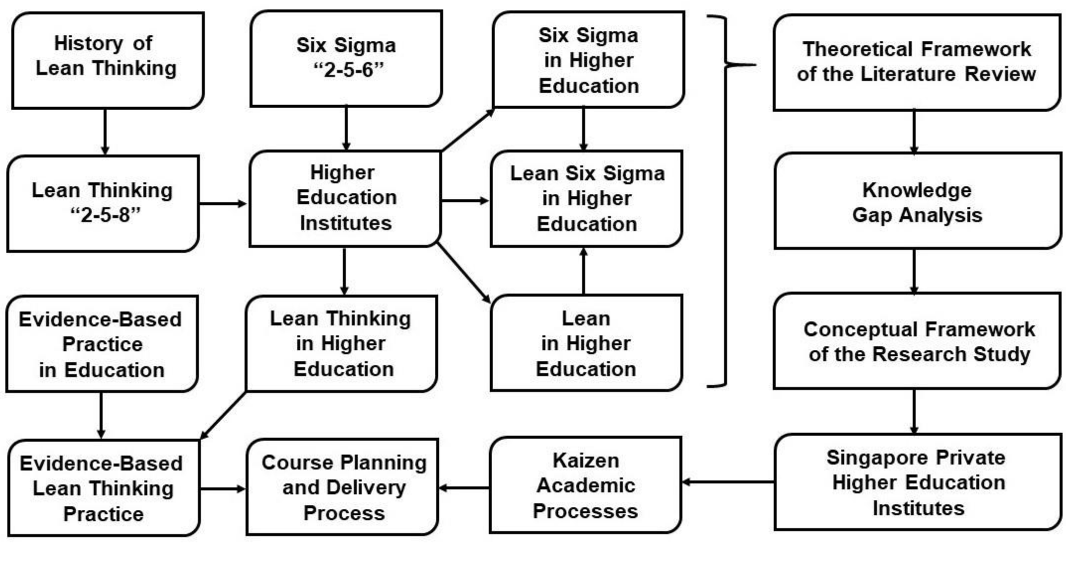


Figure 3.21 - Literature Review Key Themes (Source: Author)

3.2 History of Lean Thinking

The origins of Lean Thinking can be traced back to the 16th century. The Venetian Arsenal in Venice, Italy, started using an assembly line to manufacture boats. It could be the first historical example of flow production, an essential concept of Lean Thinking (Charron *et al.*, 2014).

In 1908, Henry Ford, the most refined car manufacturer, introduced the Model T (Shook, 2020). A modular car built using interchangeable parts. This innovation enabled Ford to pioneer flow production in his Highland Park plant in 1913. By placing fabrication equipment in the process sequence, Ford Motor Company produced cars faster, more effectively, and efficiently using a moving assembly line. In 1926, Henry Ford added product variety to the manufacturing process and introduced mass production. Ford was able to automate the flow of materials via miles of conveyor belts, and the final assembly line was rolled out to fifty more manufacturing plants worldwide (Charron *et al.*, 2014; Antony *et al.*, 2017).

During the 1930s, W Edwards Deming (Thangarajoo and Smith, 2015) created a process of undertaking continuous improvement known as the Plan-Do-Check-Act (PDCA) cycle (Maguad, 2007; Azim Khairi and Rahman, 2018). Deming was able to teach the PDCA cycle, the value of statistics and other quality improvement methods to Japanese businesses after World War II. Through this, Deming made a significant contribution to Japan's later reputation for innovative, high-quality products, and its economic power grew as a result (Charron *et al.*, 2014).

Throughout the 1960s, the Toyota Motor Company gradually developed a management system based on Lean Principles. Taiichi Ohno (Kedem, 2010; Charron *et al.*, 2014) turned the Toyota Production System (TPS) (Kedem, 2010; Shook, 2020) into an integrated framework focusing on problem-solving, leadership, production operations, supply collaboration, product and process development and customer support. Ohno developed a new perspective on just-in-time production when he visited the United States in 1956. He saw automobile plants in the United States, but he was most impressed by his encounters with American supermarkets. At that time, Japan did not have many self-service stores. Ohno was impressed by the strong customer focus and the simple, efficient, and timely access to merchandise. It was a format driven by customer demand rather than production.

In 1990, the term Lean was coined in Jim Womack's book *The Machine That Changed the World: The Story of Lean Production* (Womack *et al.*, 2007). Womack and his co-authors explained the fulfilment, product design, supply management, customer support and global management system pioneered by the best Japanese companies. Backed up by extensive evidence, the book demonstrated the competitive superiority of the Japanese system when compared to the European and North American auto industries.

Lean Thinking is a way of creating needed value with fewer resources and less waste. Lean is a practice consisting of continuous experimentation to achieve excellent value with zero waste. While Lean Thinking originated in the manufacturing industry, it has also proven effective in the service sector. Over the last 40 years, businesses and public sector organisations have used Lean to improve customer service and reduce operating costs. Lean thinking and practice occur together (Shook, 2020).

3.3 What is Lean Thinking?

3.3.1 Background

The first book, "*Lean Thinking: Banish Waste and Create Wealth in Your Corporation"* by Womack and Jones, expands on these concepts to serve as a rallying call for today's business leaders (Womack and Jones, 2003). In the second book, "*The Machine That Changed the World*", Womack and Jones demonstrated how organizations might drastically enhance their performance by adopting Toyota's "lean production" methodology (Womack *et al.*, 2007). In their books, Womack and Jones defined the five values "values, value stream, pull, flow and perfection" of Lean. Womack and Jones enable Lean manufacturing ideas to be used across industries by abstracting these values, which is what happened. The authors demonstrated a fundamental concept that can revitalize any business. Lean Thinking offers a new way of thinking (Shook, 2020). Lean thinking is a revolutionary mindset required in today's rapidly changing business world (Womack and Jones, 2003; Charron *et al.*, 2014; Thangarajoo and Smith, 2015).

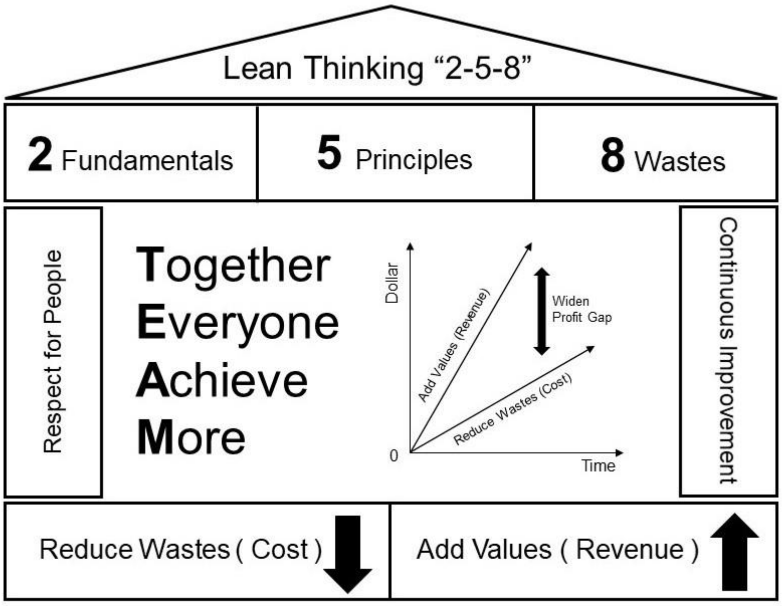
Lean is about maximizing customer value while minimising time, resources, energy, and effort. It is based on Purpose, Process, and Respect for People (Shook, 2020). Understanding what happens at value creation, improving how products and services are developed and delivered, and empowering people via problem-solving and coaching are all part of a lean approach to work. Lean Thinking practice assists the organisation in becoming both innovative and competitive, allowing them to become sustainable (Shook, 2020).

Lean is now a new, more effective way of doing work, regardless of the type of work, industry, or organisation size (Shook, 2020). Problems are considered opportunities for significant learning in a Lean organization, rather than errors to be pushed under the rug or resolved quickly. Managers function as coaches, guiding others through identifying problems and putting daily continuous improvement practices in place. Leadership entails developing a management system to promote a new engagement with the actual work at hand, not how everyone and every team wants to be doing it in the future. Start making things better through Lean today (Shook, 2020).

According to Shook (2020), the fundamental keys to Lean success do not lie in mastering tools and procedures, systems, or even “principles”. Lean urges employees at all levels of an organization to re-think services from the customer's perspective, reducing the non-value-adding process steps and emphasizing the most value-adding efforts. It gets into basic thinking, the thinking that everyone brings to each task, each team to each challenge, and the organization's goals.

3.3.2 Lean Thinking is “2-5-8”

The TPS (Kedem, 2010; Shook, 2020) is the most well-known application of Lean processes. TPS is founded on "Lean" principles such as a customer-centric approach, continuous improvement and quality through waste reduction, and tightly integrated upstream and downstream processes. TPS theory represents a house (Liker and Morgan, 2006). Every house consists of three major components. The first is a foundation base, the second is walls or pillars, and the third is the roof. The base represents stability; the more robust it is, the more stable the company is. The walls or pillars represent the basic principles, methods, and tools to produce or provide service to the customers. The roof is what the company should focus on striving. All house parts have significance and can be related to the company (Fekete and Hulvej, 2014). Lean Thinking aims to create a new way of thinking in business methodology about structuring human operations so that customers receive more significant benefits and value while reducing waste. *Figure 3.22* illustrates the Toyota House as Lean Thinking “2-5-8”.



Source: Adapted from Liker and Morgan (2006); Fekete and Hulvej (2014)

Figure 3.22 - Toyota House as Lean Thinking “2-5-8”

Lean Thinking is based on two (2) fundamentals, five (5) principles and eight (8) wastes, as demonstrated in *Table 3.20* below:

Table 3.20 - Lean Thinking “2-5-8” (Source: Author)

2 - Fundamentals (Emiliani, 2015)	**5 - Principles** (Womack and Jones, 2003)	**8 - Wastes** (Womack and Jones, 2003)
• Respect for People • Continuous Improvement	• Value • Value Stream • Flow • Pull • Perfection	• **D**efects • **O**ver-Production • **W**aiting • **N**on-Talented People • **T**ransportation • **I**nventory • **M**otion • **E**xtra-Processing

3.3.3 Lean Thinking - Two (2) Fundamentals

The Toyota Motor Corporation established Lean, a management style that emphasises “Respect for People” and “Continuous Improvement” as essential pillars. Emiliani (2015) quoted: “Respect for People enables Continuous Improvement, and Continuous Improvement does not enable Respect for People.” Emiliani (2015) explained that “Respect for People” involves recognising and appreciating the value of each individual and what they provide to the team. Next, create and maintain an environment where it is safe to communicate worries and problems, knowing that others will listen. Third, a problem-solving mindset and being open to other people's ideas and challenging one another to improve. According to Robinson and Yorkstone (2014), “Respect for People” was defined by Toyota as comprising two elements: respect and teamwork. The reasons are: people are the most potent assets; the process is all about people behaving; nothing works without people; people are all different; no one person knows everything; one cannot do everything. However, “Respect for People” does not mean agreement and compromise. It involves all people in decision making, asking for and valuing the views of others, understanding that people know what works well and what needs improvement.

“Continuous Improvement” can be highly abstract if not embedded in specific content. It assists in identifying potential for work process improvements and waste reduction. It is a never-ending strive for perfection in all areas known as Kaizen. The Kaizen principle is a Japanese term that emphasises the continuous improvement process at work. *Kai* is to take apart and make new. *Zen* is a way of thinking or becoming enlightened. Kaizen uses small incremental changes that involve everyone when applied to the workplace. Then Kaizen process entails establishing and implementing the PDCA cycle (Maguad, 2007; Azim Khairi and Rahman, 2018). Kaizen signifies “working smarter together” and “developing best practices” to ensure the workers' well-being. Kaizen benefits include reduced cost by offering small rewards; increased and improved quality by reducing errors; managing different types of people; increasing staff morale and productivity; and implementing big ideas through small but consistent actions. Robinson and Yorkstone (2014) claimed that the internal and external environments are constantly changing; customers needs are always evolving; everything can and must get better. Therefore the learning organisation can adjust to changes in the operation context by implementing the PDCA improvement cycle. Amaro *et al.* (2019) conducted a comprehensive review of case studies and surveys published between 1990 and 2018 describing Lean Production/Thinking implementations in different countries. The results showed that Lean Thinking is a natural global and transversal approach to improving all industries and services performance.

3.3.4 Lean Thinking - Five (5) Principles

- Define the *Value*

  The first Lean Principle *defines the value* (Balzer, 2016; 2020). Value is the willingness of a customer to pay for anything, and the concept of value is crucial. Customers may be unsure of what they want or cannot articulate it. Qualitative and quantitative methods are used to determine what customers want, how they want their products or services supplied, and how much they can spend (Emiliani, 2004a; Tatikonda, 2007; Thangarajoo and Smith, 2015).

- Identify the *Value Stream*

  Identify the value stream (Balzer, 2016; 2020) maps the second Lean Principle. Using the customer's value as a guide, identify all the activities that add to the customer's value. A movement is a waste if it does not bring value. There are two types of wastes: A necessary but non-value-added activity should be reduced as much as possible, whereas if it is unnecessary, it should be eliminated. In this way, customers get what they want while simultaneously reducing that product and services' production cost (Emiliani, 2004a; Tatikonda, 2007; Brouwer-Hadzialic and Wiegel, 2016).

- Make value *Flow*

  Make value flow (Balzer, 2016; 2020) stage guarantees that the process runs without interruptions or delays after removing the waste from the value stream. Breaking down procedures, levelling the workload, and redesigning the process steps are some ways for ensuring that value-adding activities run smoothly (Emiliani, 2004a; Tatikonda, 2007; Thangarajoo and Smith, 2015).

- *Pull* system

  The *pull system* (Balzer, 2016; 2020) aims to ensure that the necessary materials and information are available for the smooth flow of the process. A pull system allows just-in-time delivery for the right amount of quantities. The products or services produced will satisfy customer needs from the pull system if the value stream is followed and worked backwards through the system. (Emiliani, 2004a; Tatikonda, 2007; Thangarajoo and Smith, 2015).

- Pursuing *Perfection*

  The fifth and the most critical Lean Principle is *pursuing perfection* (Balzer, 2016; 2020). The principle incorporates continuous process improvement into the organisation's culture. Every employee should strive for perfection when delivering products or services based on customers' needs. In a Lean learning environment, the organisation always finds a way to improve daily (Emiliani, 2004a; Tatikonda, 2007; Thangarajoo and Smith, 2015).

3.3.5 Lean Thinking - Eight (8) Wastes

- *Defects*

  When a product or service is not fit for use, it is called a *defect* (Alzahrani, 2021). As a result, it requires reworking or scrapping. Thus, these are wastes because they increase operating costs while offering little value to customers. There are four different types of defect countermeasures available. First, determine the most common fault and fix it as quickly as feasible. Second, no defective items or services should be allowed to pass through the process. Third, rework the procedure so that it does not result in defects. Finally, standardise work to guarantee that the process is consistent and error-free (Douglas *et al.*, 2015; Mostafa *et al.*, 2015; Höfer and Naeve, 2017). The *defect* is one of the Assets Wastes (Balzer, 2016; 2020) (See Chapter 6).

- *Over-Production*

  In manufacturing, *over-production* (Alzahrani, 2021) refers to producing more products than are required. Furthermore, overproduction of a product results in the effect produced being more than customer demand. Applying a single-piece flow, pull, or Kanban system to control the amount of work-in-progress as the countermeasures for overproduction. In the office environment, overproduction could include useless information, extra copies of materials, and providing a service before the customer is ready (Douglas *et al.*, 2015; Mostafa *et al.*, 2015; Höfer and Naeve, 2017). *Over-production* is one of the Information Wastes (Balzer, 2016; 2020) (See Chapter 6).

- *Waiting*

  Inconsistencies in the process frequently cause *waiting* (Alzahrani, 2021) time. In the office, waiting for people to respond to emails, waiting for papers to review, unproductive meetings, and waiting for the computer to load a program are all things that happen at the workplace (Douglas et al., 2015; Mostafa et al., 2015; Höfer and Naeve, 2017). In production, waiting for materials, proper start-up instructions, suitable equipment, or insufficient operation capacity are all examples of waiting. Thus, standardising job instructions, single-piece flow or levelling processes, and producing flexible multi-skilled people are effective waiting countermeasures. *Waiting* is one of the People Wastes (Balzer, 2016; 2020) (See Chapter 6).

- *Non-Talented People*

  Staff underutilisation (Alzahrani, 2021) and intellect have been regarded as this waste. The people who perform the work are the best at detecting issues and solutions. It is impossible to improve processes if the company does not tap into the knowledge and skills of employees. Workers that are poorly taught, use the wrong tool for the job, do not suggest ideas to better the work, and placed in positions that are below their talents and qualifications are examples of *non-talented* waste (Douglas *et al.*, 2015; Mostafa *et al.*, 2015; Höfer and Naeve, 2017). *Non-Talented People* also belong to People Wastes (Balzer, 2016; 2020) (See Chapter 6).

- *Transportation*

  Transportation (Alzahrani, 2021) is considered waste by moving people, tools, inventories, equipment, or products further than necessary. Extraneous work might come from excessive mobility of persons and equipment. The production of factory location should have easy access to the materials needed for production, and workers who regularly collaborate in the office should be close to one another. Developing a U-shaped production line to maintain the flow between operations and reduce work-in-progress products is a countermeasure of transportation waste (Douglas *et al.*, 2015; Mostafa *et al.*, 2015; Höfer and Naeve, 2017). *Transportation* is one of the Process Wastes (Balzer, 2016; 2020) (See Chapter 6).

- *Inventory*

  Excess *inventory* (Alzahrani, 2021) can be caused by over-purchasing, overproducing work in progress, or producing more products than consumers demand. Manufacturing inventory waste includes broken machinery, additional finished products, excess supplies taking up warehouse space, and finished products that cannot be sold. Several methods include purchasing raw materials when required and in the appropriate quantity and establishing a queue system to avoid overproduction. Documents files are waiting to work on, clients waiting for service, idle database entries, and ancient documents files are all examples of inventory waste in the office (Douglas *et al.*, 2015; Mostafa *et al.*, 2015; Höfer and Naeve, 2017). *Inventory* also belongs to Assets Wastes (Balzer, 2016; 2020) (See Chapter 6).

- *Motion*

  The unnecessary movement of people, equipment, or machinery includes "walking, lifting, reaching, bending, stretching, and moving" is considered waste in *motion* (Alzahrani, 2021). Manufacturing motion waste includes repetitive movements that do not provide value to the customer, such as reaching for materials, walking to fetch a tool or materials, and readjusting a component after it has installed. Thus, the workstation must be well-organized, with mobility countermeasures such as placing equipment close to the production area and placing items in an ergonomic posture to prevent strain. Walking, reaching for supplies, combing through the inventory to discover what is needed, searching for files, additional mouse clicks, and double data entry are all examples of wasted motion in the office (Douglas *et* *al.*, 2015; Mostafa *et al.*, 2015; Höfer and Naeve, 2017). *The motion* belongs to Process Wastes (Balzer, 2016; 2020) (See Chapter 6).

- *Extra-Processing*

  Extra-processing (Alzahrani, 2021) is adding more labour, components, or procedures to a product or service than was required by the consumer. Extra-processing in manufacturing can include using more precise equipment, conducting more analysis, using components with more capacities, adjusting a part after installing, over-engineering a solution, having more functionalities in a product. A straightforward technique to avoid overprocessing is to always start with the client in mind, produce to the client's desired level of quality and expectation, and right the quantity. Extra-processing at the workplace can involve demanding superfluous steps in the purchase process, generating more reports than necessary, demanding unnecessary signatures, needing more forms, adding an extra function to a workflow (Douglas *et al.*, 2015; Mostafa *et al.*, 2015; Höfer and Naeve, 2017). *Extra-processing* also belongs to Information Wastes (Balzer, 2016; 2020) (See Chapter 6).

3.3.6 What Lean is Not?

According to Jones *et al.* (2006), Lean is not a management fad. The tested Lean method is used to improve the way work is done. Lean is not a quick-fix solution for the organisation. It takes time to embed and rely on employees' positive commitment and support in day-to-day work. It is not about reducing headcount, though it frequently means doing the same things with fewer people. It means that people and resources can be redeployed to add more value. Lean is more than just cost-cutting, though it does strive to provide value to customers at the lowest possible cost. Costs incurred that do not give value to the customer, on the other hand, are a waste. Lean is about more than just productivity. It is all about aligning every piece of work that flows through the process from beginning to end with as few interruptions as possible. Lean is about changing the work itself, not about who gives what order or reports to whom.

According to Hensley (2017), at least ten Lean misconceptions are applied in most organisations. The first is the underlying objective of removing people from the organisation. Second, the emphasis on tools and techniques to remove wastes, with a desperate desire for their people to know how to use the tools and techniques. Third, the focus is on eliminating waste without considering overburden or unevenness. The fourth misconception is that the executive team does not need to be involved in their employees' programs, learning, and coaching. The fifth misconception is that the organisation appears to be professional and in command. The organisation is struggling to meet the needs of its customers. Another misconception is that extensive documentation, auditing, and administration of Lean are necessary. The seventh error is discrete implementation, which optimises individual areas of a business without taking into account the connections and handoffs between them. The eighth belief is that Lean fits well with traditional western business practices. The ninth misconception is that Lean, which took a decade to develop, is still evolving and improving. The final and most common misconception about Lean applied in most organisations is that there is no need to focus on learning.

3.4 What is Six Sigma?

3.4.1 Background

Six Sigma is a data-driven, statistically-based technique to “eliminate defects in a product, process, or service.” Based on quality management concepts, Motorola's Bill Smith established it in the early 1980s, and it later became a popular management strategy at General Electric under Jack Welch in the early 1990s. Hundreds of companies worldwide have adopted Six Sigma as a business strategy. Six Sigma is becoming an integral part of organisational leadership, and its widespread adoption can help a firm achieve accurate, measurable results (Harry and Schroeder, 2005).

3.4.2 Six Sigma is “2-5-6”

Six Sigma is a measurement-based process improvement method. It is a method for improving processes and increasing customer satisfaction. This method is based on the idea of reducing process variance. Six Sigma is the result of two (2) philosophies, five (5) methodologies, and six (6) sigma levels, as shown in *Table 3.21* below:

Table 3.21 - Six Sigma Mind is “2-5-6” (Harry and Schroeder, 2005)

2 Philosophies	5 Methodologies	6 Sigma Levels	Defects per Million
• On Target	• Define	• 1st Sigma Level	• 690,000
• No Variation	• Measure	• 2nd Sigma Level	• 308,000
	• Analyse	• 3rd Sigma Level	• 66,800
	• Improve	• 4th Sigma Level	• 6,210
	• Control	• 5th Sigma Level	• 230
		• 6th Sigma Level	• 3.4

3.4.3 Six Sigma - Two (2) Philosophies

Six Sigma is a program unlike any other. It is a way of conducting business. Six Sigma is a metric, a mindset, and a goal. Six Sigma is a management philosophy based on the defect reduction approach. Creating a high-quality product at an affordable price is crucial for customer happiness and profitability to acquire a competitive advantage. Variations wreak havoc on the efficiency of the operation. While variances cannot be avoided entirely, variances can be reduced. Six Sigma strives for 3.4 defects per million opportunities. Six Sigma is a management style that emphasizes continuous improvement and making decisions based on data-driven facts that aligned with corporate goals (Harry and Schroeder, 2005).

3.4.4 Six Sigma - Five (5) Methodologies

Six Sigma is driven by the DMAIC problem-solving paradigm (Yu and Ueng, 2012; Bargerstock and Richards, 2015; Allen *et al.*, 2015). It is a five phrases process. *Define* is “to specify the problem”; *Measure* is “to quantify the problem”; *Analyse* is “to determine the cause of the problem”; *Improve* is “to implement and verify the solution”; *Control* is “to maintain the solution”. It is a critical component of a Six Sigma endeavour and is based on the scientific method. It can be used as a stand-alone quality improvement approach or as part of other process improvement initiatives, such as resolving current process issues with unknown causes.

- *Define*

  Define is the process of identifying the customer. Who are the customers and their expectations? *Define* is critical to quality issues. What are customers’ product and service requirements? *Define* is the primary business process. How to improve the procedure and project boundaries? (Yu and Ueng, 2012; Bargerstock and Richards, 2015; Allen *et al.*, 2015).

- *Measure*
  Measure analyses the performance of the core business process in question. First, develop a data collection strategy for the procedure. Next, gather information from various sources to determine the types of defects. Third, compare the customer survey results to determine the shortfall (Yu and Ueng, 2012; Bargerstock and Richards, 2015; Allen *et al.*, 2015).

- *Analyse*
  Analyse the information gathered and construct a process map to determine the root causes of defects and areas for improvement. Next, select the gaps between current and wish performance. Then, identify the sources of variation and prioritize possibilities for improvement (Yu and Ueng, 2012; Bargerstock and Richards, 2015; Allen *et al.*, 2015).

- *Improve*
  Improve the target process by devising new approaches to solving and preventing problems. Develop creative solutions by combining technology and discipline. Create and implement a strategy for implementation (Yu and Ueng, 2012; Bargerstock and Richards, 2015; Allen *et al.*, 2015).

- *Control*
  Control refers to the improvements made to keep the process on track. It is to verify that the action item created in the *Improve* phase is carried out and maintained effectively. It necessitates developing, documenting, and implementing a continuous monitoring strategy (Yu and Ueng, 2012; Bargerstock and Richards, 2015; Allen *et al.*, 2015).

3.4.5 Six Sigma - Six (6) Sigma Levels

Sigma represents the population standard deviation, a measure of variation in a dataset comprising process information. The process mean (average) of a Six Sigma process is six standard deviations away from the nearest specification limit. Six Sigma can also think of as a defect-per-million for measuring process performance. The goal is to continuously enhance the sigma level to achieve 6-Sigma once the current performance of the process has been determined. The progression from 3-Sigma to 4-Sigma to 5-Sigma will continue to lower costs and boost customer satisfaction (Harry and Schroeder, 2005). An attractive scale of Sigma level that relates to employee behaviours is the essential benefit of quality improvement (Brue, 2005), as shown in *Table 3.22*.

Table 3.22 - Scale of Sigma Level relates to Employee Behaviour (Brue, 2005)

Sigma Level	Employee Behaviours
0.0	You do not do what you have told.
0.1	I will tell you what to do next.
0.2	You will ask what to do next.
0.5	Bring me your problems.
1.0	Bring me your problems with your ideas.
2.0	Bring me your problems with your recommendation.
3.0	Bring me your problems with your recommendation. If you do not hear from me, just proceed.
4.0	Take action.

3.5 What is Lean Six Sigma?

3.5.1 Background

The purpose of both the Lean and Six Sigma methods is the same. Both strive to remove waste and produce the most efficient system possible, but their tactics are quite different. The primary distinction between Lean and Six Sigma is determining the source of waste. Lean encourages work standardisation and flow by eliminating waste such as non-value-added processes and procedures, whereas Six Sigma minimises process variation and improves process control. When these two disciplines are employed together, they have shown to be highly beneficial. As a result, “Lean Six Sigma” was born (Raja Sreedharan and Raju, 2016).

Organizations want to “improve things for the better,” as the name Kaizen implies, but they need a management paradigm that combines the advantages of both Lean and Six Sigma. As a result of this integration, Lean Six Sigma was born (Raja Sreedharan and Raju, 2016). Lean (effectiveness) refers to "doing the right things (customers values) right" and eliminating non-value activities (wastes). Six Sigma (efficiency) means "doing the right thing (customers values) right for the first time and at all times" and reducing variations (defects). Lean Six Sigma removes wastes and lowers deviations (Sunder, 2016; Pilkauskaite-Valickiene and Valickas, 2016). Manufacturing and service industries can use Lean Six Sigma tools and methodologies to optimize production processes with higher quality, shorter lead time and lower costs.

3.5.2 Lean Six Sigma in Different Industries

Raja Sreedharan and Raju (2016) conducted 235 articles of systematic literature review for Lean Six Sigma. The authors investigated the various definitions, methodologies, demographics, and industries. The Lean Six Sigma frequency distribution varied between industries is shown in *Table 3.23*.

The manufacturing industries, accounting for 42.13% of 99 articles, has a large percentage of the Lean Six Sigma spread, and the service industries accounted for 34.89% of 82 articles. On the contrary, Lean Six Sigma spread in Education Institutes is very low (1.7%) due to a lack of knowledge of the potential business benefits of Lean Six Sigma in specific industries. The researcher noticed the gap from the Lean Six Sigma articles using the statistical data presented in *Table 3.23*.

Table 3.23 - Articles of Lean Six Sigma Distribution (Raja Sreedharan and Raju, 2016)

Industry	No. of Articles	Percentage
Manufacturing	99	42.13 %
• Aerospace	6	2.55 %
• Automobile	23	9.79 %
• Chemical	4	1.70 %
• Electronic components	8	3.40 %
• Parts manufacturer	38	16.17 %
• Others	20	8.51 %
Service	82	34.89 %
• Banking Finance	16	6.81 %
• Education Institutes	4	1.70 %
• Government Organisations	7	2.98 %
• Healthcare	33	14.04 %
• Information Technology enabled	23	9.79 %
Infrastructure	10	4.26 %
Argo/Food	5	2.13 %
None	39	16.59 %
Grand Total	235	100 %

3.6 Higher Education Institutes

3.6.1 Management of Education

Emiliani (2004b) suggested that management education should be enhanced. Management education can incorporate three critical improvements to benefit society while also improving practice and enterprise results for financial and non-financial. The author classified it into "business principles, the concept of waste and root cause analysis".

The first step is to improve the business principles. Caux Round Table Principles for Business (Carroll, 2013) outlined "the seven general principles and six stakeholder principles as the role of the global business community in improving economic and social conditions" shown in *Table 3.24*.

Table 3.24 - Caux Round Table Principles for Business

General Principles	**Description**
Principle 1	Beyond shareholders toward stakeholders.
Principle 2	Toward innovation, justice and world community.
Principle 3	Beyond the letter of the law toward a spirit of trust.
Principle 4	Respect for rules.
Principle 5	Support for multilateral trade.
Principle 6	Respect for the environment.
Principle 7	Avoidance of illicit operations.
Stakeholder Principles	**Description**
Customers	Treating all customers with dignity.
Employees	Taking dignity of every employee interests seriously.
Owners/Investors	Trust our investors.
Suppliers	Mutual respect with suppliers and contractor's relationship.
Competitors	Fair economic competition is one of the basic.
Communities	Contribute to such forces of reform and human rights.

Source: (Carroll, 2013)

The concept of waste is the second improvement. Emiliani (2004b) identified and removed the waste, significantly reducing the response time for every operation. As a result, costs reduce, and customer satisfaction increases. However, many job practices are planned without this understanding. It only contributes 5% to 10% added value either in the office or the field. According to Emiliani (2004b), value-added and non-value-added human activities were sometimes inevitable and even required. Behaviours are a part of any activity's execution process. Wasteful behaviours cause delays and rework, raising expenses and lowering customer satisfaction. One crucial element is that “Thinking” businesses have to reduce or eliminate waste. Management education implements Kaizen as continuous improvement in any process where the concept of waste would receive better economic and social benefits.

Douglas *et al.* (2015) defined waste as non-value-adding activities and behaviours that can be removed. High waste management practice, also known as conventional management, is taught in most business schools. Low waste management is far less frequent in business school education, based on the Toyota Management System's principles and practices. According to Höfer and Naeve (2017), different customers have different kinds of value-adding, hidden and obvious waste, as shown in *Table 3.25*.

Table 3.25 - Value-Adding and Waste (Höfer and Naeve, 2017)

Customer and their key goals	Examples of value-adding	Examples of hidden waste	Examples of obvious waste
University → Reputation	The student act as a positive ambassador for the university	The university provides technical and laboratory infrastructure to support the student’s research	The company does not allow publication of the outcome of the thesis.
Professor → Publications	The content of the thesis is advanced enough to be published.	The professor writes an assessment of the thesis.	Reword is required due to an incomplete analysis before it can be published.
Company →Solved problems	The company benefits from the knowledge transfer with the university.	The contract needs to be drawn up and the student need to be supervised.	The student fails to finish his/her thesis.
University staff → Rewarding job	The staff members have a well-paid easy to perform job in a satisfying environment.	The administrative part of thesis handling has to be covered.	Requests need to be answered.
Student → The degree	The student gets a good mark for his/her thesis and a good job at that company.	The student has to travel between university and company.	Mismatches between different customer expectations cause redundant work.

The third improvement is to conduct root cause analysis. According to Emiliani (2004b), when people make mistakes in business realities, people are not blamed for errors in the “Thinking” management system. People reviewed the process extensively using numerous root detection tools, causes, and countermeasures the repeat mistakes. A “no blame” environment is essential to increase employee engagement and allow information to flow. Genuine improvement is impossible if people are perceived as waste while business processes are the source of waste.

Emiliani (2004b) stated that the three proposed "improvements to management education will give higher social benefits while also serving corporate objectives." There is a substantial difference in waste awareness between traditional management practice due to management education and the "Thinking" management system. It decreases the amount of variance in financial and non-financial performance and the number of resources required by the company.

3.6.2 The Need for Change in Higher Education

According to Balzer (2010; 2020), many universities in Higher Education are failing to meet the needs of services for parents, students, faculty, department, campus office, donors, employers, and alumni. The peoples and officials participating in these processes are exceedingly slow, adding little benefit. The author observed that no single "owner" was responsible for confirming that it runs smoothly in academic affairs, student affairs, and administration processes. Furthermore, many university processes are poorly documented, and there are no standardised written instructions that outline specific expectations for each participant's phases and activities. Employees directly involved in the university processes, which do not benefit from employees, cannot express their complaints and suggestions. The author also noticed that universities had not developed an environment that encourages them to transition into a learning organization and improve continuously to serve the peoples and organizations who benefit from their work. Balzer (2010; 2020) concluded that change in Higher Education is a must.

On the other hand, Robinson and Yorkstone (2014) argued that limited resources, increased mandatory personnel costs, and increased student enrolment have made it difficult to maintain existing programs. The cost of Higher Education has been a topic of discussion for several years. College costs are rising faster than in most other economic sectors (Comm, C.L. and Mathaisel, 2005b; Emiliani, 2005). The authors stated that two factors contribute to the survival of Higher Education. First, Higher Education has historically been heavily subsidised by the government. Second, competition for academically prepared students was less intense in the past, and it is not the case in the twenty-first century. HEIs compete to provide students with quality education, flexible course delivery, and user-friendly online services. Furthermore, technological advancements have greatly expanded student options and flexibility. As a result, institutes must become more flexible, responsive, efficient and effective to improve customer ("students") services.

3.7 Higher Education

3.7.1 Background

Higher Education is education in a college or university at the advanced level. It is the learning stage at colleges, academies, universities, seminaries, and institutions. It is also known as the third stage or post-secondary or tertiary education. Vocational schools, trade schools, and career colleges are examples of Higher Education institutions that give academic degrees or professional certificates. Higher education worldwide faces extraordinary challenges, such as rising expectations for what services universities should provide to increase demand for college graduates with even more skills and capacities (Lo, 2014).

3.7.2 Six Sigma approaches in Higher Education

Weinstein *et al.* (2008) developed a way for improving MBA students' classroom experience by introducing them to "Six Sigma Process Improvement Projects" at local businesses. In this study, educators play an essential role in incorporating Total Quality Management (TQM) into the curriculum to help graduates comprehend supplier chain relationships, view value works as a process, and work autonomously. The authors argued that educators recognise excellence as "a culture of beliefs, values, behaviour, thinking, orientation, a collection of facts, ideas and tools." According to this research, it is possible to link the gap between theoretical and practical problems. It ensures future managers understand the significance of quality instruments used to improve Higher Education.

Zhao (2011) developed a theoretical method based on "Six Sigma management" principles to improve the quality of Higher Education. "Six Sigma management" was utilized in various industries to increase quality and eliminate defects. The five principles for better quality management are shown in this research. It included thinking about "students, teachers, employers, and society; making decisions based on evidence and facts; focusing on process management;

encouraging teamwork; putting the customer first". The customer was the central tenet of Six Sigma management ("students, teachers, and employers"). According to this study, the ratio of teachers to students in Chinese universities is substantially higher than international standards, which evaluated the quality of education at Chinese institutions.

A case study has determined the importance of quality in Higher Education and its outcomes in Taiwan. Yu and Ueng (2012) used the Six Sigma DMAIC technique and the framework for analyzing significant performance to create a feedback program to improve educational quality. The study employed twenty attributes, separated into five groups: "teaching preparation, teaching materials and methods, teaching attitudes, professional development, and teaching administration coordination".

Various questionnaires were produced and assessed as part of Six Sigma's defining phrase. The key features in the measure phrase were determined using an indicator of the teaching output during the assessment process. The status of each attribute was assessed using the "teaching effective analysis matrix", which is a slight modification of "importance-performance analysis". The "teaching effective analysis matrix" chart improves the poor qualities. The effectiveness of the improvements checked in the control phase, and each attribute on the "teaching effective analysis matrix" was found to be in the teaching capability zone. It provides teachers with a continual feedback system.

Cudney *et al.* (2014) did a comprehensive literature assessment on Six Sigma activities in Higher Education. According to the review, there was very little literature on the application of Six Sigma in education. Many articles have provided blueprints for implementing Six Sigma in education, and however, they have left out case studies and quantitative implementation analyses. As a result, the authors suggested future research to build models for usage in all academic levels, including classrooms, curriculum, and strategic initiatives.

Six Sigma is frequently employed in the retail and manufacturing industries but rarely employed in education. HEIs encounter a variety of difficulties that challenge the scientific solution. Alkoot (2019) used the Six Sigma process enhancement approach as an example of a scientific strategy for improving educational institution outcomes. The author showed how Six Sigma might be implemented in HEIs to improve student results by employing this scientific way of process management. Adoption of Six Sigma may result in the elimination of defects and variation in the processes for the system under consideration (Antony, 2014).

Critical Success Factors (CSFs) are vital elements that enable the success of projects. MacIel-Monteon *et al.* (2020) recommended creating and validating an instrument for evaluating the Six Sigma CSFs implementation in Higher Education improvement projects. The instrument was validated among Mexican institutions of Higher Education, yielding 743 surveys. The author found eleven essential success factors: managerial engagement and dedication, Six Sigma linkages with the institutional strategy, Six Sigma links with suppliers, coordination, and team member selection. The findings demonstrated that the proposed instrument is statistically accurate, allowing HEIs to use it to determine how important Six Sigma success factors are treated during the implementation of improvement projects.

3.7.3 Lean Six Sigma approaches in Higher Education

Lean Six Sigma aims for six standard deviations between the nearest specification limit and the mean from product to service or manufacturing to delivery. Lean Six Sigma is a methodology and systematic approach for removing defects in any process. Lean Six Sigma can assist in improving the quality and efficiency of the organisation. Many organisations have reaped significant benefits from Lean Six Sigma implementation. The advantage of Lean Six Sigma in improving Higher Education quality and satisfaction of students has been established by Haerizadeh and Sunder (2019).

Antony *et al.* (2012) studied the challenges, barriers, and critical factors that affect applying and enhancing Lean Six Sigma in Higher Education. The authors identified the challenges of implementing Lean Six Sigma in Higher Education. First, these challenges include a “lack of understanding of the educational system process, a lack of awareness of benefits." Next, "a lack of vision for establishing a continuous improvement culture." Third, "a lack of understanding of the true Voice of Customer (VOC), and a lack of resources." Besides, the authors investigated and evaluated the CSFs to conquer the challenges of employing Lean Six Sigma in Higher Education Institutes in the research. These CSFs are "uncompromising support and commitment from top management, effective communication at all levels, strategic and visionary leadership, project selection and prioritisation and organisation culture". The study also identified and addressed effective strategies that enhance Higher Education quality, such as "project charter; cause and effect analysis; processing mapping; visual management; and Pareto analysis". The authors concluded that Lean Six Sigma is noteworthy not just in manufacturing but also in education.

Antony (2014) argued that combining Lean and Six Sigma is a good strategy for Higher Education, and experts are highly advised to apply to this. In a subsequent analysis, the author identified a theoretical study employing secondary school sources for evaluating the readiness factors a university needs to have in place to succeed in Lean Six Sigma. It found that Lean Six Sigma is not yet broadly accepted in Higher Education due to the misperception that it is a manufacturing industry methodology. However, if a range of preparation factors are in place, it can effectively reduce process inefficiencies. These readiness factors include: First, "an institution should have active leadership with a clear vision to develop the desired culture of continuous improvement." Next, "there must be constant and consistent managerial support and commitment to the required resources." Third, "the projects chosen for the Lean Six Sigma must be consistent with the university's strategy." Fourth, "the projects selected must be customer-focused." Lastly, "the right people to be educated and involved." Besides, Antony (2014) concluded the readiness factors required to implement Lean Six Sigma in the Higher Education sector to deliver and sustain. The significance of preparation factors is the ingredients to implement Lean Six Sigma in an educational system successfully. When these readiness factors are taken into account, Lean Six Sigma helps to improve processes and increase efficiency in HEIs.

Lean Six Sigma has been used in the production and service industries successfully. Lean Six Sigma principles can improve the Higher Education processes effectiveness and efficiency (Antony, 2015). According to Svensson *et al.* (2015), "King Abdullah University of Science and Technology (KAUST)" has improved business operations by using Lean Six Sigma methodology. The Lean Six Sigma program was introduced in 2011 to systematically improve the quality of business processes in administrative functions and create a platform for employees to make process innovations. However, Antony (2015) found that the challenges of implementing Lean Six Sigma in Higher Education can be grouped into three areas such as "organisational, technical, and individual".

Vats and Sujata (2015) demonstrated using Lean methodology and tools to achieve quality without waste in the student project implementation processes under the proper supervision of higher faculty in software engineering. According to the authors, improving the "Teaching and Learning Process" is an important key process area in the education sector for project implementation. The Lean Six Sigma approach can be beneficial to educational institutions to improve the "Teaching and Learning Process". The authors concluded that Lean Six Sigma approaches have consistently reduced lead time and waste from products or services to achieve quality. Almost every industry has adopted Lean and Six Sigma techniques.

Cudney *et al.* (2018) demonstrated "a systematic review of the relevant literature on the Lean and Six Sigma approaches in Higher Education". These approaches could enhance the administrative processes and teaching methods of HEIs. Such methodologies can be adopted and implemented to enhance the Higher Education quality while also adding benefit that consistently improves student satisfaction. On the other hand, Singh, M. and Rathi (2019) conducted the study to reveal the challenges and values associated with implementing Lean Six Sigma for the business organisation. A total of 216 research papers were reviewed from 2000 to 2018, covering five primary sectors: "manufacturing, health care, human resource, economy, and education". The author observed that many non-value-added activities associated with the student and the system are considered waste in higher institutions. Student-related wastes included "lack of regular study;

concentration in class; and inadequate self-study”. System-related wastes included “teaching help topics that typically taught in other classes; an excessive review of prerequisite materials; unnecessary and excessive introductions; teaching outdated topics; waiting for unprepared students to catch up; and book searching time in the library”.

Higher education is facing challenges in modern times due to declining funding from state governments and donors, opposition to raising tuition fees, unequal student enrollment, low student retention, etc. In these challenging circumstances, the time has come to consider seriously implementing Lean Six Sigma in Higher Education. Six Sigma is used less frequently in Higher Education than Lean. Lean Six Sigma is a process improvement technique that integrates the best elements of both Lean and Six Sigma processes by merging the distinct concepts, methods, and tools (Gupta et al., 2020). The introduction of Lean, Six Sigma, and Lean Six Sigma can improve the education sector. As a result of implementing these quality improvements, society may benefit from enhanced education (Sony *et al.*, 2020).

3.7.4 Lean Thinking in Education versus Education 4.0

The fourth industrial revolution (IR4.0) has become an essential strategic approach in the technological change of manufacturing and others. Bittencourt *et al.* (2021) identified that Lean is seen as an essential agent in the performance of IR4.0. Lean concepts like work standardisation, organisation, and transparency are fundamental in supporting the implementation and consolidation of IR4.0.

According to Taghavi and Beauregard (2020), Lean considers any activity that does not add value to the product as waste and removes them from the manufacturing process to reduce costs. IR4.0 optimizes the computerization of the third industrial revolution, making the manufacturing process more intelligent, more effective and productive. The authors found that the integration of Lean and IR4.0 positively impacts companies. However, there is no similar opinion about how the two approaches influence each other, such as Lean is a basis for IR4.0; or interaction IR4.0 and Lean; or IR4.0 completes Lean.

Sharma (2019) said IR4.0 is disciplined by artificial intelligence and digital-physical frames, making the human-machine interaction even more versatile. Organisations can replace people working in specific fields with more intelligent robots by preparing students for the next life and working with IR4.0. IR4.0 brought about a state of change in education. Education requires the use of relevant information and skills. Creative Education 4.0 ends innovation by improving education and skills to make future learning more personal, super, intelligent, portable, global and virtual.

On the other hand, Halili (2019) pointed out that technological advancements in teaching and learning could enhance the teaching and learning process and create learners' interest in participating in the learning materials. The technological advancements in IR4.0 consist of 3D Printing, augmented reality, virtual reality, cloud computing, hologram, biometrics, multi-touch LCD screen, Internet of Things, artificial intelligence, big data and QR-code for educational purposes. Education 4.0 completes the phenomenon of digital penetration in our everyday lives.

Education 4.0 defines as "the use of technology in the teaching and learning contexts." (Lawrence *et al.*, 2019). The author discovered the strengths and weaknesses of Education 4.0 in the HEIs. The strengths of Education 4.0 are: "creates an opportunity for educators to engage in new technology tools; enhances the knowledge and usage of technology; development of technology classroom into the 21st-century skills". The weakest are: "resistance to change; digitally connected, socially disconnected.". However, according to Spiridonova *et al.* (2021), HEIs are beginning to implement Lean practices to improve their processes. Lean can provide a significant positive synergetic effect reserve of resource-saving and labour productivity increase for the preparation and maintenance of the educational process. In other words, Lean Thinking in Higher Education can help to implement the Education 4.0 processes.

3.8 Lean Higher Education

3.8.1 Background

Balzer (2010; 2020) published two books, the first and the second edition, of "*Lean Higher Education: Increasing the Value and Performance of University Processes",* which discussed such projects in academic settings, including critical success factors and strategies to track progress. Lean Thinking to Higher Education is also referred to as Lean Higher Education. The author aimed to improve the efficiency and effectiveness of Higher Education operations. Lean Higher Education can reduce costs, meet public demands, leverage institutional resources, and respond to Higher Education expectations such as scholarship, educational and outreach missions. It is relevant and can generalisable to the SPHEIs context. According to Ziskovsky and Ziskovsky (2007), examples of representative school processes are communication, conferences, maintenance, emergency procedures, budgeting, technology, negotiation, fields trips, activities, registration, reporting, instruction, teaching, learning, certification, etc.

Balzer *et al.* (2015) showed that implementing and sustaining Lean Higher Education has benefited the university. The author addressed the four keys essential techniques. The first step is to analyse and improve institutional readiness. Second, increasing executives' awareness, knowledge, and support for Lean Higher Education. Third, strategic planning, Lean leadership, and assistance will provide Lean Higher Education. Finally, accelerating with the push to Lean Higher Education on a campus-wide basis.

3.8.2 Lean Higher Education Principle

Lean has five principles: "identify value, map the value stream, create flow, establish pull, and seek perfection". According to Womack and Jones (2003), the Lean Principle has become the guideline to optimise any process in any system. Kang and Manyonge (2014) defined the Lean Principle as "defining value, mapping the value stream, creating flow, responding to the customer pull and pursuing perfection". Tatikonda (2007) also agreed that the Lean system "adds value to the customer" and the Lean tenets "define value, identifies value stream, make value flow, pull system and pursue perfection". Furthermore, Kedem (2010) argued that the Lean Principle could apply in different organisations and industries.

Lean Higher Education has been practised in the United States, the United Kingdom, and other countries since 2004 (Balzer, 2010; 2020). The author described how some universities and pioneer academic institutes in the United States have practised and implemented Lean on student programs, research, technology transfer, financial resource, human resources, and physical resources, as shown in *Table 3.26*.

Balzer (2010; 2020) has declared the Lean Higher Education principle as:

- "*Define* the *value* of the process from the perspective of the beneficiaries."
- "*Identify* the *value stream* of the flow process to add value."
- "Eliminate many types of waste and *make value flow* to the process."
- "Make '*pull system*' rather than 'push system'."
- "*Pursue perfection* through continuous improvement and transformation."

Table 3.26 - List of Universities and Institutes (Balzer, 2010; 2020)

Country	University and Institutes
USA	• Bowling Green State University (United States) • Carleton University (United States) • Miami University (United States) • Michigan Technological University (United States) • University of Central Oklahoma (United States) • University of Iowa (United States) • University of Michigan (United States) • University of Notre Dame (United States) • University of Washington (United States)
UK	• Edinburgh Napier University (Great Britain) • University of St Andrews (Great Britain) • University of Strathclyde (Great Britain) • University of Sheffield (Great Britain)
Others	• Macquarie University (Australia) • UiT the Arctic University of Norway (Norway) • University of Waterloo (Canada)

3.8.3 Lean Higher Education Seven Types of Waste

On the other hand, Kang and Manyonge (2014) illustrated waste in HEIs from students' perspectives. *Defects* refer to "incorrect course material, repeating the exam materials or coursework". *Overproduction* refers to "out-of-date teaching material". *Waiting* refers to "waiting for a service, waiting for incorrect information, or waiting for a resource to become available". *Transportation* refers to "the lack of facilities that allow students to access and submit assignments". *Inventory* refers to "students who are waiting for the results or feedback on their coursework". The *Motion* refers to "students being moved between classrooms unnecessarily". *Extra-Processing* refers to "overlapping modules in which students study the same course content more than once".

In contrast, Maguad (2007) defined Lean Waste as "anything in the process that does not add value for the customer". HEIs should focus on waste reduction.

- *Defects* refer to "the waste in the form of corrections, inaccurate or incomplete information which can lead to scrap or rework".
- *Overproduction* signifies "the waste of administrative and academic offices producing more than is requested for day-to-day operations".
- *Waiting* implies "wasting time to meet with a financial or academic advisor, the decision on enrolment application, and receiving approval for a request".
- *Transportation* relates to "the waste generated when people, equipment, materials, and information is moved around campus.
- *Inventory* waste refers to "the waste of inventory build-up in terms of storage, overstocking, and obsolete or incorrect items".
- *Motion* means "the waste of motion occurs when there are non-value-added steps in a process".
- *Extra-Processing* indicates "the waste in excess or lack of people, materials, equipment, and resources required to facilitate teaching and learning".

3.8.4 Lean Higher Education Eight Types of Waste

According to Dahlgaard and Ostergaard (2000), there are eight types of waste in Higher Education. There is a disjointed approach to teaching, coaching, and testing, which leads to pupils failing tests. Then some graduate students cannot find work and cannot learn for the rest of their lives or enrol pupils in courses they lack the essential qualifications to pass. Also, studies do not add value to the students' experience. Poor planning means the materials and facilities needed for teaching, coaching, and testing are insufficient for time, cost, and quality.

Teachers and students in downstream activities are also waiting because upstream activities at the level of supported staff have not been completed on time, and vice versa. Another waste is support staff moving from one location to another or from one time to another for no apparent reason or fixing damage and mistakes they are not accountable. Finally, the failure of the course and support operations did not suit the requirements of customers both within HEIs.

In contrast, Kazancoglu and Ozkan-Ozen (2019) investigated and defined the eight wastes of Lean philosophy in HEIs. The findings showed that the most significant wastes in the business school were repeated tasks, misunderstanding errors, an excessive number of academic units, the creation of excessive information, talent wastes, motion and transportation wastes. According to Vats and Sujata (2015), list of eight wastes associated with the teaching-learning processes are:

- Lack of standards followed by large groups (defects).
- Extended hours to prepare for the examination, laboratory, and presentation (overproduction).
- Lectures were improperly substituted (waiting).
- Students do not fully participate in practical sessions (non-utilised talent).
- Inequitable information distribution (transportation).
- The workflows are adjusted between teachers and students incorrectly (inventory).
- Isolated communication within a specific project team (motion).
- Interactions between students and mentors are excessive (extra-processing).

3.8.5 Lean Higher Education Four Types of Waste

Balzer (2010; 2020) has consolidated the four types of waste for Lean Higher Education.

- *People wastes* are "the type of wastes that occurs when universities fail to capitalise on the knowledge skills and abilities of employers and workgroups".
- *Process wastes* are "the collection of wastes that occur due to flaws in the design or implementation of university processes".

- *Information wastes are "the type of waste* that occurs when the available information for supporting university processes is insufficient".
- *Asset wastes are "the type of waste* that occurs when the university does not use its resources most effectively".

Qayyum and Manarvi (2017) applied four types of wastes to review Lean concepts and an assessment of HEIs in Pakistan. The research results showed:

- *People Wastes* are "universities fail to fully capitalise on employees' knowledge, skills and abilities and workgroups".
- *Process Wastes* are "the result of defects in the design or execution of university processes".
- *Information Wastes* are "when there is insufficient information available to support university processes".
- *Assets Wastes* are "when the university's resources are not used effectively".

3.8.6 Lean Higher Education Tools

The collection of Lean Tools put together in a container serves as a framework for implementing a complete Lean system.

- *Hoshin Kanri*

  Hoshin Kanri, also known as Policy Management, is a strategic planning process in which company-wide strategic goals are communicated and implemented (Emiliani, 2005). It is used for taking strategic goals and successfully communicating them down through the organisation, then backing them up, and finally putting them into action by employees with a shared commitment. It eliminates the waste caused by inconsistency in direction and poor communication. Hoshin Kanri is working to pull all employees in the same direction simultaneously. It is accomplished by aligning the company's priorities (Strategy) with the middle management strategies (Tactics) and the role of all employees (Operations).

- *5S*

  5S (Osada, 1991) is a strategy of arranging work areas to complete the work quickly, effectively, and safely. 5S is a workspace organisation framework that employs five Japanese words to represent its principles or phrases: "Seiri (Sort), Seiton (Set in order), Seiso (Shine), Seiketsu (Standardise), and Shitsuke (Sustain)" (Randhawa and Ahuja, 2017).

Seiri (Sort) refers to the split-up of disorder from other items. Seiton (Set in order) is arranging items using ergonomic principles. Seiso (Shine) is cleaning the area, tools, machines, and other equipment to bring them back to near-new condition. Seiketsu (Standardise) is one of the essential Lean manufacturing principles. The process ensures common standards and ways of working on what has been done in the first three stages of 5S. Shitsuke (Sustain) provides that the company maintains housekeeping, conducting audits that continue to improve by using the previous stages of 5S. 5S should embed in the business operation and responsibility for all employees in the organisation (Randhawa and Ahuja, 2017).

- *Plan-Do-Check-Act*

  A basic simple four-stage approach that assists teams in preventing recurring errors and optimising processes is Plan-Do-Check-Act (PDCA). The PDCA cycle is a reiterative approach for continuous product, people, and service improvement. The Plan-Do-Check-Act model involves testing solutions, reviewing outcomes, and improving processes (Suárez-Barraza and Rodríguez-González, 2015; Dinis-Carvalho and Fernandes, 2017; Tılfarlıoğlu and Anwer, 2017).

- *Poka-Yoke*

  Poka-Yoke is a Lean mechanism that assists an operator in avoiding mistakes and is also known as mistake-proofing. Poka-Yoke reduces product failures by "preventing, correcting, or drawing attention to human errors as they occur". Poka-Yoke principles for dealing with mistakes in the order of priority are elimination, prevention, replacement, facilitation, detection and mitigation (Sondermann *et al.*, 2018).

- *Muda / Muri / Mura*

  Muda is a Japanese word that means "useless" or "waste", and it has eight forms. These eight forms of wastes (DOWNTIME) are: "**D**efect, **O**ver-**P**roduction, **W**aiting, **N**on-talented people, **T**ransportation, **I**nventory, **M**otion and **E**xtra-processing". Muri is the overloading or overburdening of employees, machines, or processes. Mura is the unevenness, fluctuation, or variation in work or the workplace. No Muda, No Muri, No Mura (Southworth, 2010) is the ideal state to achieve and maintain in any Lean system. Processes should be free of wastes, overloading and unevenness or variation.

- *Value Stream Mapping*

  Value Stream Mapping is a technique for charting process flow, identifying wastes in the flow, determining the root cause of wastes, and identifying ways to reduce or eliminate waste. The value stream is the activities, processes, and steps involved in creating and delivering benefits to the customer. Understanding the value stream is critical if an organisation wish to provide value to the customers, reduce wastes in processes, and achieve cost-effectiveness (Brouwer-Hadzialic and Wiegel, 2016; Dinis-Carvalho and Fernandes, 2017).

- *Kaizen*

  Kaizen is a method of continuous improvement. It is based on the concept that small, constant, or consistent positive change can significantly improve. Most processes degrade in performance over time, and continuous improvement attempts to prevent this by continuously implementing minor improvements. It is where Kaizen fits in perfectly. Kaizen can be thought of as PDCA cycles that constantly implement minor improvements. As a result, the processes never degrades and continues to function efficiently and effectively (Emiliani, 2005; Suárez-Barraza and Rodríguez-González, 2015; Kregel, 2019).

3.8.7 Lean Higher Education Practices

Lean is a method of continuously improving workplace activity. The goal of the Lean practice is to enhance value-adding activity while reducing non-value-adding activity, or waste, to make work “leaner”. The best practices of Lean were defined by Nightingale (1999) in a Lean proposal framework built by the Massachusetts Institute of Technology MIT), according to Clare L. Comm and Mathaisel (2005). The author demonstrated that the nine practices “*optimise, transfer, utilise, integrate, relate, focus, promote, improve, change”* have applied to Higher Education. Cristina and Felicia (2012) claimed that Lean means giving customers more value while using fewer resources and reducing waste. Lean is the cornerstone for organizations to improve processes and achieve manufacturing and services excellence continually. According to Emiliani (2015), the concepts of the Lean are “Respect for People” and “Continuous Improvement” are essential for the education approach.

LeMahieu et al. (2017) used Lean for education to build various ways to improve educational quality. According to the authors, Lean aims to create and deliver the most significant value to “customers” in the education system while using as few resources as possible and eliminating waste. Lean for education engages the institutes in problem-solving, quality improvement, and continuous learning with PDCA cycles. However, Qayyum and Manarvi (2017) claimed that the philosophy Lean system and tools could resolve educational problems. Lean may appear simple to implement as “just common sense”, but it requires a substantial commitment to implement in practice.

Höfer and Naeve (2017) said that Lean Management aids in the improvement of all three factors in an organisation to manage change successfully. The following three factors must be maximised: the “ability to do”, “willingness to do”, and “allowed to do”. The factor “ability to do” is determined by “knowledge, methods, and education”. The factor “willingness to do” is determined by “motivation”, whereas the factor “allowed to do” is determined by “leadership and the specific structure of an organisation”. According to the authors, universities now need to become “decathletes” with ten different skills: “Excellence in teaching; online distance learning; research and development; gaining research funds; providing service to students; managing international partners; alumni management; cooperation with companies and knowledge transfer; self-marketing; ranking management and accreditation”.

According to Barroso *et al.* (2010), implementing the Lean concept in HEIs must include seven practice components: the environment for change, employee empowerment, leadership, communication, culture, training, and measurement. Recently, Sfakianaki and Kakouris (2019) created a structured approach for adopting Lean practice in primary and secondary education, with valid and reliable empirical data.

According to Balzer (2010; 2020), using Lean to improve administrative and academic processes has a substantial and quantifiable impact on an entire institution, including department or unit level, and achieves effective improvement. Applying Lean is a serious mission that will have the most significant effect in long-term and strategic planning. After years of research, Balzer et al. (2016) compiled a body of knowledge about Lean in Higher Education. In Higher Education, "customers" and "products" are disputed. The success of colleges and universities is essential to a wide-ranging of stakeholders such as administrators, faculties, students, future employers, and governments are the most common.

3.8.8 Lean Higher Education Application Evidence

A couple of success stories using Lean Higher Education to improve their academic and administrative procedures from known universities.

- *"University of Minnesota"*

  The University of Minnesota in the United States used Lean techniques in several departments, including "plant operations, health care system, accounts payable, human resources, finance, research administration, and business school". Most departments showed improvement after applying Lean (Dragomir, C. and Surugiu, 2013).

- *"Rensselaer Polytechnic Institute"*

  Rensselaer Polytechnic Institute applied lean to improve course design and delivery of academic functions (Emiliani, 2004a; Emiliani, 2005). The Lean methodology increased student satisfaction based on student evaluations at the end of the course for five semesters. This study proved the potential for Higher

Education to implement Lean techniques, particularly in the academic function, in the future.

- *"University of Central Oklahoma"*
  The University of Central Oklahoma in Edmond, Oklahoma, adopted the concept of Lean Thinking to become a Lean University. It is due to "budget reduction, insufficient funding, cost increase, outdated administrative process, employee job dissatisfaction, and a low level of productivity". Lean Thinking began with the administrative process and later spread to other divisions. Identifying and eliminating waste in products or services was the primary focus of Lean implementation. The University of Central Oklahoma used a four-step model: identifying opportunities, designing solutions, implementing, and continuously improving (Dragomir, C. and Surugiu, 2013).

Comm, C.L. and Mathaisel (2003) reported the essential factors driving changes in quality of education, student population change, university rating, higher public expectations and higher cost. The authors said Lean Higher Education could apply in administrative and academic services. Dragomir, C. and Surugiu (2013) agreed that "Lean Higher Education is not only dominant in administrative processes, but has important applications to academic processes" and fully supported Comm, C.L. and Mathaisel (2003). Poland (2015) emphasised that "Lean directly translates into a cost reduction of services in both public and private HEIs" that serve three functions: "educating students, conducting research, and benefiting the environment". The author said, "Lean transformed the educational service process into a pull system (focus on student needs) rather than a push system (focus on capacity)". Balzer (2010; 2020) agreed that the most common Lean approaches could apply to the university service activity. Finally, Qayyum, A. and Manarvi (2017) claimed that there are differences and similarities between Lean practices in the complex delivery processes of both the manufacturing and education industries.

Higher Education business operations appeared to be well suited to the Lean Higher Education implementation. General administrative service, billing, procurement, hiring and faculty contract were typical examples of improved processes. Other application areas included operations of campus departments, information technology, conference planning and facility maintenance. Administrative functions in Higher Education are similar to business processes in general. Lean Higher Education studies concentrated on student services such as financial aid, fundraising, dining services, mental health counselling, class registration, advising, student housing services. Compared to corporate operations or student support services, there are fewer Lean Higher Education improvements in academic practice, such as course development, delivery, and grading.

3.8.9 Global Lean for Higher Education

Yorkstone (2019) edited a book that aimed to provide diverse readings from global Lean experts and practitioners, sharing findings, methods, resources, and case studies that provide rich knowledge and practical observations to guide universities pursuing Lean adoption. It is a valuable resource for universities investigating the potential application of Lean at their institutions. It also provides additional tools, approaches, and new ideas for continuous improvement to help universities already implement Lean.

This book is not about Lean theory. Twenty-four well-known Lean Higher Education experts in attendance and emerging practitioners from countries like Australia, Canada, Malaysia, Poland, the United Kingdom, and the United States discussed how HEIs must move forward with Lean and the lessons learned. These 24 chapters have comprised six sections, "*Starting-Out, People, Project, Technology; Sustaining Lean* and *Culture*". Each contribution allowed the reader to choose the most exciting and approach field drawn from a different institution. However, this book appeared to be UK-centric, with roughly two-thirds of the contributions coming from the United Kingdom. The researcher has written the book review journal (Yorkstone, 2019).

3.9 Lean/Lean Thinking, Six Sigma, Higher Education Relationship

After reviewing the above literature, the researcher summarised the relationship between Lean/Lean Thinking, Six Sigma, and Lean Higher Education, as shown in *Figure 3.23.* Lean or Lean Thinking has the same theory concept (Womack and Jones, 2003; Womack *et al.*, 2007). Lean is about doing more with less. Lean thinking is a logical and systematic approach that focuses on creating an organizational environment that continuously seeks and eliminates waste.

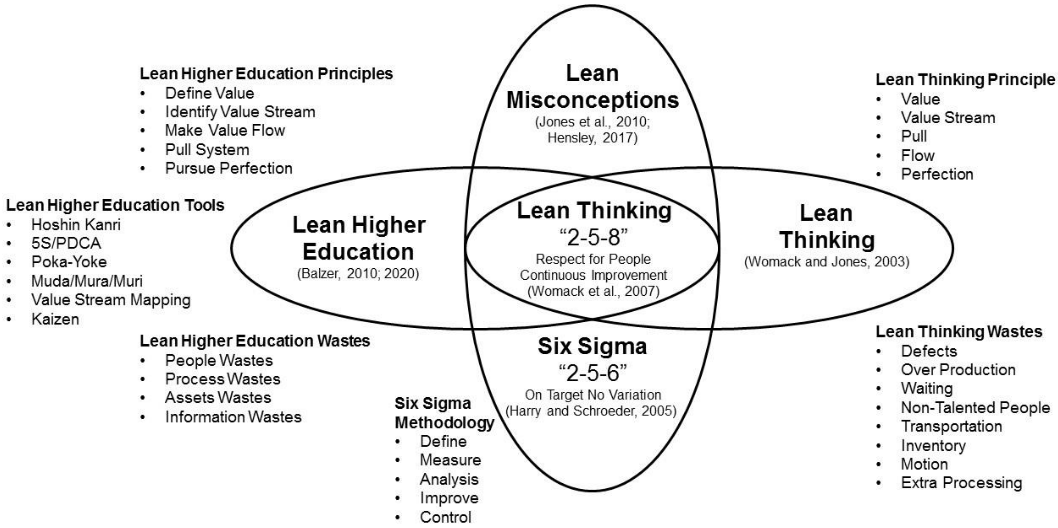


Figure 3.23 – Lean/Lean Thinking, Six Sigma, Higher Education (Source: Author)

The Lean Thinking "2-5-8" (Womack and Jones, 2003) management philosophy emphasises "Respect for People" and "Continuous Improvement" (Womack *et al.*, 2007) as core tenets. Six Sigma "2-5-6" (Harry and Schroeder, 2005) is a measurement based on the process improvement "On Target" and "No Variation" strategy. According to Womack and Jones (2003), Lean Thinking has five principles and eight wastes. However, Balzer (2010; 2020) has stated the Lean Higher Education principle as "*Define Value*, *Identify Value Stream*, *Make Value Flow*, *Pull system* and *Pursue perfection"*. Balzer (2010) has consolidated the four types of waste as "*People Wastes, Process Wastes*, *Information Wastes and Asset wastes"* for Lean Higher Education. Jones *et al.* (2006) identified four types of Lean misconception, whereas Hensley (2017) argued that at least ten Lean misconceptions are applied in most organisations.

3.10 Lean Thinking in Higher Education

3.10.1 Administrative and Operation Processes

Ziskovsky and Ziskovsky (2007) researched a case study, K-12 Education, to improve student performance, education delivery and saving costs using the Lean Process Improvement. According to the authors, Lean management is a new concept for the education industry, especially the application of Lean Principles to education. The Lean school adopted a can-do attitude, positive cultures, enhanced involvement, and genuine responsibility to improve student learning processes. A Lean school system includes respecting all people and the community to program outcomes and school operations.

Doman (2011) demonstrated a case study that adopting Lean Principles in the administrative process for a small group of undergraduate students at Oakland University has been applied successfully. On the other hand, Thirkell and Ashman (2014) reviewed the implementation of Lean at two UK universities. The authors found that lack of acceptance in all aspects of an administrative university environment was also due to accepting and transferring Lean in Higher Education. Mostafa *et al.* (2015) found that operation is essential in achieving world-class HEIs. The operational activities of HEIs should ink to the Lean concept, which introduced a procedure for incorporating Lean into operational activities. The author added transformation of the operation process into proactive and predictive, ensuring a consistent process using Lean Principles.

Magalhães *et al.* (2019) improved administrative processes in a university department's office using Lean Office tools. The study concentrated on registration, recurring, student database, satisfaction survey, and various administrative functions. The benefits included an 84% reduction in time searching files, managing projects and developing student registration forms. Another 69% reduction in time was searching for student particulars, creating a visual dashboard for analysis and monitoring, handling information and identifying KPI.

Similarly, Petrusch *et al.* (2019) looked into the impact of Lean thinking on administrative services at private HEIs in Brazil. According to the authors, there was little indication of extensive Lean thinking adoption in administrative procedures of Brazilian private HEIs. There is a knowledge gap about the application of Lean to Brazilian academic operations. The authors argued that Lean practices learn to use the Lean Principles and methods. The HEIs efficiency measures showed expected and verifiable progress in the Lean Thinking implementation.

Using theoretical and empirical evidence, Petrusch and Vaccaro (2019) examined “the value of the academic-administrative services” for Brazilian students in HEIs. Convey the value attributes for administrative and academic services from the student perspective. The eight value attributes are “reliability, empathy, access, responsiveness, communication, personalisation, imperceptibility and self-service technology convenience” were investigated. Depending on the administrative and academic services and the strategy of institutes, the value attributes may receive differing degrees of significance and effort.

Wheeler-Webb and Furterer (2019) used the Lean Six Sigma methodology to enhance a university campus office's schedule, quotation, invoice, and payment processes. The sponsors and process owners were on board to make the project successful from the start. According to the authors, a similar process applied at other HEIs or industries also use the Six Sigma methodology to increase productivity and cost-effectiveness for enhancing other functions in the organisations.

Managerialism has long been associated with problems in Higher Education. Lean Management is an instrument of managerialism. According to Cano *et al.* (2020), it was a philosophy that could resolve issues and reduce resources without putting additional strain on staff. Higher Education uses a Lean management strategy that prioritises value creation and cost reduction for stakeholders. The study demonstrated how the system could assist universities in addressing some of the issues associated with managerialism.

Mundth *et al.* (2020) investigated how Lean concepts and methods guide change initiatives in the HR department of a major public university. HR was able to incorporate Lean concepts and practices to enhance organizational processes and structures effectively. Lean has spread throughout industries, and in recent decades, it has piqued the interest of the public sector in general and particularly HEIs.

Klein *et al.* (2021) suggested a Lean management system for waste management in Brazilian HEIs, to educate administrators academic and service employers about university waste. According to the findings, the most critical problems to address on university campuses are information loss and overprocessing waste. Universities could use waste prioritisation to prioritise their operation and select methods that would assist them in creating more value for their end-users. This study contributed to the theoretical and functional fields by demonstrating a fundamental process for incorporating Lean practices and principles in government agencies and HEIs.

3.10.2 Curriculum Design and Delivery Processes

Emiliani (2004a) was the first academic to apply the principles and practices of Lean Higher Education. The study used Lean design and delivered a leadership course for graduate businesses to improve consistency, reduce waste and improve the quality of course materials. He demonstrated how Lean Principles and practices were applied to a graduate course in leadership by part-time working professional students seeking MSc in management and MBA degrees in a classroom setting. Using Lean Principles and practices to course design and delivery necessitates professors challenging their beliefs about what and how they teach. The results showed higher student satisfaction, clearer expectations, less ambiguity regarding lectures and assignments, standard formats for projects, smoothing individual and team assignments over the semester, and better management of students' time in and outside class.

In a similar study, Emiliani (2005) used Kaizen, a rapidly improving Lean-based experience, to improve the content of graduate business courses. According to the author, Kaizen can help Higher Education institutions compete more effectively against traditional non-profit and newer for-profit sources of Higher Education. He investigated how the Kaizen process applied for ten courses in a part-time executive MS degree program in management. The author concluded that Kaizen was a successful process for improving graduate business school courses and the value proposition for students.

Pusca and Northwood (2016) demonstrated how Lean Principles improved an engineering design course’s content, instructional methods, and assessment methods. He explained how Lean tools such as value stream mapping, root cause analysis, and Kaizen were used to identify problems and solutions for course improvement. He revealed that a certain degree of flexibility must consider in all aspects of the teaching and learning process. The Lean Principles and tools should be chosen and applied with the human element of the relationship between all parties involved in mind, namely students, academic staff, and non-academic staff.

Mirth (2017) designed and delivered a traditional lecture-based Kinematics of Machines, Engineering course using Lean Management Principles. First, remove even minor lectures from class meeting times to improve the kinematics course. Then, restructuring the system into larger meeting time blocks provides more extended work periods. Third, giving students more responsibility for defining their own uniform set of due dates for their assignments.

Zighan and EL-Qasem (2020) discussed the use of Lean Thinking in re-evaluating the business school's curriculum, syllabus, and planned learning goals at several private and public universities in Jordan to increase graduate employability by defining and removing non-value-added practices. The authors learned that implementing Lean Thinking in business school has two benefits. They allowed the school curriculum creator to eliminate several unnecessary and non-value-added operations while emphasising and improving value-added processes. In practice, the authors identified various non-value-added and excessive business school curriculum practices and recommended developing a more employability-focused curriculum.

Alves *et al.* (2020) conducted an exploratory analysis of the experience and value of incorporating Lean Education into curricula from the academic perspective. The authors agreed that Lean Education provides such competencies to new practitioners and has developed and implemented such workshops in various settings, involving over 100 participants, primary academics with teaching responsibilities in training the future workforce. More than half of the participants gave the workshop content a high rating, demonstrating that academicians value

Lean Education. Nonetheless, only a minor percentage of people understand Lean Education or teach it in the classroom.

3.10.3 Teaching and Learning Processes

According to Tatikonda (2007), they used the Lean Principle in their Accounting Courses to help ensure that students gained the knowledge and skills that would make them most desirable to employers. The author concluded that educators could improve their content, pedagogy, organisation, and assessment methods by implementing Lean Principles and techniques developed in the industry. Smith (2015) asserted that the Lean theory and selected techniques might apply to the design of a traditional undergraduate construction course to support effective learning and student development. The author found that applying one specific Lean method – one-piece flow – can be used in the construction estimating class. Smith (2015) demonstrated student perceptions of what is known as "small batch size learning" or "one-piece informational flow".

Tılfarlıoğlu and Anwer (2017) said that to apply Lean Thinking and create a Lean Culture classroom, a visual sheet, pre-planing, takt-time, standard work must be organised in the school syllabi, schedules, and associated materials. Other classroom tools, such as Pareto charts, root cause analysis, and weekly quality assessments, must also be available. The authors emphasised that teachers can eliminate reasons that add no value and focus their efforts on advancing teaching and learning by applying a Lean methodology to teaching processes. The author demonstrated how to use Lean production in education by identifying the process and then focusing on what adds value to students, empowering students to do continuous improvement, eliminating what does not add value through Kaizen, conducting PDCA, and forming teams to support and share.

Dinis-Carvalho and Fernandes (2017) applied Lean concepts in teaching and learning in student-centred learning environments. A pilot study was conducted as part of an engineering course at the University of Minho in Portugal. The model used was beneficial and contributed to improving the teaching and learning process while also encouraging the teacher to engage in continuous reflection on practice. According to Alves *et al.* (2017), Lean Thinking principles can apply to the teaching and learning process in the classroom by involving students in the improvement process and collecting continuous feedback. The author concluded that the Lean Principles and Lean Tools used for learning improvement are linked to Lean Thinking. Students would engage in Lean Thinking by conducting analysis and illuminating solutions using a Lean Tool or a set of Lean Tools.

Garay-Rondero et al. (2019) demonstrated that the Lean Thinking Learning Space (LTLS) is challenge-based, problem-based, project-based, and experiential learning. LTLS is a type of competency-based education that provides a learning environment for Higher Education with an interactive approach to teaching engineering content developing disciplinary and personal competence. According to Alves *et al.* (2020), Lean Thinking is a philosophy, a way of life, and applicable in various contexts. It has the same goal of improving the learning methodology process by using its principles and tools in administrative methods of schools and universities, classroom, and pedagogical project curricula.

During the SARS-CoV-2 pandemic, an Engineering Education environment applied the Lean 6S methodology. Jiménez *et al.* (2020) used the Lean 6S methodology, which focuses on developing three critical phases: cleaning, standardisation, and protection, to ensure the control of the SARS-CoV-2 health risk. The areas of selected implementation to verify the impact were the virtual spaces for the development of the teaching activity: centre accesses, learning rooms, and functional laboratories. A continuous evaluation of occupational safety provides this assurance.

Teachers in primary education face high-stress levels, but they lack coping strategies to reduce their work stress. Riezebos and Huisman (2020) created a value stream mapping method for education. They investigated its application as a rational coping mechanism for teams of teachers and other workers dealing with work-related stressors. Value stream mapping for schooling is a well-structured improvement tool that focuses on concepts of visualisation, engagement, and process thinking to help teachers analyse their processes in the absence of Lean

Thinking contexts. Using this method, the authors established rational coping mechanisms to alleviate teacher work-related stress.

Bhat *et al.* (2020) investigated the scope of collaborative learning in Outcome-Based Engineering Education (OBEE) using the Lean Thinking methodology. They investigated whether it could be successfully implemented in Indian Higher Education. The goal of implementing OBEE was to streamline the process, eliminate waste, and ensure the sustainability of the improved process. The study found that not only did the turnaround time improve, but so did the student performance. Furthermore, it improved team performance and spirit throughout the process. This method ensured that the process adds value while successfully applying industry best practices to Higher Education. This study demonstrated how its implementation could improve process efficiency and course productivity.

3.10.4 Leadership and Sustainability

Customer value is significant in "Lean Production Systems". The customer decides whether there is a value-add to the activities. The customer generally pays for products and services but not manufacturing operations and facilities. Dombrowski and Mielke (2013) sought to identify the relevant Lean leadership principles. Lean leadership is neither a replacement for nor addition to "Lean Production Systems". Lean leadership of the Lean Thinking organisation is missing from learning between the Lean toolbox and the continuous improvement.

Dombrowski and Mielke (2013) defined Lean Leadership as:

> "*Lean leadership is an organized system for the sustainable implementation and continuous improvement of Lean Production Systems. It describes the cooperation of employees and leaders in their mutual striving for perfection. It includes the customer focus of all processes as well as the long-term development of employees and leaders.*"

According to the authors, there are five principles. First, the "*improvement culture* encompasses all thoughts and behaviours in a never-ending pursuit of perfection". Next, "*self-development* is an essential principle of Lean leadership because some elements are determined by the leader's personality, while other elements can develop to learn". Third, the "*qualification* of employees is a key task in Lean leadership. It allows employees to take part in continuous improvement". Fourth, "Lean leaders should visit the shop floor regularly to understand the processes and make the most excellent decisions using the *Gemba* principle". The fifth principle is "*hoshin kanri*", also known as policy deployment in management. In summary, these five principles of "*improvement culture*, *self-development*, *qualification*, *Gemba*, and *hoshin kanri*" will assist executives in implementing Lean leadership.

Comm, C.L. and Mathaisel (2005a) stated that when Higher Education focuses on cost or budget control initiatives with the knowledge of implementing Lean practices, the results frequently reduce waste, improve operational efficiency, and contribute to economic sustainability. The authors investigated how universities and colleges pursued Lean practices to ensure educational institutions sustainability, despite the rising operating costs. Eighteen university administrators from public and private institutions answered the open-ended qualitative questionnaires. The authors noticed that many organisations identified Lean thinking as short-term cost savings rather than giving their clients the most value in processes. This reason was the inability of educational institutions to recognise their target customers and many old HEIs, who are struggling with the process change concept.

Comm, C.L. and Mathaisel (2005b) emphasised the importance of top leadership dedication, such as a President or Chancellor, to successfully implement the Lean approach. The authors proposed that Lean methods, such as "outsourcing non-core operations, partnering within and outside the institution, and leveraging new technologies", could be implemented in HEIs without identifying the specific technique.

Comm, C.L. and Mathaisel (2003) quoted, "Lean can mean 'less' in terms of waste, design time, and costs. Lean can also mean 'more' in terms of more employee empowerment, more flexibility and capability, more productivity, more quality, more customer satisfaction, and more long-term competitive success".

Lean is concerned with activities that add value. On college and university campuses, the use of Lean Thinking and cost-cutting strategies is becoming more visible. For example, contracted out to part-time instructors to design coursework has become a standard procedure. The process for achieving sustainability, on the other hand, is critical for colleges and universities. According to the authors, the proposed framework contains nine Overarching Practices (OP). Each OP has several enablers or best practices.

OP-1: "*Optimise the flow of products and services, either affecting or within the process, from concept design through point-of-use.* University establishes an online process for students to register for all courses."

OP-2: "*Provide processes and technologies for the seamless and timely transfer of and access to pertinent data and information.* University establishes distance learning for many required courses at the university."

OP-3: "*Optimise the capability and utilisation of people.* University offers distance learning courses to faculty to train them to teach these courses."

OP-4: "*Implement an integrated product and process, development teams*. University involves industry, administration, the board of trustees, faculty and staff, and students in making major policy changes at the university."

OP-5: "*Develop relationships based on mutual trust and commitment.* University develops good relationships with competing schools in terms of obtaining transfer students and jointly contributing to the community."

OP-6: "*Continuously focus on the customer*. University surveys students regularly at the beginning and end of each semester in their classes to ascertain their expectations and perceptions of their courses."

OP-7: "*Promote Lean Thinking at all levels*. Lean Thinking must be practised from the top down – from the university president to the janitorial staff."

OP-8: "*Continuous process improvement.* University offers bonuses or recognition to employees who "think out of the box" in promoting Lean initiatives."

OP-9: "*Maximise stability in a changing environment.* University offers distance learning courses to non-traditional students."

The 4P Model explains "how philosophy (long-term thinking), process (eliminate waste), people and partner (respect, challenge and grow them) and problem-solving (continuous improvement process and learning)". Dombrowski and Mielke (2014) claimed 4P Model is necessary to sustain Lean implementation and has 15 Rules:

R-01: "Continuous improvement demands the leader's continuity."

R-02: "Leaders have to promote the continuous improvement process but may not intervene directly in problem-solving."

R-03: "Errors will always occur - their consequences should be avoided."

R-04: "Self-awareness is the first step toward (self-) improvement."

R-05: "After a promotion, the status quo has internalised."

R-06: "Lean leadership requires different abilities and behaviour."

R-07: "Leaders have to make themselves in their actual job superfluous."

R-08: "All employees need to develop individually."

R-09: "Learning has to take place in short cycles."

R-10: "Decisions based on facts."

R-11: "The Gemba is the place of action and learning."

R-12: "Leading at the Gemba only works with a small leader to-employee ratio."

R-13: "Long-term goals never abandoned in favour of short-term goals."

R-14: "The target system is also used to assess employee development."

R-15: "In striving for perfection, the formulation of precise intermediate goals is indispensable."

Over the last ten years, management education has paid more attention to sustainability (Figueiró and Raufflet, 2015). The authors conducted a "systematic review" of 63 articles circulated between 2003 and 2013 in international Higher Education and management education journals. These articles were to be mapped and reviewed in four categories: paper type, challenges, teaching techniques, and curriculum orientation. Figueiró and Raufflet (2015) identified three opportunities for incorporating sustainability into management education. The first is research-based learning theories, which provide knowledge and change initiatives. The second component is more practical and concerns the design, identifying student learning outcomes. The third area concerns sustainability in management education and learning assessment.

3.10.5 Quality and Performance

Emiliani (2006) concentrated on addressing some apparent flaws in courses and degree programs to create highly differentiated educational opportunities that are more relevant to the needs of the students and the organisations hiring graduates. He proposed a series of interconnected changes and a fundamental restructuring of the MBA program to simplify, emphasise, and improve relevance. The curriculum offered for a completely restructured MBA program includes unique features that would broaden the value proposition for both students and employers. The proposed changes serve as a dialogue, debate, and future planning framework. Similarly, Hines and Lethbridge (2008) agreed that higher education had much opportunity to reduce waste and increase customer value.

Douglas et al. (2015) debated that to improve bottom-line performance, HEIs can reduce eight wastes (D.O.W.N.T.I.M.E.) and the costs of poor quality by using Lean Thinking. According to Cudney et al. (2018), Lean is a process improvement methodology that eliminates different forms of waste or activities with no value. It can accomplish without lowering the quality of services. Examples of wastes are photocopying mistakes, assignment or examination mark submission errors, and funding application processes. Douglas et al. (2015) translated Lean's eight wastes into a higher education context by identifying and providing, illustrating the wastes, the costs associated with them to both the institution and customer and proposing various solutions for their elimination. Simmons and Young (2015) discussed how Lean concepts fit with consumer value enhancement targets (student concern from a Lean perspective), reducing waste (costs), and encouraging graduates' performance and productivity.

Tight (2019) identified and analysed many of the systematic reviews and meta-analyses of Higher Education research areas or aspects conducted. The author demonstrated the breadth and depth of Higher Education research by identifying eight themes that require additional attention: teaching and learning, course design, the student experience, quality, system policy, institutional management, academic work, knowledge, and research. However, Sfakianaki and Kakouris (2019) revealed that the following factors are essential for Lean Thinking Education: top management leadership; employee empowerment and cooperation;

education training and learning; measurement evaluation and data reporting; supplier partnership; changing environment and culture; student value; continuous improvement; identification of waste and quality with zero defects. Koromyslova *et al.* (2019) provided a case study of a Kaizen event held in a multi-disciplinary academic department of an engineering college that demonstrated proof of concept. An overview of the continuous improvement journey at the Construction and Operations Management (COM) Department of South Dakota State University (SDSU). Higher education is a labour-intensive operation, so the department strives to eliminate non-value-added faculty and staff activities, reduce time and effort required in everyday processes, and improve student learning experiences. The need to strategically optimise resources to meet stakeholder requirements, reduce waste or costs, and increase satisfaction with under-performing operations drives colleges and universities to adopt Lean practices. Kregel (2019) wondered, on the other hand, "Can the Kaizen philosophy successfully apply to course quality in HEIs?" The author noticed that course concepts, material, presentation style, and content significantly impacted exam grades. As a result, Kaizen could successfully improve course quality, particularly in newly developed courses.

Davidson *et al.* (2020) published a systematic review on quality frameworks in Higher Education. Quality frameworks establish a baseline for teaching and student learning. Lean Six Sigma is an improvement methodology, and this paper will discuss the factors that drive Lean Six Sigma implementation in HEIs. The findings indicate that academic, professional practice must go beyond quality assurance to achieve student transformation. According to the authors, the success factors for implementing Lean Thinking in Higher Education are leadership and culture, implementation planning and coordination, communication, and student focus.

While some HEIs in Ireland have adopted Lean Six Sigma, only a few have implemented an integrated Lean Six Sigma strategy for waste reduction in the research grant application process. Dempsey *et al.* (2020) used an online survey of 240 academics and researchers to identify barriers and waste in the research grant application process within an Irish HEI in an EU environment. Using the

Lean Six Sigma lens, the primary waste in the research grant application process from an academic and researcher perspective is described as editing and revising applications, liaising and interacting with partners, and waiting for information. The author concluded that key obstacles, organised thematically, were strategic thinking, partner recognition and coordination, eligibility, method, time, and support and mentoring.

3.11 Evidence-Based Practice

3.11.1 The Basic of Evidence-Based Practice

Evidence-based practice is nothing new or complicated, or mind-blowing. It is not a disruptive approach to any problem that changes the paradigm. It does not have complex equations and does not need a team of geniuses. It would not be possible to think outside the box with excellent concepts. It will do something much more exciting, engaging, and significant than all of these put together. It will assist in making better decisions (Jones, 2018; Briner, 2019).

Briner (2019) asserted that there are four (4) sources to gather evidence to help to identify the problems. These sources are "Scientific Literature (empirical studies), Organisational (internal data), Stakeholders (values and concerns) and Practitioners (professional expertise)". Evidence-based practice is about making decisions using the best available evidence from multiple sources conscientious, explicit, and judicious. These six (6) steps are "asking, acquiring, appraising, aggregating, applying and assessing" to increase the likelihood of a favourable outcome shown in *Table 3.27* (Jones, 2018; Briner, 2019). Jones (2018) used the concept of evidence-based practice in education to establish the critical abilities required for any type of practice.

Table 3.27 - Six Steps for Evidence-Based Practice (Jones, 2018; Briner, 2019)

Action	Description
Asking	Translating a practical issue or problem into an answerable question.
Acquiring	Systematically searching for and retrieving the evidence.
Appraising	Critically judging the trustworthiness and relevance of the evidence.
Aggregating	Weighing and pulling together the evidence.
Applying	Incorporating the evidence into the decision-making process.
Assessing	Evaluating the outcome of the decision taken.

3.11.2 Evidence-Based Practice in Education

Evidence-based practice's basic idea is that good quality decisions should be based on critical thinking and the best available evidence. Although all lecturers and educational leaders use evidence to make decisions, many overlook the quality of that evidence. As a result, are terrible decisions based on unfounded beliefs and fads like Brain Gym, Learning Styles, and Interactive Whiteboards. The bottom line is bad decisions, poor student outcomes, and a lack of understanding of why things go wrong. The evidence-based practice seeks to improve decision-making. It is a decision-making and day-to-day work practice approach that assists educators, whether lecturers, department heads, or senior leaders, in critically evaluating the extent to which they can trust the evidence they have at hand. It also assists educators in identifying, finding and assessing additional evidence relevant to their decisions (Jones, 2018).

3.11.3 Misconceptions of Evidence-Based Practice in Education

Table 3.28 summarises the eight misconceptions of evidence-based practice (Jones 2018). It is critical to dispel these misconceptions for three reasons. First, these misconceptions prevent practitioners from making the most of the potential of evidence-based practice to improve student outcomes. Second, by conflating evidence-based practice with research, lecturers are being mistakenly encouraged to be researchers rather than evidence-based practitioners seeking to improve student outcomes. Third, failing to make good use of evidence-based practice can increase the waste of scarce resources (Jones, 2018).

Table 3.28 - Misconceptions of Evidence-Bases Practice (Jones, 2018)

Misconceptions	Description
Misconception 1	Evidence-based practice ignores the practitioner’s professional experience.
Misconception 2	Evidence-based practice is the same as research-informed practice.
Misconception 3	Evidence-based practice involves lecturers undertaking research.
Misconception 4	Evidence-based practice is all about numbers and statistics.
Misconception 5	School Leaders make decisions and do not have time for evidence-based practice.
Misconception 6	Each school is unique, so the usefulness of scientific evidence is limited.
Misconception 7	If you do not have high-quality evidence, you cannot do anything.
Misconception 8	Good-quality evidence gives you the answer to the problem.

3.11.4 Source of Evidence in Education

Before making an important decision, an evidence-based school leader starts by asking, "What is the available evidence?" An evidence-based school leader discovers the known by looking for evidence from multiple sources rather than relying solely on personal judgment. According to the principles of evidence-based practice, four sources of evidence should be considered (Jones, 2018). The first source of evidence is *educational and other research*, research published in academic journals, findings from published academic studies. The second source of evidence is *school/college*, which provides evidence in many forms. These are the facts, figures, and data gathered from the school/college. The third source of evidence is *experiential*, the professional experience and judgment of lecturers, school leaders and other school-related professionals. The fourth source of evidence is *stakeholder* values and concerns of people who may be affected by the decision.

3.11.5 Evidence-Based Lean Thinking Practice

Lean Thinking is a methodology of high performance that enables organisations to focus on improvement and value. The foundation of Lean Thinking is "Respect for People" and "Continuous Improvement". Lean Thinking has a long history in manufacturing, more recently in the service environments, health care, and the public sectors (Gupta *et al.*, 2016). The application of Lean Thinking in Higher Education can transform this sector and the number of Lean practitioners in universities.

Evidence-based practice is a systematic approach to synthesising and generalising relevant data findings from research studies that support the impact of an outcome and the application of the evidence (Jones, 2018). This study aims to bridge this gap to investigate how SPHEIs use Lean Thinking practice in CP&DP, which are at the heart of any academic institute, either directly or indirectly, to achieve student learning development and satisfaction

3.12 Theoretical Framework of the Literature Review

Varpio *et al.* (2020) defined a theoretical framework: "A researcher-constructed structure explaining the concept and premises, from the theory or theories that ground the study and scaffold. It answers the question: 'How does this theory shape the study?' " The researcher created a literature review theoretical framework after reviewing the literature in critical themes, as shown in *Figure 3.24*.

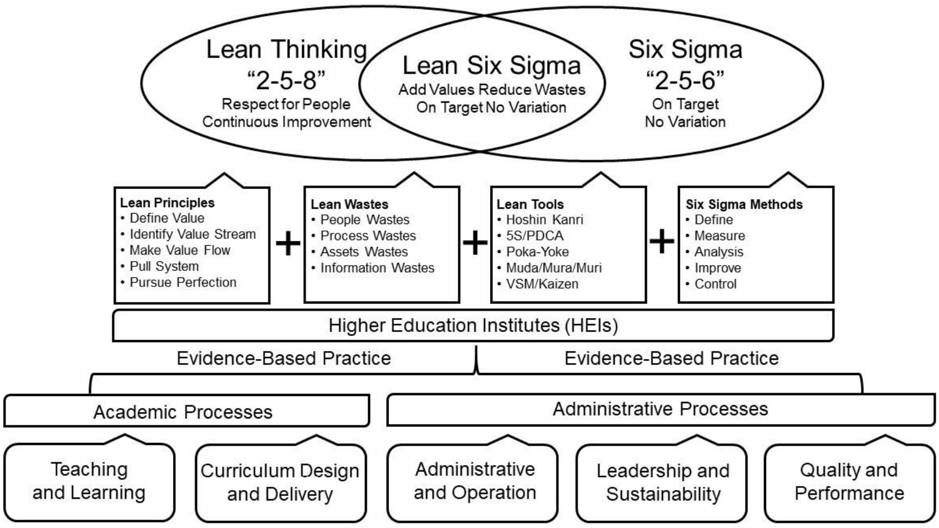


Figure 3.24 - Theoretical Framework of the Literature Review (Source: Author)

Higher education is one of the most challenging industries to apply Lean/Lean Thinking. There is a substantial knowledge of Lean literature in manufacturing, government, banking, and health care industries. On the other hand, there is insignificant literature about Lean/Lean Thinking in PHEIs, even though Six Sigma, Lean Six Sigma, or Lean/Lean Thinking has been widely used for Higher Education by different countries (Coowar *et al.*, 2006; Thirkell and Ashman, 2014; Jahan and Doggett, 2015; Lu *et al.*, 2017; Sremcev *et al.*, 2018; Singh, M. and Rathi, 2019). However, most previous studies have been conducted on universities in the United States, the United Kingdom and India. This literature review revealed the critical Lean/Lean Thinking in Higher Education themes: administration and operation process; curriculum design and delivery process; teaching and learning process; leadership and sustainability; quality and performance. According to Shook (2020), Lean Thinking practice will assist the SPHEIs in becoming both innovative and competitive, allowing them to become sustainable. Lean Thinking maximises customer value while minimising time, resources, energy, and effort.

3.13 Knowledge Gap Analysis

The researcher identified a research gap, as shown in *Figure 3.25*. Lean Thinking is not a new concept (Womack and Jones, 2003; Womack et al., 2007), but SPHEIs have yet to fully explore and adopt Lean Thinking (Toh, 2012). According to Balzer (2010; 2020), Lean Higher Education is a powerful strategy supported by Lean Thinking. Lean Thinking is strategic planning that includes vision and values, alignment and leadership, aligned people and thinking, execution, and transformation. SPHEI strategic planning intertwines with marketing, operational decisions, and other issues. SPHEIs must transform to become more efficient and effective, and therefore it is necessary to investigate whether Lean Thinking can improve academic processes and change SPHEIs. Evidence-based practice is a systematic approach to synthesising and generalising relevant data findings from research studies that support the impact of an outcome and its application (Jones, 2018). Stakeholder evidence is “the values and concerns of people who may be affected by the decision” (Jones, 2018). In addition, the researcher found only two articles on Six Sigma and Lean management connected to Singapore in bibliometric analysis (See Chapter 2). Thus, there appears to be a gap in the recent literature concerning Lean Thinking practice in the SPHEIs. This study aims to bridge this gap by investigating, exploring, and proposing how evidence-based Lean Thinking practice in CP&DP, which are at the heart of any academic institute, can achieve student learning development and satisfaction.

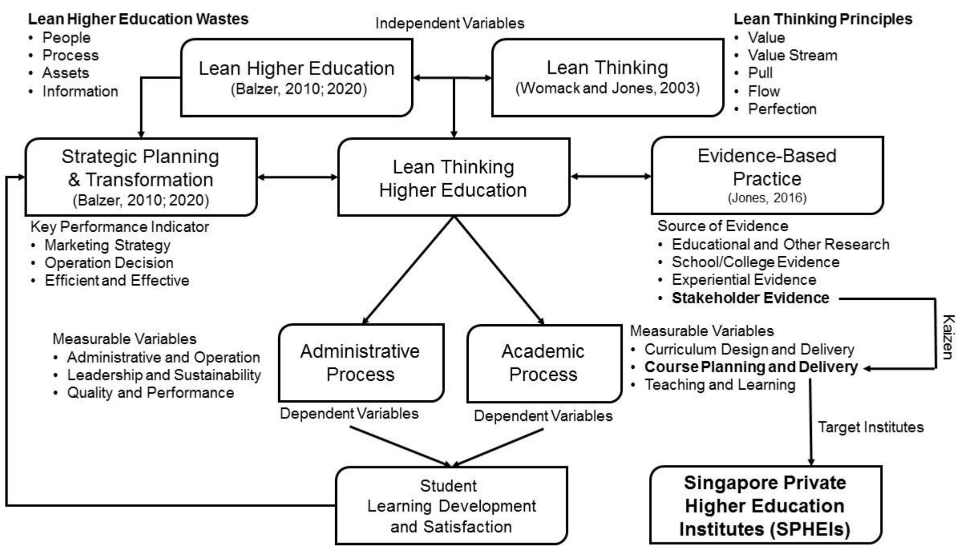


Figure 3.25 - Knowledge Gap Analysis (Source: Author)

3.14 Conceptual Framework of the Research Study

Varpio *et al.* (2020) defined conceptual framework: "A researcher-constructed logically-developed argument justifying the need for the research study. It shapes the study design and guides its development. It answers questions of 'Why is this research important?' and 'How does it contribute new knowledge?' " The researcher created a conceptual framework of the CP&DP shown in *Figure 3.26*.

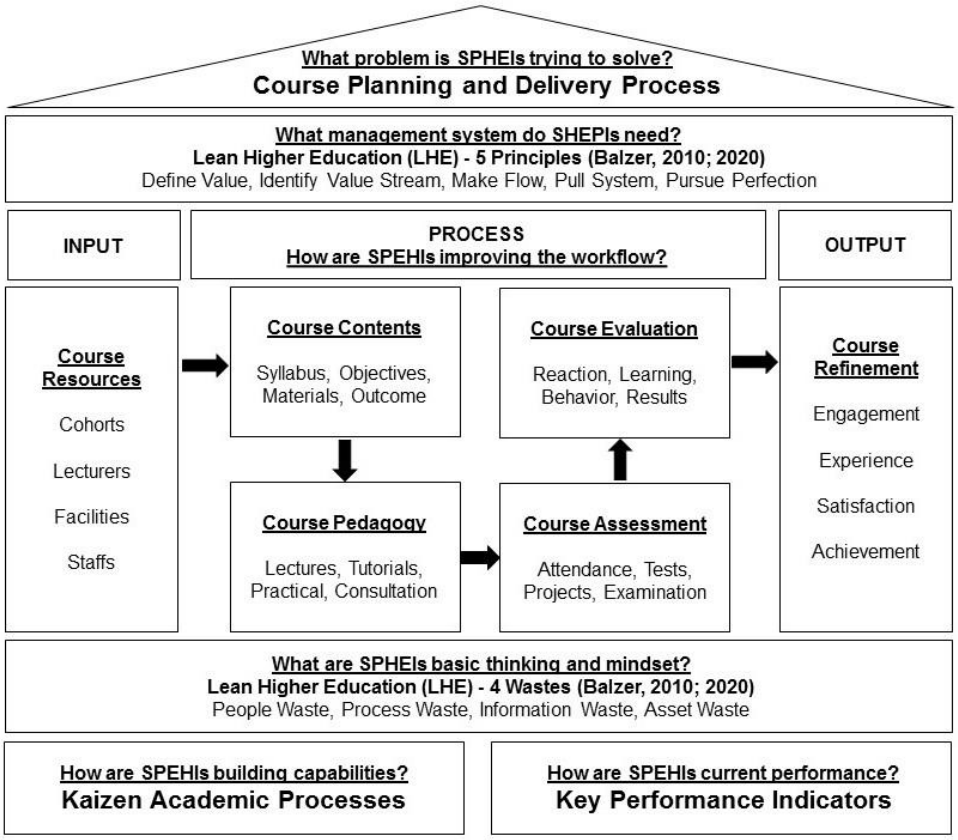


Figure 3.26 - Conceptual Framework of the Research Study (Source: Author)

- ***What problem is SPHEIs trying to solve?***

  The problem begins by clarifying whether SPHEIs have established the value-driven function of their institutes. For example, if the administrators plan the timetable, have they clearly defined their target from a student's perspective regarding quality, cost, and lead time? Then what is their current situation as compared with the target? The administrators may need a month to plan the timetable, but students and lecturers expect it to be ready in two weeks. That gap is a problem that needs to be solved.

- ***What management system do SPHEIs need?***

  SPHEIs may encounter management system problems as they develop their people's ability to improve work processes. It could be related to how the SPHEIs are organised. How does the system connect to the day-to-day operations at the actual workplace? How does communication and work review on a daily, weekly, and monthly basis help? What are leadership behaviours (Shook, 2020) required to identify and resolve problems as soon as possible?

- ***What are SPHEIs basic thinking and mindset?***

  This question seeks to identify the fundamental thinking or mindset that underpins SPHEI. One of the basic assumptions is that SPHEIs will focus on improving value-added work and demonstrate respect for people by ensuring the work is also value-added. Another fundamental mindset in shortening the lead time from four to two weeks is to focus the work on the needs of the students and lecturers. The results from transforming the educational process as SPHEIs improve their work (Shook, 2020).

- ***How are SPHEIs improving the workflow?***

  SPHEIs must first prioritise front-line work to achieve their purpose as an institute. Have SPHEIs broken down and clarified what the job needs and what improvements are required? In timetable planning as an example, is it the resource shortage, process constraints, or logistics related issues? Many standard Lean tools like 5S, Kaizen, PDCA, Value Stream Mapping, and many others assist SPHEIs in improving their work (Shook, 2020).

- ***How are SPHEIs current level of performance?***

  SPHEIs must assess their current institute's performance using the following key indicators: Higher Education Performance, Higher Education Productivity, Higher Education Quality, Delivery Values, Remove Wastes, Student Satisfaction and Student Development.

- ***How are SPHEIs building capabilities?***

  According to Shook (2020), once SPHEIs define the problem and the improvements needed to address it, they will discover that they may not solve their problems with their current capabilities. To reduce the time it takes to deliver their timetable by two weeks, they may need to add new capabilities to the planning process. Furthermore, developing the ability to transform is a natural part of the Lean transformation process. How capable are the institutes of solving problems and continuously improving? How have SPHEIs defined the skills they require and devised a plan to develop them?

Lean Thinking maximises customer value while minimising time, resources, energy, and effort. Whatever role people play in institutes, whether it is improving the work of one operator on the ground or trying to change processes in an entire institute, this is not an easy task for SPHEIs to transform using Lean Thinking practice. (Shook, 2020). The study contributes to the Lean Thinking Kaizen Academic Process Canvas (See Chapter 6) guideline for SPHEIs. The statistical study data contribute to developing a policy for the CPE to use as a benchmark.

3.15 Chapter Summary

The researcher conducted the literature review on Six Sigma, Lean Six Sigma, Lean/Lean Thinking and Higher Education. This chapter supplied an overview of Six Sigma and Lean/Lean Thinking, including their theories, methodologies, and tools.

The following points are highlighted in the review:

- There is substantial knowledge of the Lean literature in manufacturing, government, banking, and health care industries. However, there has been insignificant literature about the use of Lean Thinking in Higher Education. Higher education is one of the most challenging industries that Lean Thinking can be applied.

- Most completed studies are based at universities in the United States, the United Kingdom, and India, benefiting from Lean Higher Education significantly. This review illustrated the critical Lean Thinking in Higher Education themes administration and operation process; curriculum design and delivery process; teaching and learning process; leadership and sustainability; quality and performance.

- The review also looked at evidence-based practice in Higher Education, such as the source of evidence and common misconceptions, before moving on to evidence-based Lean Thinking practice.

- The researcher has developed and discussed the theoretical framework of literature review, knowledge gap analysis, and conceptual framework of the research study.

The following chapters will deal with empirical research through a suitable research design and methodology used to deliver the research questions.

Chapter 4 – Research Methodology

4 Research Methodology

4.1 Introduction

This chapter addresses the research methodology and design employed in this research project. Quantitative and qualitative categories are the two primary types of research methods. Quantitative research uses statistical methods to solve problems, validate hypotheses and interpret the derived outcomes/analysis, whereas qualitative research focuses on words, emotions, feelings, sounds, and other non-numerical elements (Dudovskiy, 2011; Alan Bryman, 2015; Zikmund, William, Quinlan, Christina, Carr, Jon, Griffin, Mitch, Babin, 2019; Creswell and Guetterman, 2019). Dudovskiy (2011) also structured various types of research methods, as shown in *Figure 4.27*. The three types of research methods are the "nature of the study", the "purpose of the study", and "research design". The "nature of the study" used descriptive and analytical research. Descriptive research typically requires surveys and investigations aimed at verifying facts. Analytical research requires analysing facts already available for critical evaluation. Next, the "purpose of the study" can be divided into fundamental and applied research. Fundamental research tries to solve a problem by broadening the scope of the application of discipline. Applied research aims to do away with theory by contributing to the fundamentals of the profession. Third, "research design" can be divided into exploratory and conclusive. Exploratory studies are designed to learn more about the research area and do not strive to provide definite or conclusive solutions to research questions. Conclusive studies have resolved research questions definitively and conclusively.

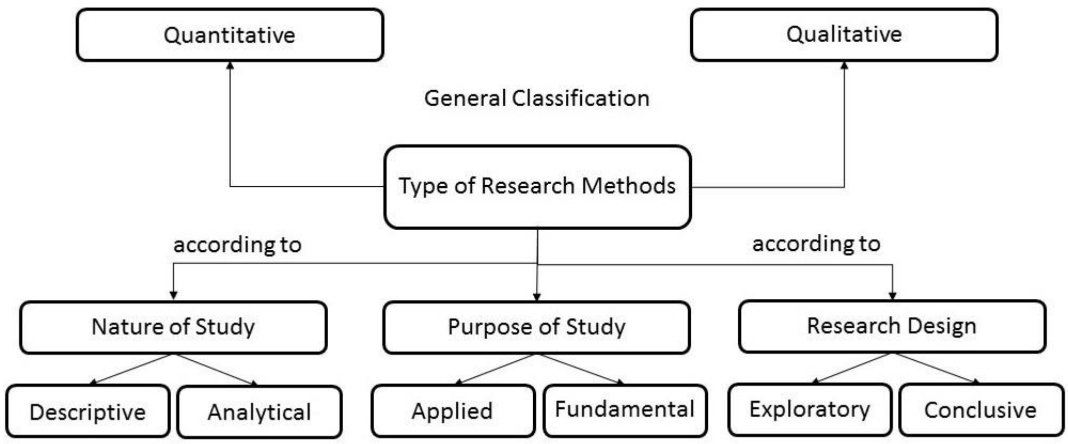


Figure 4.27 - Type of Research Methods (Dudovskiy, 2011)

A cross-sectional survey collects more facts about the context of the Lean Thinking practice in the SPHEIs. An empirical study was conducted, using triangulation embedded mixed-method, to address the bibliometrics analysis and literature review gap. Since the study aims to investigate the application of Lean Thinking practice in CP&DP for SPEHIs, the research work examines the role of academic processes and describes the characteristics of the population without attempting to change the current scenario of SPEHIs. It is descriptive due to the nature of the study.

4.2 Research Onion

The research onion model was developed by Saunders *et al.* (2015) in their book titled *Research Methods for Business Students*. This model explains the different stages of writing a dissertation to help researchers create a well-organised methodology. The research onion model consists of six main layers shown in *Figure 4.28,* which symbolically illustrates how different elements involved in the research can examine to develop the final research design.

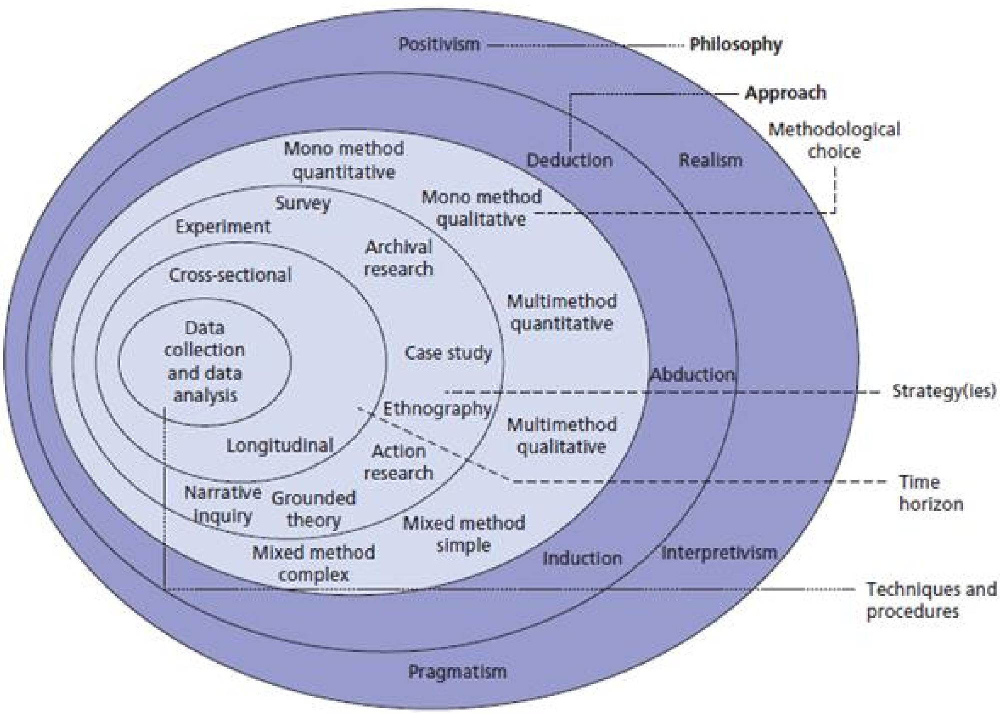


Figure 4.28 - Research Onion (Saunders et al., 2015)

Research methodology ("how we should best collect the data") is a systematic approach for collecting and evaluating data in the research process. It provides a logical explanation behind the steps taken in the research, and defines, explains and predicts phenomena. It is defined as the study of methods ("details of exactly how we collect the data") by which knowledge is gained, and it aims to lay out the research work plan. According to Saunders *et al.* (2015), the research methodology is divided into different layers of research onion model such as Research Philosophy, Research Approaches, Methodological Choices, Research Strategies, Time Horizons, Data Collection and Data Analysis, as shown in *Figure 4.28*. The researcher explains and justifies each layer of methodological research decisions to have maximum credibility.

4.3 Research Design

Research design (Saunders et al., 2015) is the framework of research methods and techniques chosen by the researcher to answer research questions. The strategy defines the study type, research problem, hypotheses, independent and dependent variables, experimental design, and, if applicable, data collection methods and a statistical analysis plan. The research design for this project is illustrated in *Table 4.29*.

Table 4.29 - Research Design (Saunders et al., 2015)

Elements	Description (Source: Author)
Research Philosophy	Epistemology pragmatism (Section 4.4)
Research Approach	Abductive (Deductive/Inductive) to test the hypotheses (Section 4.5)
Methodological Choice	Embedded Mixed-Methods (Section 4.6)
Research Strategy	Collection of quantitative and qualitative data in parallel (Section 4.7)
Time Horizons	Cross-sectional survey (Section 4.9.1)
Data Collection	Using an online survey (formerly BOS) to collect the data (Section 4.9.2)
Triangulation Approach	Methodological, Data and Theoretical Triangulation (Section 4.9.3)
Sampling	Sampling Respondents and Survey Administration (Section 4.10)
Data Analysis	Analyse and interpret both quantitative and qualitative data (Section 4.11)

4.4 Research Philosophy

According to Dudovskiy (2011), a research philosophy can be viewed in two ways: epistemology and ontology. In a business study, epistemology is concerned with the sources of knowledge. Ontology is concerned with the nature of reality. Epistemology is emphasis what is known to be true. However, ontology is a belief system that represents an individual's interpretation of what constitutes a fact. Dudovskiy (2011) illustrated the epistemology and ontology of three major research philosophies related to business studies shown in *Table 4.30*.

Table 4.30 - Comparison of Research Philosophy (Dudovskiy, 2011)

Research Philosophy	**Epistemology How should we investigate the world**	**Ontology How we view the world**
Positivism	"Focus on causality and law-like generalisations, reducing phenomena to simplest elements."	"External, objective and independent of social actors."
Interpretivism	"Focus upon the details of the situation, a reality behind these details, subjective meanings, motivating actions."	"Socially constructed, subjective, may change, multiple."
Pragmatism	"Focus on practical applied research, integrating different perspectives to help interpret the data."	"External, multiple views are chosen to enable the best answering of the research question."

Positivism is based on the idea that science is the only way to learn about the truth. Positivism depends on quantifiable observations that lend themselves to statistical analysis. Interpretivism integrates human interest into a study and involves researchers interpreting elements of the study. Interpretivism studies usually focus on meaning and may use multiple methods to show different issues, such as interviews and observations. Pragmatism recognises different methods of interpreting, and no single point of view can ever give the entire picture. Pragmatics can combine both positivism and interpretivism. The scope of single research according to the nature of the research question (Dudovskiy, 2011; Alan Bryman, 2015; Quinlan, Christina, Zikmund, 2015; Zikmund, William, Quinlan, Christina, Carr, Jon, Griffin, Mitch, Babin, 2019).

A large sample is the data collection technique for positivism. Data is highly structured; measured in quantitative may also be qualitative. For interpretivism, data is in small samples, qualitative investigate in-depth approach. The third research philosophy, pragmatism, is mixed or multiple method designs, data collection is quantitative and qualitative (Dudovskiy, 2011). The research philosophy of this study was epistemology ("how we should investigate the world") pragmatism.

4.5 Research Approach

Dudovskiy (2011) concluded that pragmatics research philosophy could integrate research strategies and approaches within the same study shown in *Table 4.31*. Pragmatists use a method or combination of methods that advance specific research in the best possible way to find answers to research questions.

Table 4.31 - Positivism, Interpretivism and Pragmatism (Dudovskiy, 2011)

Research Philosophy	Research Strategy	Research Approach
Positivism	Quantitative	Deductive
Interpretivism	Qualitative	Inductive
Pragmatism	Quantitative and Qualitative	Abductive (Deductive/Inductive)

Dudovskiy (2011) used quantitative research methods focusing on statistics and mathematical calculations to measure the degree of occurrences. The quantitative method describes, explains, predicts, data collection and analysis extensive sample size data with the aim of testing hypothesis and building on existing knowledge, deductive in orientation. The qualitative method interprets, collects, and analyses small sample data to construct the meaning with phenomenon attached, inductive in direction. Qualitative research methods are exploratory, primarily concerned with understanding the underlying causes and motives.

A deductive approach concerns formulating a current hypothesis theory or hypotheses and then devising a research method to evaluate the hypotheses. At the beginning of the study, the researcher developed a collection of hypotheses in studies with the deductive method. At the start of an inductive approach, no theories or hypotheses would be applicable. In contrast, the inductive approach or reasoning begins with observations and ends with theories offered near the end of the research process. (Dudovskiy, 2011; Alan Bryman, 2015; Quinlan, Christina, Zikmund, 2015; Zikmund, William, Quinlan, Christina, Carr, Jon, Griffin, Mitch, Babin, 2019).

Deductive reasoning is "criticised for lacking clarification in selecting a theory to be tested via formulating hypotheses". Inductive reasoning is "criticised for not having any amount of empirical data that will necessarily enable theory-building". The abductive approach is "set to address weaknesses associated with deductive and inductive approaches". Abductive reasoning has "overcome these weaknesses via adopting a pragmatist perspective" (Dudovskiy, 2011; Alan Bryman, 2015; Quinlan, Christina, Zikmund, 2015; Zikmund, William, Quinlan, Christina, Carr, Jon, Griffin, Mitch, Babin, 2019). After reviewing the research approach, the researcher adopted the abductive (deductive/inductive) in this study.

4.6 Methodological Choice

O'Leary (2017) argued that the research approach relies on quantitative data, which is numerical data, then interpreted statistically. Frequently associated with a set of assumptions that participants will answer research questions truthfully, researchers explain the data collection process and how researchers will maintain anonymity and confidentiality to maximize truthfulness. On the other hand, an approach is highly reliant on qualitative data, which are words, images, experiences and observations that are not qualified. Often tied to a set of assumptions related to research, it is context-bound; research based on inductive forms of logic; categories of research interest; recognize and acknowledge the value-laden nature of the research. According to the author, a mixed research approach employs qualitative and quantitative data.

Mixed methods research is a method for conducting research that involves collecting, analysing, and integrating quantitative and qualitative data in a single study or a longitudinal investigation program. This form of research combines qualitative and quantitative research to understand better a research problem or issue than either research approach alone (Creswell, 2015; Creswell *et al.*, 2017). The mixed-methods notation is shown in *Table 4.32*.

Table 4.32 - Mixed Methods Notation (Creswell et al., 2017)

Notation	Description
"Qual"	"Qualitative"
"Quan"	"Quantitative"
"UPPER CASE"	"Indicate that method is dominant in the study design and purpose (e.g. QUAN)."
"lower case"	"Indicate the less-dominant method in the study (e.g. qual)."
"QUAL, QUAN"	"Common indicates methods equal in dominant."
"QUAL + QUAN"	"Plus-sign indicates methods occurs at the same time (i.e. concurrent design)."
"QUAL → QUAN"	"Arrow indicates methods occur in a sequence (i.e. sequence design) with the first noted method occurring chronologically before the latter."
"QUAN (qual) "	"The method in brackets is embedded within a larger design, with the non-bracket method dominant (i.e. embedded design)."
"QUAL →← QUAN"	"The method is implemented in a recursive process (e.g. Qual → Quan → Qual → Quan)."
"QUAL → QUAN → [QUAN + qual]"	"The mixed-method [QUAN + qual] is used within a single study/project within a series of studies."
"QUAN + QUAL ="	"An equal sign denotes the purpose of integration in a concurrent design (e.g. convergence, divergence, explanation)."

Mixed methods have many different designs, and researchers frequently use other notation to refer to these designs. There are two types of mixed methods research designs depending on whether qualitative or quantitative data are collected concurrently or sequentially, as shown in Figure 4.29.

- **Exploratory and Explanatory Mixed Methods Design**

  Exploratory and explanatory mixed methods design are examples of sequential mixed methods design. In a sequential mixed methods design, data is first collected. Analysis of the data using the first method precedes the design and is then followed by the execution of data collection by the second method (Creswell, 2015).

- **Convergent and Embedded Mixed Methods Design**

  Convergent and embedded mixed methods are examples of concurrent mixed methods design. In a concurrent mixed methods design, qualitative and quantitative data are collected at the same time frequently from the same people or participants (Creswell, 2015).

- **Multiphase and Iterative Mixed Methods Design**

  Finally, a multiphase or iterative mixed methods design can be formed by combining a series of sequential and concurrent designs (Creswell, 2015).

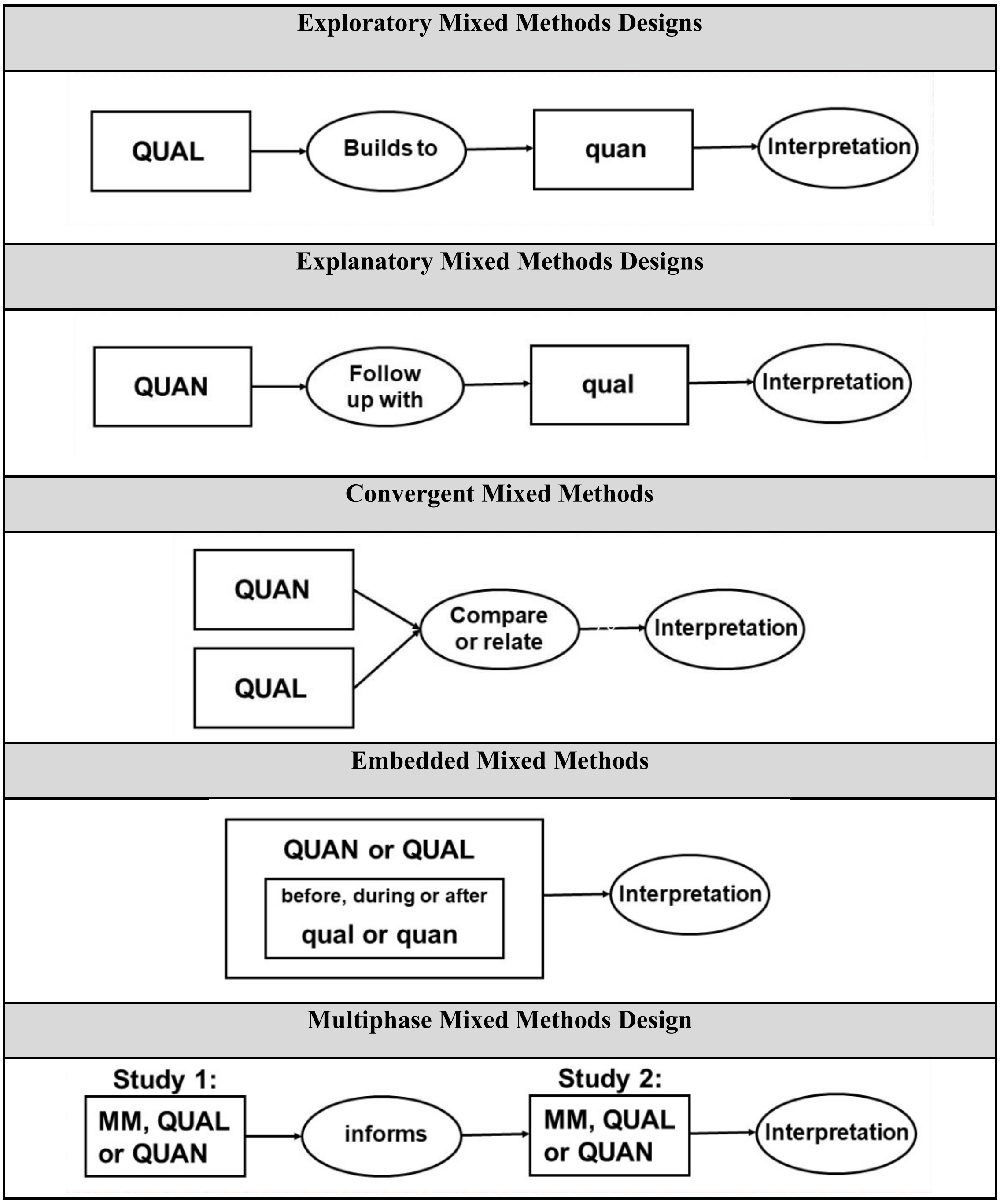


Figure 4.29 - Type of Mixed Methods Design (Creswell, 2015)

The researcher has adopted an embedded mixed-method design [QUAN(qual)] (Creswell, 2015) to collect and analyse both quantitative and qualitative data shown in *Figure 4.30*. In embedded mixed-method design, mixing occurs in a parallel way, either concurrently or with some time-lapse, by administering quantitative and qualitative questions (Creswell, 2015). The data is gathered for both quantitative and qualitative simultaneously, analysed separately, and then compared and related.

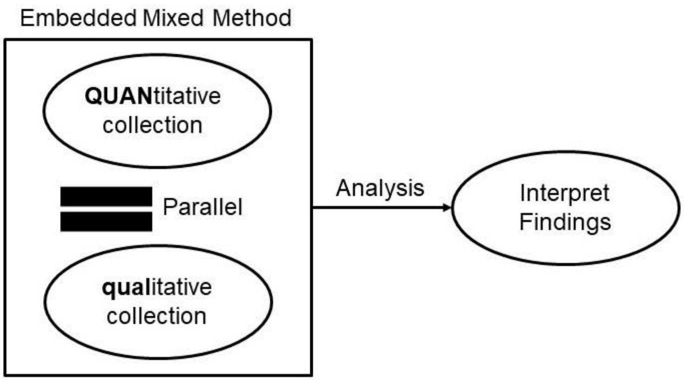


Figure 4.30 - Embedded Mixed-Method Design (Source: Author)

Data for this study was gathered using both quantitative (self-administered survey questionnaires) and qualitative methods (self-administered open-structure questions). Both quantitative and qualitative methods were critical in answering the research questions and developing the Lean Thinking Kaizen Academic Process Canvas (See Chapter 6). The online survey began in June 2020, but data collection took several months due to Singapore's COVID19 lockdown ("circuit breaker") since April 2020.

4.7 Research Strategy

This mixed-methods study looks at CP&DP's evidence-based Lean Thinking practice for SPHEIs. It aims to trace the relationship between independent variables (Lean Principle, Wastes and Tools) and dependent variables (course resources, course contents, course pedagogy, course assessment, course evaluation and course refinement). The researcher collected quantitative and qualitative data in parallel. Quantitative data were statistically analysed to demonstrate that the concept theory of Lean Thinking can positively improve CP&DP for SPHEIs. The qualitative data suggest that Lean Thinking has a significant impact and influence on the CP&DP for SPHEIs, which results in the independent-dependent variable relationships. The purpose of collecting both quantitative and qualitative data is better to understand the quantitative results at a deeper level using qualitative data. Both methods are essential in answering the research questions. It is descriptive due to the nature of the study.

4.8 Structure of Survey Questions

Figure 4.31 depicts the interdependence of the hypotheses of Lean Thinking versus CP&DP. There are three (3) hypotheses. The first null hypothesis ($H01_{null}$) seeks to ascertain the current level of evidence for Lean Thinking practice in SPHEIs. The second null hypothesis ($H02_{null}$) looks into the relationship between dependent variables (course resources, course contents, course pedagogy, course assessment, course evaluation and course refinement) and independent variables (Lean Principles, Wastes and Tools). The third null hypothesis ($H03_{null}$) is to understand the current Lean thinking practice level that can significantly influence KPI for SPHEIs. These hypotheses are associated with the research questions (RQs). The research questions (RQs) align with the research objectives (ROs), and the research objectives answer the research aim.

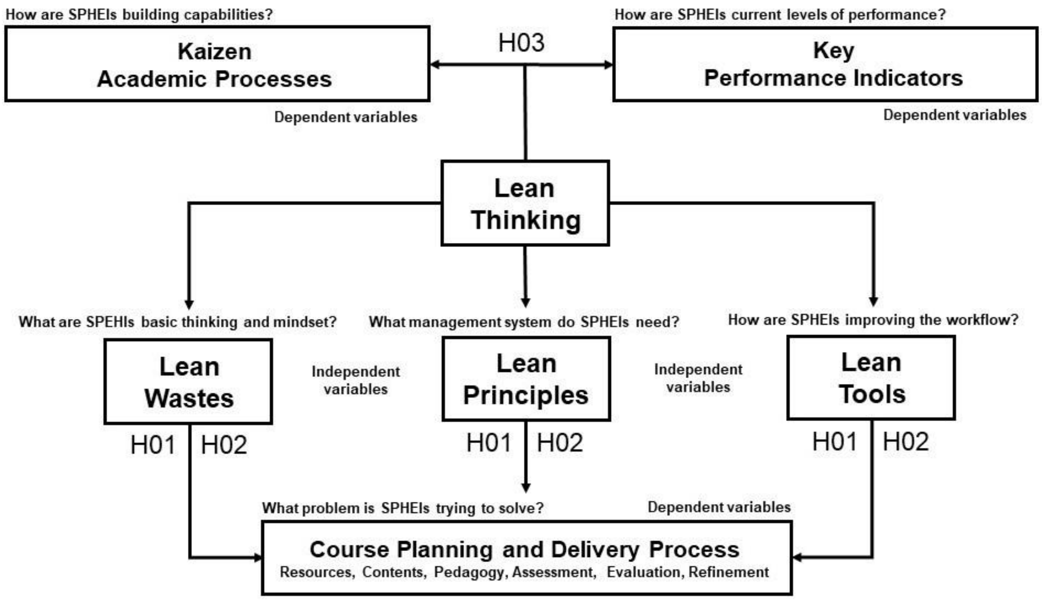


Figure 4.31 - Research Hypotheses (Source: Author)

There were nine (9) self-administrated Likert scale questionnaires (C1 to C9) and five (5) self-administrated open-structure questions (C10.1 to C10.5). The relationship of research questions, research objectives and research hypotheses are shown in *Table 4.33*.

The first research question (RQ1) determines the current level of Lean Thinking evidence practice in SPHEIs. The CP&DP classifies into six categories: course resources, course contents, course pedagogy, course assessment, course evaluation and course refinement. Lean Tools competency has Hoshin Kanri, 5S, PDCA, Poka-Yoke, Muda (Waste), Muri (Overburden), Mura (Unevenness) and Value Stream Mapping. Both results address the first null hypothesis ($H01_{null}$), the current Lean Thinking evidence-practice level in SPHEIs for CP&DP.

The second research question (RQ2) addresses the essential aspect of the study. The purpose of this study is to look at the significant influence and correlation between independent variables (Lean Principle and Wastes) and dependent variables (course resources, contents, pedagogy, assessment, evaluation and refinement). To investigate the second null hypothesis ($H02_{null}$), how SPHEIs practice Lean Thinking directly or indirectly.

The third research question (RQ3) investigates the current Lean Thinking practice that influences the KPI in SPEHIs. It examines the third null hypothesis ($H03_{null}$), the significant influence and correlation between Lean Thinking practice in the CP&DP versus KPI, Lean Tools competency versus KPI, and Lean Thinking relationship versus KPI.

The final research question (RQ4) investigates how SPHEIs use Lean Thinking practice to improve academic processes. The purpose of collecting more qualitative facts is to interpret, understand, and answer the quantitative research questions more resounding.

Table 4.33 - Research Questions, Objectives and Hypotheses (Source: Author)

<table>
<tr><th>Dependent Variables</th><th>Attributes used in Survey Questionnaire</th><th>Independent Variables</th><th>Research Questions, Objectives and Hypotheses</th></tr>
<tr><td colspan="4">Lean Thinking evidence-practice + Lean Tools competency</td></tr>
<tr><td colspan="3">Q1: How do you plan (know) the course resources used?</td><td rowspan="14"><u>Self-administrated Likert scale questionnaires</u>

RQ1: WHAT is the current level of Lean Thinking evidence practice in SPHEIs for the Course Planning and Delivery Process?

RO1: To access the current level of Lean Thinking evidence practice in SPHEIs for Course Planning and Delivery Process.

H01$_{(Null)}$: There is NO evidence showing SPHEIs deploy Lean Thinking practice in Course Planning and Delivery Process.</td></tr>
<tr><td>Course Resources
[C1]</td><td>C1.1 Cohorts
C1.2 Lecturers
C1.3 Facilities
C1.4 Timetable
C1.5 Overall</td><td>• Process Wastes
• People Wastes
• Assets Wastes
• Information Wastes
• Identify Values</td></tr>
<tr><td colspan="3">Q2: How do you plan (know) the course contents of each module?</td></tr>
<tr><td>Course Contents
[C2]</td><td>C2.1 Syllabus
C2.2 Objectives
C2.3 Materials
C2.4 Outcomes
C2.5 Overall</td><td>• Information Wastes
• Process Wastes
• Assets Wastes
• People Wastes
• Value Stream</td></tr>
<tr><td colspan="3">Q3: How do you plan (know) the course pedagogy of each module?</td></tr>
<tr><td>Course Pedagogy
[C3]</td><td>C3.1 Lectures
C3.2 Tutorials
C3.3 Practical
C3.4 Consultation
C3.5 Overall</td><td>• Process Wastes
• Assets Wastes
• Information Wastes
• People Wastes
• Create Flow</td></tr>
<tr><td colspan="3">Q4: How do you plan (know) the course assessment of each module?</td></tr>
<tr><td>Course Assessment
[C4]</td><td>C4.1 Attendance
C4.2 Tests/Quizzes
C4.3 Coursework
C4.4 Examination
C4.5 Overall</td><td>• People Wastes
• Information Wastes
• Process Wastes
• Assets Wastes
• Create Flow</td></tr>
<tr><td colspan="3">Q5: How do you analyse (feedback) the course evaluation of each module?</td></tr>
<tr><td>Course Evaluation
[C5]</td><td>C5.1 Reaction
C5.2 Learning
C5.3 Behaviour
C5.4 Results
C5.5 Overall</td><td>• Information Wastes
• Process Wastes
• People Wastes
• Assets Wastes
• Establish Pull</td></tr>
<tr><td colspan="3">Q6: How do you enhance (improve) the course refinement of each module?</td></tr>
<tr><td>Course Refinement
[C6]</td><td>C6.1 Engagement
C6.2 Experience
C6.3 Satisfaction
C6.4 Achievement
C6.5 Overall</td><td>• Assets Wastes
• Process Wastes
• Information Wastes
• People Wastes
• Pursue Perfection</td></tr>
<tr><td colspan="3">Q7: What are the Lean Tools used in the Course Planning and Delivery Process?</td></tr>
<tr><td>Lean Tools competency
[C7]</td><td>C7.1 Hoshin Kanri
C7.2 5S
C7.3 PDCA
C7.4 Poka-Yoke
C7.5 Muda (Waste)
C7.6 Muri (Overburden)
C7.7 Mura (Unevenness)
C7.8 VSM</td><td>• C1 Course Resources
• C2 Course Contents
• C3 Course Pedagogy
• C4 Course Assessment
• C5 Course Evaluation
• C6 Course Refinement</td></tr>
<tr><td colspan="4">Lean Thinking relates to the Course Planning and Delivery Process</td></tr>
<tr><td colspan="3">Q8: What are the possibilities to use Lean Thinking in the Course Planning and Delivery Process?</td><td rowspan="2"><u>Self-administrated Likert scale questionnaires</u>

RQ2: WHAT is the relationship between Lean Thinking versus the Course Planning and Delivery Process?

RO2: To interpret the relationship between Lean Thinking versus the Course Planning and Delivery Process.

H02$_{(Null)}$: There is NO correlated evidence between Lean Thinking versus Course Planning and Delivery Process.</td></tr>
<tr><td>Lean Thinking relationship [C8]
- 5 Lean Principles
4 Wastes</td><td>C8.1 Identify Value
C8.2 Value Stream
C8.3 Create Flow
C8.4 Establish Pull
C8.5 Pursue Perfection
C8.6 People Wastes
C8.7 Process Wastes
C8.8 Information Wastes
C8.9 Assets Wastes</td><td>• C1 Course Resources
• C2 Course Contents
• C3 Course Pedagogy
• C4 Course Assessment
• C5 Course Evaluation
• C6 Course Refinement</td></tr>
</table>

Dependent Variables	Attributes used in Survey Questionnaire	Independent Variables	Research Questions, Objectives and Hypotheses
Key Performance Indicators (KPI)			
Q9: What is your current institute key performance level?			**Self-administrated Likert scale questionnaires**
Key Performance Indicators [C9]	C9.1 HE Performance C9.2 HE Productivity C9.3 HE Quality C9.4 Delivery Values C9.5 Remove Wastes C9.6 Student Satisfaction C9.7 Student Development	• C1 to C6 • C7.1 to C7.8 • C8.1 to C8.9	RQ3: HOW does current Lean Thinking practice influence Key Performance Indicators in SPHEIs? RO3: To understand the current Lean Thinking practice that influences Key Performance Indicators in SPHEIs. H03$_{(Null)}$: There is NO evidence showing the current Lean Thinking practice can influence Key Performance Indicators in SPHEIs.
Self-Administrated Open-Structure Questions			
C10.1 What are the main current problems in the Course Planning and Delivery Process?		Relate to C1 to C6	**Self-administrated open-structure questions** RQ4: HOW do SPEHIs deploy Lean Thinking practice to Kaizen academic processes? RO4: To understand how SPEHIs deploy Lean Thinking practice to Kaizen academic processes
C10.2 Is there any other element that is important in the Course Planning and Delivery Process?		Relate to C1 to C6	
C10.3 How much do you know about Lean Thinking (add values and reduce wastes) in Higher Education?		Relate to C7	
C10.4 Do you believe Lean Thinking practice can improve the Course Planning and Delivery Process in your institutes?		Relate to C8	
C10.5 Do you see Lean Thinking practice link the strategic planning and transformation in your institutes?		Relate to C9	

4.9 Collaborative Survey Development

4.9.1 Time Horizon

The researcher adopted a cross-sectional survey and collected data from many people at one time in a cross-sectional study. Furthermore, variables are considered in cross-sectional studies without affecting them. The nature of the research questions had a significant impact on the study design since the first step in defining how the research was conducted. It determines what type of information is to be obtained by the study (Alan Bryman, 2015; Saunders *et al.*, 2015).

The advantage of a cross-sectional study design is that researchers only collect data at one point in time, making it less expensive and time-consuming than other types of research. Furthermore, cross-sectional studies enable researchers to collect information from a large number of people and compare differences between groups (Alan Bryman, 2015; Saunders *et al.*, 2015). However, cross-sectional studies only reflect a single measurement of both the alleged cause and effect and they may not provide definitive information on cause and effect relationships. Cross-sectional studies only look at a single point in time, and the studies cannot use to assess long-term trends or evaluate behaviour across time (Alan Bryman, 2015; Saunders *et al.*, 2015).

4.9.2 Data Collection

From gathering data or capturing research evidence to analysing outcomes and making an effect in presenting the findings, surveys are an everyday aspect of education and research. The researcher used an online survey (formerly BOS), available on the website (https://onlinesurveys.ac.uk), which the university recommended to collect the data. The online survey tool is for academic research, education and public sector organisations. It is a powerful, easy to use tool for creating online surveys, and over 300 different organisations use it in the UK and internationally. Researchers can use the online survey tool to generate, execute, and analyse surveys across the entire organization. The online dashboard is shown in Appendix 9.

4.9.3 Triangulation Approach

Triangulation is the act of blending several research methods, overlapping each other, sometimes being complimentary, others being the opposite, to study one aspect. Triangulation is also known as mixed-method research. Louis Cohen (2017) said that "triangulation is an attempt to map out or fully explain the richness and complexity of human behaviour by studying it from multiple perspectives". Carter *et al.* (2014) viewed "triangulation as a qualitative research approach for determining validity by combining data from many sources. In qualitative research, triangulation refers to using various methods or data sources to build a thorough understanding of phenomena".

Noble and Heale (2019) noted that triangulation is also a tool for improving the validity and credibility of study findings. Validity is "concerned with the amount to which a study accurately represents or evaluates the notion or concepts explored. Credibility relates to the trustworthiness and believableness of a study".

There are four types of triangulation (Carter *et al.*, 2014; Noble and Heale, 2019):

- Theoretical triangulation encourages the use of multiple speculative schemes to interpret a phenomenon.
- Data triangulation includes matters such as periods, space and people.
- Methodological triangulation promotes multiple data collection methods such as interviews and observations.
- Investigator triangulation includes several researchers in a study.

Triangulation minimises bias and does not always aim at cross-validate results, and captures different aspects of the same phenomenon. Triangulation is valuable for the research process and beneficial to the research process. Data triangulation improves analysis because additional information sources provide further insight into a subject. When multiple sources support the same data, inadequacies in single-source data are reduced (Heale and Forbes, 2013; Johnson, 2017). The forms of triangulation used in this study are summarised in *Table 4.34*.

Table 4.34 - Triangulation Mixed-Methods Approach (Source: Author)

Type	As applied in this study
Theoretical Triangulation	To investigate Lean Thinking evidence-based practice related to CP&DP.
Data Triangulation	To collect primary data from two (2) SPHEIs. To use an online survey (formerly BOS) to collect data.
Methodological Triangulation	To collect quantitative data via a self-administered Likert scale questionnaire. To collect qualitative data via a self-administered open-structure question.

- **Theoretical Triangulation**

  The researcher adopted the theoretical triangulation (Carter *et al.*, 2014; Heale and Forbes, 2013) mixed-methods research design for CP&DP, surveyed on Administrators (AD), Lecturers (LE) and Students (ST) from selected SPHEIs, shown in *Figure 4.32.*

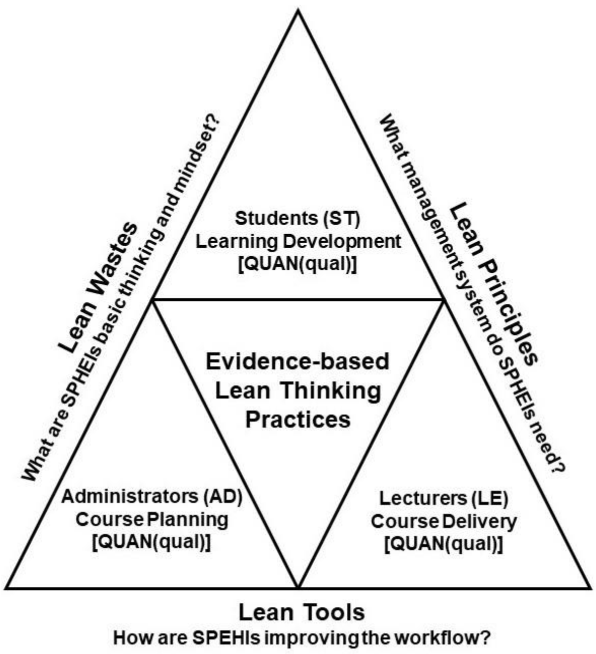


Figure 4.32 - Theoretical Triangulation Mixed-Methods Design (Source: Author)

- **Data Triangulation**
  Surveys on Administrators (AD), Lecturers (LE) and Students (ST) were conducted from selected SPHEI shown in *Figure 4.33.*

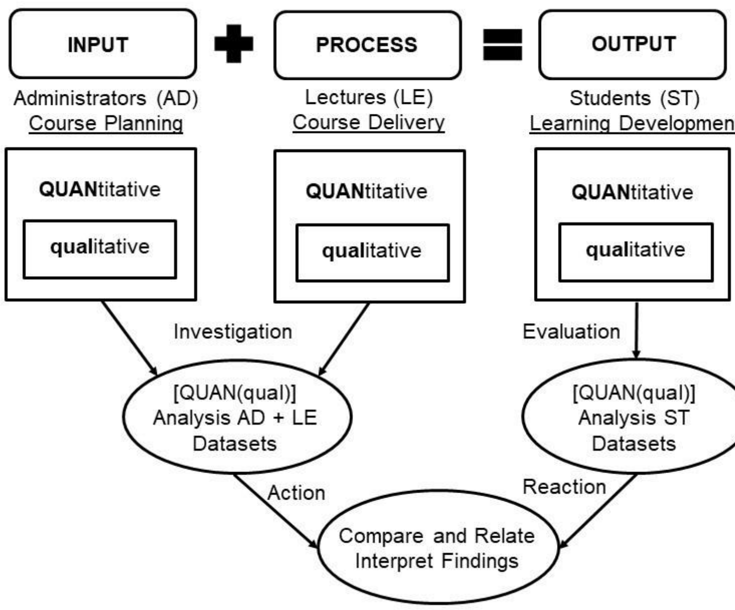


Figure 4.33 - Data Triangulation Mixed-Methods Collection (Source: Author)

The researcher collected data from two (2) SPHEIs. Since each SPHEI had three (3) datasets (Administrators, Lecturers and Students), there was a total of six (6) datasets. Datasets were combined and analysed as cross-case, shown in *Table 4.35*.

Table 4.35 - Data Triangulation Mixed-Methods Datasets (Source: Author)

Process Flow	Triangulation Data	SPHEIs-A	SPHEIs-B	Combined Dataset
Input	Administrators (AD) Course Planning	Dataset A1	Dataset B1	Dataset A1+ B1+ A2 + B2
Process	Lecturers (LE) Course Delivery	Dataset A2	Dataset B2	
Output	Students (ST) Learning Development	Dataset A3	Dataset B3	Dataset A3 + B3

- **Methodological Triangulation**

The researcher extended the four critical features (See Chapter 1) from Tatikonda (2007) and integrated them with Lean Principles and Lean Wastes (See Chapter 3) from Balzer (2010; 2020) to this study, as shown in *Table 4.36*.

Table 4.36 - Features in Course Planning and Delivery Process (Source: Author)

Critical Features (Tatikonda, 2007)	CP&DP (Source: Author)	Lean Principles (Balzer, 2010; 2020)	Lean Wastes (Balzer, 2010; 2020)
-	Course Resources	Identify Value	People Wastes Process Wastes Information Wastes Asset Wastes
Course Contents	Course Contents	Value Stream	
Course Pedagogy	Course Pedagogy	Create Flow	
Course Organisation	Course Assessment	Create Flow	
Course Assessment	Course Evaluation	Establish Pull	
	Course Refinement	Pursue Perfection	

The methodological triangulation mixed-methods survey has two formats. The quantitative format is a self-administered Likert scale questionnaire, and the qualitative structure is self-administered open-structure questions shown in *Table 4.37*.

Table 4.37 - Methodological Triangulation Mixed-Method Survey (Source: Author)

Dependent Variables	**Attributes used in Survey Questionnaire**	**Independent Variables**	**AD Survey Questionnaires**	**LE Survey Questionnaires**	**ST Survey Questionnaires**
Lean Thinking evidence-practice + Lean Tools competency					
Q1: How do you plan (know) the course resources used?					
Course Resources [C1]	C1.1 Cohorts C1.2 Lecturers C1.3 Facilities C1.4 Timetable C1.5 Overall	• Process Wastes • People Wastes • Assets Wastes • Information Wastes • Identify Values	**QUAN** C1.1 to C1.5	**QUAN** C1.1 to C1.5	**QUAN** C1.1 to C1.5
Q2: How do you plan (know) the course contents of each module?					
Course Contents [C2]	C2.1 Syllabus C2.2 Objectives C2.3 Materials C2.4 Outcomes C2.5 Overall	• Information Wastes • Process Wastes • Assets Wastes • People Wastes • Value Stream	**QUAN** C2.1 to C2.5	**QUAN** C2.1 to C2.5	**QUAN** C2.1 to C2.5
Q3: How do you plan (know) the course pedagogy of each module?					
Course Pedagogy [C3]	C3.1 Lectures C3.2 Tutorials C3.3 Practical C3.4 Consultation C3.5 Overall	• Process Wastes • Assets Wastes • Information Wastes • People Wastes • Create Flow	**QUAN** C3.1 to C3.5	**QUAN** C3.1 to C3.5	**QUAN** C3.1 to C3.5
Q4: How do you plan (know) the course assessment of each module?					
Course Assessment [C4]	C4.1 Attendance C4.2 Tests/Quizzes C4.3 Coursework C4.4 Examination C4.5 Overall	• People Wastes • Information Wastes • Process Wastes • Assets Wastes • Create Flow	**QUAN** C4.1 to C4.5	**QUAN** C4.1 to C4.5	**QUAN** C4.1 to C4.5
Q5: How do you analyse (feedback) the course evaluation of each module?					
Course Evaluation [C5]	C5.1 Reaction C5.2 Learning C5.3 Behaviour C5.4 Results C5.5 Overall	• Information Wastes • Process Wastes • People Wastes • Assets Wastes • Establish Pull	**QUAN** C5.1 to C5.5	**QUAN** C5.1 to C5.5	**QUAN** C5.1 to C5.5
Q6: How do you enhance (improve) the course refinement of each module?					
Course Refinement [C6]	C6.1 Engagement C6.2 Experience C6.3 Satisfaction C6.4 Achievement C6.5 Overall	• Assets Wastes • Process Wastes • Information Wastes • People Wastes • Pursue Perfection	**QUAN** C6.1 to C6.5	**QUAN** C6.1 to C6.5	**QUAN** C6.1 to C6.5
Q7: What are the Lean Tools used in the Course Planning and Delivery Process?					
Lean Tools competency [C7]	C7.1 Hoshin Kanri C7.2 5S C7.3 PDCA C7.4 Poka-Yoke C7.5 Muda (Waste) C7.6 Muri (Overburden) C7.7 Mura (Unevenness) C7.8 VSM	• C1 Course Resources • C2 Course Contents • C3 Course Pedagogy • C4 Course Assessment • C5 Course Evaluation • C6 Course Refinement	**QUAN** C7.1 to C7.8	**QUAN** C7.1 to C7.8	Not Applicable
Lean Thinking relates to the Course Planning and Delivery Process					
Q8: What are the possibilities to use Lean Thinking in the Course Planning and Delivery Process?					
Lean Thinking relationship [C8] - 5 Lean Principles 4 Wastes	C8.1 Identify Value C8.2 Value Stream C8.3 Create Flow C8.4 Establish Pull C8.5 Pursue Perfection C8.6 People Wastes C8.7 Process Wastes C8.8 Information Wastes C8.9 Assets Wastes	• C1 Course Resources • C2 Course Contents • C3 Course Pedagogy • C4 Course Assessment • C5 Course Evaluation • C6 Course Refinement	**QUAN** C8.1 to A8.9	**QUAN** C8.1 to A8.9	Not Applicable
Note: • AD denoted as "Administrators". LE denoted as "Lecturers". ST denoted as "Student".					

<table>
<tr><th>Dependent Variables</th><th>Attributes used in Survey Questionnaire</th><th>Independent Variables</th><th>AD Survey Questionnaires</th><th>LE Survey Questionnaires</th><th>ST Survey Questionnaires</th></tr>
<tr><td colspan="6">Key Performance Indicators (KPI)</td></tr>
<tr><td colspan="6">Q9: What is your current institute key performance level?</td></tr>
<tr><td>Key Performance Indicators
[C9]</td><td>C9.1 HE Performance
C9.2 HE Productivity
C9.3 HE Quality
C9.4 Delivery Values
C9.5 Remove Wastes
C9.6 Student Satisfaction
C9.7 Student Development</td><td>• C1 to C6
• C7.1 to C7.8
• C8.1 to C8.9</td><td>QUAN
C.1 to C9.7</td><td>QUAN
C9.1 to L9.7</td><td>Not Applicable</td></tr>
<tr><td colspan="2">C10.1 What are the main current problems in the Course Planning and Delivery Process?</td><td>Relate to C1 to C6</td><td rowspan="5">QUAL
C10.1 to C10.5</td><td rowspan="5">QUAL
C10.1 to C10.5</td><td rowspan="2">QUAL
C10.1 to C10.2</td></tr>
<tr><td colspan="2">C10.2 Is there any other element that is important in the Course Planning and Delivery Process?</td><td>Relate to C1 to C6</td></tr>
<tr><td colspan="2">C10.3 How much do you know about Lean Thinking (add values and reduce wastes) in Higher Education?</td><td>Relate to C7</td><td rowspan="3">Not Applicable</td></tr>
<tr><td colspan="2">C10.4 Do you believe Lean Thinking practice can improve the Course Planning and Delivery Process in your institutes?</td><td>Relate to C8</td></tr>
<tr><td colspan="2">C10.5 Do you see Lean Thinking practice link the strategic planning and transformation in your institutes?</td><td>Relate to C9</td></tr>
<tr><td colspan="6">Note:
• AD denoted as “Administrators”. LE denoted as “Lecturers”. ST denoted as “Student”.</td></tr>
</table>

The researcher developed nine (9) survey questionnaires and five (5) open-structure questions. Each survey question broke down into five to seven attributes asked in the self-administered Likert scale (Likert, 1936) questionnaires format. The dependent attributes correspond to independent variables of five (5) Lean Principles and four (4) Lean Wastes). The distribution of survey questions is illustrated in *Table 4.38*.

Table 4.38 - Distribution of Survey Questions (Source: Author)

<table>
<tr><th>Self-Administrated Survey Questionnaires</th><th>Likert Scale Questionnaires</th><th>Open-Structure Questions</th><th>Merged Datasets for Analysis</th></tr>
<tr><td>Administrators (AD)
Course Planning</td><td>9 QUAN questions
C1.x to C9.x</td><td>5 qual questions
C10.1 to C10.5</td><td rowspan="2">AD + LE
4 Datasets</td></tr>
<tr><td>Lecturers (LE)
Course Delivery</td><td>9 QUAN questions
C1.x to C9.x</td><td>5 qual questions
C10.1 to C10.5</td></tr>
<tr><td>Students (ST)
Learning Development</td><td>6 QUAN questions
C1.x to C6.x</td><td>2 qual questions
C10.1 to C10.2</td><td>ST
2 Datasets</td></tr>
</table>

Note: x denoted as number

To understand the impact of students’ learning outcomes, merging the AD and LE datasets was essential to investigate evidence-based Lean Thinking practice in CP&DP. The researcher used SPSS to process numerical data to analyse and interpret quantitative data. Using NVivo or Microsoft Excel to process code and theme analysis to manipulate qualitative data, then present graphs and charts (See Chapter 5).

4.10 Sampling Respondents and Survey Administration

4.10.1 Sampling Strategy

The sampling strategy refers to the procedures and plans for selecting a sample from the target population, as well as the formula for calculating sample statistics using appropriate estimation approach. These statistics are the estimates utilised to infer the population parameters (Cohen, 2017). The aim is to make sure that the research sample is representative of the general population. *Table 4.39* shows the sampling process steps for this research project.

Table 4.39 - Sampling Process (Source: Author)

Elements	Description
Target Population	27 SPHEIs had graduated from full-time bachelor's level EDPs.
Sampling Frame	11 SPHEIs had a high employment rate and invited them to participate in the survey. However, only 2 SPHEIs were accepted.
Sampling Unit and Method	Stratified Sampling: Faculty and Programmes.
Sample Size	Respondents: Administrators, Lecturers and Students.
Sampling Plan	To use an online survey (formerly BOS) to collect data.
Select the Sample	To target an adequate survey rate and the item response rate

4.10.2 Target Population

A population is defined in terms of elements, sampling units, extent and time. Since there is rarely enough time or resources to collect information from everyone or everything in a population, the goal is to find a representative sample or subset of that population (Cohen, 2017).

The CPE has already released the results of the PEIs GES 2017/18. The job findings for the 2017/18 cohort were similar to the 2016/17 cohort, according to media released on April 10, 2019 (SSG, 2020). These twenty-seven (27) PEIs form the target institutes for this study, also known as the target population. *Table 1.2* shows that the overall employment rate for the 2017/18 cohort ranged from 42.1% to 90.9 % across eleven (11) PEIs (See Appendix 1, Annex C) with ten or more respondents (PEIs Survey, 2020). Therefore, eleven (11) PEIs were contacted via email in Feb 2020 and invited to participate in this research study (See Chapter 1).

Table 4.40 - PEIs Graduate Employment Survey (PEIs Survey, 2020)

S/No	Private Higher Education Institutes (PHEIs)	Overall Employee Rate	Response Rate[15]	No of Respondents[16]
1	Parkway College of Nursing and Allied Health	90.9%	81%	11
2	Ngee Ann Academy	85.4%	66%	41
3	Singapore Institute of Management	84.7%	45%	1,799
4	Kaplan Higher Education Academy	78.3%	44%	452
5	Curtin Education Centre	78.1%	34%	50
6	James Cook University	75.3%	27%	81
7	ERC Institute	65.9%	27%	44
8	PSB Academy	65.1%	39%	146
9	Management Development Institute of Singapore	64.7%	23%	68
10	Air Transport Training College	65.2%	73%	23
11	Raffles College of Higher Education	42.1%	14%	19
			Total	2,734

4.10.3 Sampling Frame

A sampling frame reflects the entire population and can be defined as every element in the sample and includes every item. A list of population elements, preferably the whole population, with relevant contact information is the most straightforward frame (Cohen, 2017).

The researcher contacted the 11 PEIs, who have high employment rates ranging from 42.1% to 90.9 %, via email in Feb 2020 and invited them to participate in the survey. However, only two (2) SPHEIs agreed to take part in the research survey before the COVID19 lockdown ("circuit breaker") in April 2020. Hence, the researcher decided on these two (2) SPHEIs as the sampling frame for this study.

4.10.4 Sampling Unit and Method

According to Cohen (2017), "a sampling unit is a fundamental unit that contains a single element or a collection of items from the population to be sampled". The sample frame determines which sampling unit is used, and the sampling method specifies how to choose sample units.

15 "Response Rate refers to the percentage of graduates from full-time degree programmes in PEIs who responded to the survey."

16 "Results of PEIs based on a small sample size of fewer than 30 full-time fresh PEIs degree graduates may not be representative of the institution's graduate employment outcomes."

A stratified sampling strategy was created for each SPHEI by separating the population into non-overlapping groups. Then a simple random sample was selected from each stratum shown in *Figure 4.34*. Each SPHEIs had three Faculties (School of Business, School of Engineering and School of Life Science), each faculty had three Programme Types (Bachelor, Master and Doctorate). Hence, stratified sampling was applied in the selected Faculties and Programme Types. Stratified random sampling helps to ensure that the sample reflects different subgroups or strata. The Head of Faculty were allowed to randomly select the Programme Types for this study and do an online survey to collect the data from three respondents (Administrators, Lecturers and Students). The target was to have an adequate survey rate and the item response rate for this study. The researcher did not find any missing data from the online survey.

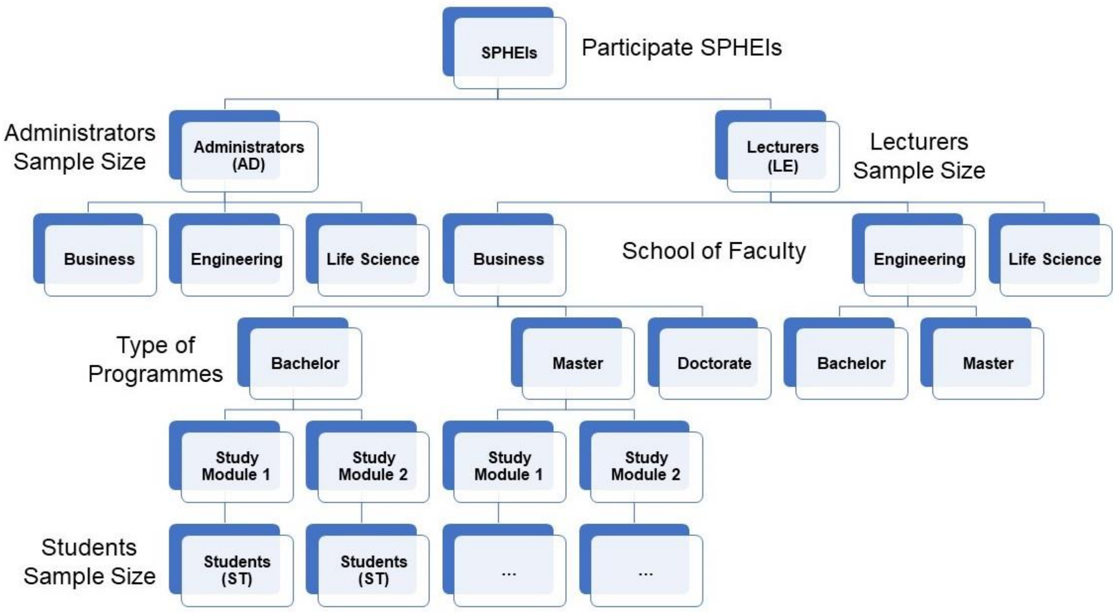


Figure 4.34 - Stratified Sampling Design (Source: Author)

4.10.5 Sample Size

The sample size calculation depends primarily on the type of sampling designs used. Three criteria were used to determine the appropriate sample size: the level of precision, the level of confidence or risk, and the degree of variability in the attributes are measured (Naing, 2003). Bartlett II *et al.* (2001) suggested that researchers use 50% to estimate P, where P is the percentage of a sample having a characteristic. It will result in the maximization of variance and produce the maximum sample size shown in *Table 4.41*.

Table 4.41 - Population and Sample Size (Taherdoost, 2018a)

	Variance of the population P=50%					
	Confidence level=95% Margin of error			*Confidence level=99% Margin of error*		
Population Size	5	3	1	5	3	1
50	44	48	50	46	49	50
75	63	70	74	67	72	75
100	79	91	99	87	95	99
150	108	132	148	122	139	149
200	132	168	196	154	180	198
250	151	203	244	181	220	246
300	168	234	291	206	258	295
400	196	291	384	249	328	391
500	217	340	475	285	393	485
600	234	384	565	314	452	579
700	248	423	652	340	507	672
800	260	457	738	362	557	763
1000	278	516	906	398	647	943
1500	306	624	1297	459	825	1375
2000	322	696	1655	497	957	1784
3000	341	787	2286	541	1138	2539
5000	357	879	3288	583	1342	3838
10000	370	964	4899	620	1550	6228
25000	378	1023	6939	643	1709	9944
50000	381	1045	8057	652	1770	12413
100000	383	1056	8762	656	1802	14172
250000	384	1063	9249	659	1821	15489
500000	384	1065	9423	660	1828	15984
1000000	384	1066	9513	660	1831	16244

Administrators are the non-academic staff in charge of the students' academic-related activities, and the planner schedules the students' courses for every cohort faculty. Staff in charge of campus operations, facilities maintenance, sales and marketing, were excluded from this study.

Lecturers are the academic staff involved in teaching modules at any school (School of Business, Engineering and Life Science) and assigned to programmes (Bachelor, Master and Doctorate) that depend on lecturers' discipline and subject matter expertise. SPHEIs contract a substantial number of stand-by local part-time lecturers (having a full-time job in the day and part-time teaching at night) and employ a few local full-time lecturers in the respective faculty. However, SPEHIs use the foreign university faculty lecturers as the course or program leader, then engage local part-time lecturers to teach and act as supporting academic staff.

The researcher contacted the two (2) participating SPHEIs. There was unlikely to have a substantial number of Administrators, full-time and part-time active Lecturers to participate in the survey because the research context (See Chapter 1) has narrowed down to CP&DP. Hence, the researcher targeted to collect at least 30 samples size of *Administrators* and *Lecturers* with a 5% margin error from the two (2) participating SPHEIs.

For this study, *students* referred to as full-time and part-time in their selected EPDs from the twenty-seven (27) SPHEIs. According to PEIs graduate employment survey 2017/18, about 10,200 full-time graduates had completed full-time bachelor's level EDPs at twenty-seven (27) PEIs (See Chapter 1) (SSG, 2020). The researcher roughly estimated that the population size of twenty-seven (27) SPHEIs was about 10,000 students in this period. Hence, the researcher targeted to collect 370 samples size with a 5% margin of error, shown in *Table 4.41* from the two (2) participating SPHEIs.

4.10.6 Sampling Plan

It is the development of the specific procedures the sample will choose. The sampling plan guides the researcher in selecting the study sample to minimise potential errors in the sampling process. This research sampling plan is designed so that the resulting data will contain a representative sample of the parameters of interest and allow for all research questions, as stated in the aim, to be answered. The online survey (formerly BOS) tool is for academic research, education and public sector organisations. It is a powerful, easy to use tool for creating online surveys, and over 300 different organisations use it in the UK and internationally. The researcher used an online survey (https://onlinesurveys.ac.uk), which the university recommended to collect the data. There are actual activities performed in the process of selecting a sample. The implementation of the sample plan consists of determining the parameters and values that will be measured, sampling scheme design and format for data storage design.

4.11 Analysis and Reporting of Survey Data

4.11.1 Data Management

Data analysis requires the use of data management software. Organise data into variables, identify and code them, and analyse them once they are in a database. Data from online surveys are automatically recorded into a database, and the results are delivered in real-time. Survey responses are also examined for missing data and decisions about what to do with it. Unanswered questions or incomplete surveys can result in missing data (Fink, 2016).

4.11.2 Prepare and Check Data Files

Compiling online surveys in an electronic file, merging data files, verifying data entry errors, and coding the data are all part of the survey data preparation and validation process. Suppose the survey collected demographic information, respondent names, emails, or other unique identifiers. Firstly, respondents were identified by their answers. Next, if multiple data files exist, files need to be merged and checked for data entry errors. Finally, preparing the code data for analysis make the results easier to comprehend (Irwin and Stafford, 2016). Anyone can use a clean data set to generate results identical to the researcher. A "validation" option in an online survey helps standardise data collecting, and it ensures that the information provided by respondents is the information requested in the survey (Fink, 2016).

4.11.3 Data Analysis

Non-numerical information is notes, interview transcripts, text documents, audio recordings, video recordings, photographs referred to as qualitative data"(Dudovskiy, 2011). Quantitative data analysis involves critical examination and interpretation of figures and statistics and an attempt to determine the explanation for the development of main findings (Dudovskiy, 2011). The researcher conducted quantitative data analysis and interpretation using SPSS and Excel to process numerical data. The results would be analysed and compared within and between groups of two SPHEIs.

Content analysis is a qualitative method for identifying common themes or concepts in the responses to open-ended survey questions. Content analysis requires coding comments and responses to open-ended questions. The researcher interpreted qualitative description using Nivo/Excel to process framework analysis. The framework analysis method consists of several stages: familiarisation, identifying a thematic framework, coding, charting, mapping, and interpretation.

4.11.4 Calculate Response Rates

The researcher determined whether the survey results would generalise to the target population, not just to those who responded to the survey. For non-probability samples, survey results cannot be generalised to a target population to skip this step. Two response rates are calculated for probability sampling procedures: survey response rates and item response rates (Irwin and Stafford, 2016). The survey response rate is the number of people who answered the survey divided by the number of people in the sample. It is usually expressed in the form of a percentage. Item response rates are for an item defined in the group eligible for a set of questions and whether or not they answer those questions (Atrostic *et al.*, 2000). The researcher targeted an adequate survey rate and the item response rate for this study.

4.11.5 Calculate Summary Statistics

Statistical methods are mathematical formulas, models, and techniques used in the statistical analysis of raw research data. Fink (2016) said statistical methods allow the researcher to make statements about statistical significance and measure the meaningfulness of survey results. The choice of statistical testing for the research hypotheses is shown in *Figure 4.35*. The researcher used a nonparametric approach to analyse the data. Some statistical methods produce information on the likelihood that a particular outcome will occur within a group and can also be used to compare among groups. Other methods use correlations as the basis for predicting the value of one variable from the other. The application of statistical methods extracts information from research data and provides different ways to assess the strength of research outputs.

Statistics is a branch of mathematics dealing with collecting, analysing, interpreting, and presenting masses of numerical data. The researcher also calculated the summary statistics such as frequency, percentage, maximum, minimum, total, median, and mean (Irwin et al., 2016) to answer the research hypotheses.

Nominal Data	Ordinal Data | Interval Data | Ratio Data	
Compare	Parametric (normal distributed)	Nonparametric (not normal distributed)
Chi-Square Test	One Sample t-Test	Wilcoxin Rank-Sum Test

Parametric (normal distributed) Ordinal Data | Interval Data | Ratio Data				
2 groups			> 2 groups	
Compare	Difference		Difference	
Paired	Paired	Unpaired	Paired	Unpaired
Pearson's Correlation	Paired t-Test	Independent t-Test	Repeated Measure ANOVA	On way ANOVA

Nonparametric (not normal distributed) Ordinal Data | Interval Data | Ratio Data				
2 groups			> 2 groups	
Compare	Difference		Difference	
Paired	Paired	Unpaired	Paired	Unpaired
Spearman's Correlation	Wilcoxon Rank-Sum test	Mann Whitney U Test	Firedman test	Kruskal-Wallis Test

- **Chi-Square**
  To test for a difference among groups in term of a categorical DV.
- **t-Test**
  To test for a difference between two groups in terms of one DV.
- **Pearson Correction**
  To test for a relationship between two variables.
- **ANOVA**
  To test for a difference among two or more groups in terms of one DV.
- **Multiple Regression**
  To determine the degree to which two or more IV are related to (or predict) on DV.

IV denotes as "Independent Variable"
DV denotes as "Dependent Variable"

Figure 4.35 - Choice of Statistical Testing Guide (Source: Author)

4.11.6 Present the Results in Tables or Figures

The researcher considered conveying the findings to allow the audience to comprehend and interpret the results and their implications. First, consider the overall message and presentation structure regarding the target audience. Next, present the data in tables and figures in the most effective way. Infographics visual representations of statistics and other information drew attention and conveyed information successfully (Irwin *et al.*, 2016).

4.12 Validity and Reliability

The process of evaluating the reliability of survey questions is referred to as validating a survey. Validating a survey is neither quick nor straightforward, and many difficult-to-control factors can affect the reliability of a question. This research work has used content validity, construct validity and internal reliability to validate the survey.

Content validity is a more formal, statistic-based approach in which the experts in the field assess the questions based on how well they cover the material (Taherdoost, 2018b). If some test questions measure data that is not required, it can create bias. Content validity is done by taking feedback from Lean Thinking practitioners and academic leaders in SPHEIs (See Chapter 5).

Construct validity is a technique to determine the validity of a test and shows that the test is measuring the construct it claims to be assessing (Taherdoost, 2018b). Construct validity is reviewed by statistics experts for the research instrument. All comments were taken into consideration, and the instrument was appropriately modified.

Internal reliability, often known as internal consistency measures, is how well the test measures what the researchers want it to calculate. Cronbach's alpha result is between 0 and 1 but has limitations (Agbo, 2010). The acceptable reliability score is 0.7 and higher (Taherdoost, 2018b). Scores with a small number of items have lower reliability associated with them. Sample size can also influence your results for better or worse. The Item Response Theory (IRT) is another theory method of analysing test or questionnaire responses to improve measurement accuracy and reliability. This method is free of bias elements, but it frequently fails to determine the estimation value on the item data that answered either correctly or incorrectly (Jumailiyah, 2017). This research work has multiple Likert questions in the survey questionnaires that form a scale. Cronbach's alpha is an excellent way to determine if the scale is reliable because it is still a widely used measure (See Chapter 5) and researcher will consider. The researcher will consider IRT for future research.

The pilot study was conducted with the variables identified based on the extensive literature survey done by the researcher. All the variables were grouped to prepare the rough questionnaire and collected responses from the respondents. The questionnaires were amended and modified based on the inputs.

4.13 Ethical Consideration

Ethical Considerations can specify as one of the essential parts of the research. According to Alan Bryman (2015), the following ten points represent the most important principles related to ethical considerations in dissertations:

- "Research participants should not be subjected to harm in any way whatsoever."
- "Respect for the dignity of research participants should be prioritised."
- "Full consent should be obtained from the participants before the study."
- "The protection of the privacy of research participants must be ensured."
- "An adequate level of confidentiality of the research data should be ensured."
- "It must ensure that the individuals and organisations involved in the research are anonymous."
- "Any deception or exaggeration about the aims and objectives of the research must be avoided."
- "Affiliations in any forms, sources of funding, as well as any possible conflicts of interests must be declared."
- "Any type of communication concerning the research should be done with honesty and transparency."
- "Any type of misleading information, as well as the representation of primary data findings in a biased way, must be avoided."

The ethics application form was submitted to the Research Degree Board (RDB) for approval before data collection began. The privacy of participants was taken care of through the research process. The survey informed participants that the survey results would be used for research purposes only. This survey is entirely voluntary, and they can refuse to answer any questions for any reason. All responses to the questionnaire will remain anonymous (See Appendix 3). The Research Ethics Committee (REC) has approved the ethical application:

- Application ID: ETH1920-0022 date 18 Nov 2019
    - Outline of the Proposal Project
    - Participant Information Sheet (See Appendix 4)
    - Participant Consent Form (See Appendix 5)
    - Survey Questionnaires – Administrators (See Appendix 6)
    - Survey Questionnaires – Lecturers (See Appendix 7)

    - Survey Questionnaires – Students (See Appendix 8)
- Application ID: ETH1819-0068 dated 22 May 2019
    - Data Management Plan
    - Health and Safety Research Risk Assessment
    - Travel Plan and Risk Assessment
    - Researcher Biography
    - Research Project Management Plan

4.14 Chapter Summary

This chapter provided a detailed discussion of the need for research, from selecting the research philosophy paradigm and strategy to the method chosen for data collection and analysis. It also justified the choice of the triangulation embedded mixed-method approach that combines quantitative with qualitative supporting. It clarified how the combination of self-administered Likert scale questionnaires and open-structure questions enabled the researcher to answer the key research questions within the available resources and time. The thesis now turns to the presentation and analysis of the results, beginning in the next chapter.

Chapter 5 – Findings and Discussion

5 Findings and Discussion

5.1 Introduction

This chapter is structured according to the research questions one to four. It presents the findings and results of the survey concerning the extent to which Lean Thinking practice is adopted directly or indirectly by SPHEIs. The survey questions are attached in Appendix 6 (Administrators), Appendix 7 (Lecturers) and Appendix 8 (Students). There were nine (9) self-administered Likert scale questionnaires (C1 to C9) and five (5) self-administered open-structure questions (C10.1 to C10.5).

5.2 Data Analysis Procedures

According to Tsagris and Pandis (2021), the Kolmogorov-Smirnov and the Shapiro-Wilk tests are frequently used to test normality. However, the authors claimed that "with low sample sizes, tests will tend to not reject the normality assumption, even in cases they should, because of low power". Secondly, "with large sample sizes, the tests will reject normality with a high probability even in the presence of small and acceptable deviations from normality". Therefore, "the results of the normality assumption can differ depending on the test used". There was 34 Administrator (AD) and Lecturer (LE) respondents data, and 303 Student (ST) respondents data collected, where checking normality of data was not required. The researcher used a nonparametric procedure to analyse the data. The choice of statistic testing is shown in *Figure 5.36.*

Nominal Data	Ordinal Data | Interval Data | Ratio Data	
Compare	Parametric (normal distributed)	Nonparametric (not normal distributed)
Chi-Square Test	One Sample t-Test	Wilcoxin Rank-Sum Test

Parametric (normal distributed) Ordinal Data | Interval Data | Ratio Data				
	2 groups		> 2 groups	
Compare	Difference		Difference	
Paired	Paired	Unpaired	Paired	Unpaired
Pearson's Correlation	Paired t-Test	Independent t-Test	Repeated Measure ANOVA	On way ANOVA

Nonparametric (not normal distributed) Ordinal Data | Interval Data | Ratio Data				
	2 groups		> 2 groups	
Compare	Difference		Difference	
Paired	Paired	Unpaired	Paired	Unpaired
Spearman's Correlation	Wilcoxon Rank-Sum test	Mann Whitney U Test	Firedman test	Kruskal-Wallis Test

- **Chi-Square**
To test for a difference among groups in term of a categorical DV.
- **t-Test**
To test for a difference between two groups in terms of one DV.
- **Pearson Correction**
To test for a relationship between two variables.
- **ANOVA**
To test for a difference among two or more groups in terms of one DV.
- **Multiple Regression**
To determine the degree to which two or more IV are related to (or predict) on DV.

IV denotes as "Independent Variable"
DV denotes as "Dependent Variable"

Figure 5.36 - Choice of Statistical Testing Guide (Source: Author)

The collected data was analysed in four stages, using the SPSS version 26.0. In the first stage, the level of evidence practices of each attribute, using five Lean Principles, four Lean Wastes and eight Lean Tools, was assessed. The results are purely based on the respective mean values. Following this, significance tests were carried out to investigate the difference between groups. The Independent-Samples Mann-Whitney U Test was used for the level of evidence practices, competency, relationship and performance. In the third stage, the researcher performed Spearman's rho correlation analysis to determine the inter-relationship between Lean Thinking practice in CP&DP, Lean Tools competency and Lean Thinking relationship versus KPI. In the final stages, the researcher understood the quantitative results deeper using supportive qualitative data on how SPHEIs deployed the Lean Thinking in the CP&DP as evidence-based practices. The code or theme was then interpreted to give meaning to the data from the self-administered open-structure questions.

5.3 Structure of Survey Questions

Figure 5.37 constructed to show the hypotheses of inter-relationship between Lean Thinking and CP&DP (See Chapter 4). There were nine (9) self-administered Likert scale questionnaires (C1 to C9) and five (5) self-administered open-structure questions (C10.1 to C10.5). The relationship of research questions, objectives and hypotheses is shown in *Table 5.42*.

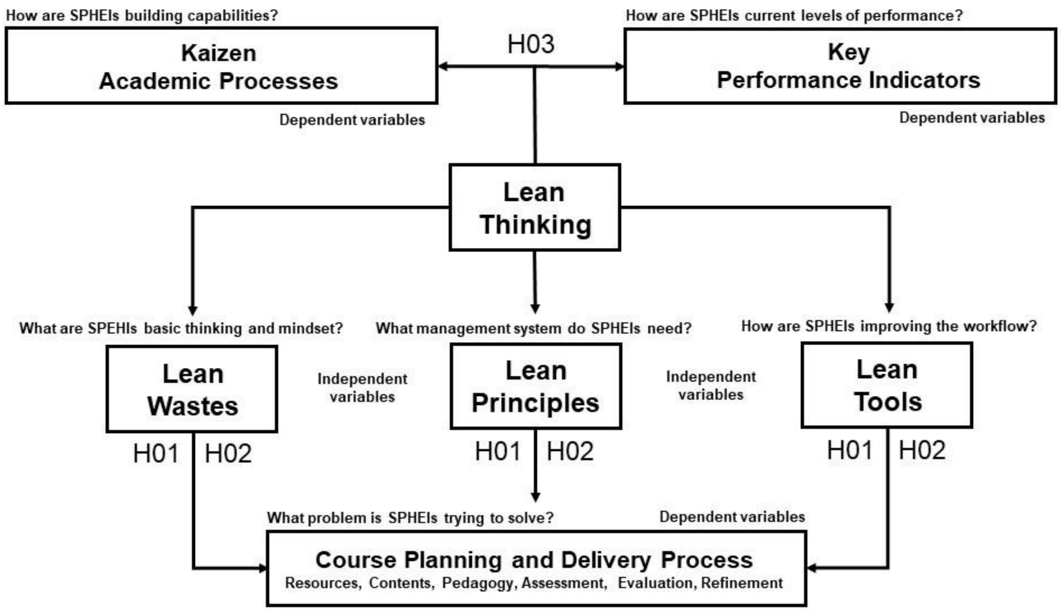


Figure 5.37 - Research Hypotheses (Source: Author)

Table 5.42 - Research Questions, Objectives and Hypotheses (Source: Author)

Dependent Variables	Attributes used in Survey Questionnaire	Independent Variables	Research Questions, Objectives and Hypotheses
Lean Thinking evidence-practice + Lean Tools competency			
Q1: How do you plan (know) the course resources used?			**Self-administered Likert scale questionnaires** RQ1: WHAT is the current level of Lean Thinking evidence practice in SPHEIs for the Course Planning and Delivery Process? RO1: To access the current level of Lean Thinking evidence practice in SPHEIs for Course Planning and Delivery Process. $H01_{(Null)}$: There is NO evidence showing SPHEIs deploy Lean Thinking practice in the Course Planning and Delivery Process.
Course Resources [C1]	C1.1 Cohorts C1.2 Lecturers C1.3 Facilities C1.4 Timetable C1.5 Overall	• Process Wastes • People Wastes • Assets Wastes • Information Wastes • Identify Values	
Q2: How do you plan (know) the course contents of each module?			
Course Contents [C2]	C2.1 Syllabus C2.2 Objectives C2.3 Materials C2.4 Outcomes C2.5 Overall	• Information Wastes • Process Wastes • Assets Wastes • People Wastes • Value Stream	
Q3: How do you plan (know) the course pedagogy of each module?			
Course Pedagogy [C3]	C3.1 Lectures C3.2 Tutorials C3.3 Practical C3.4 Consultation C3.5 Overall	• Process Wastes • Assets Wastes • Information Wastes • People Wastes • Create Flow	
Q4: How do you plan (know) the course assessment of each module?			
Course Assessment [C4]	C4.1 Attendance C4.2 Tests/Quizzes C4.3 Coursework C4.4 Examination C4.5 Overall	• People Wastes • Information Wastes • Process Wastes • Assets Wastes • Create Flow	
Q5: How do you analyse (feedback) the course evaluation of each module?			
Course Evaluation [C5]	C5.1 Reaction C5.2 Learning C5.3 Behaviour C5.4 Results C5.5 Overall	• Information Wastes • Process Wastes • People Wastes • Assets Wastes • Establish Pull	
Q6: How do you enhance (improve) the course refinement of each module?			
Course Refinement [C6]	C6.1 Engagement C6.2 Experience C6.3 Satisfaction C6.4 Achievement C6.5 Overall	• Assets Wastes • Process Wastes • Information Wastes • People Wastes • Pursue Perfection	
Q7: What are the Lean Tools used in the Course Planning and Delivery Process?			
Lean Tools Competency [C7]	C7.1 Hoshin Kanri C7.2 5S C7.3 PDCA C7.4 Poka-Yoke C7.5 Muda (Waste) C7.6 Muri (Overburden) C7.7 Mura (Unevenness) C7.8 VSM	• C1 Course Resources • C2 Course Contents • C3 Course Pedagogy • C4 Course Assessment • C5 Course Evaluation • C6 Course Refinement	
Lean Thinking relates to the Course Planning and Delivery Process			
Q8: What are the possibilities to use Lean Thinking in the Course Planning and Delivery Process?			**Self-administered Likert scale questionnaires** RQ2: WHAT is the relationship between Lean Thinking versus the Course Planning and Delivery Process? RO2: To interpret the relationship between Lean Thinking versus the Course Planning and Delivery Process ss. $H02_{(Null)}$: There is NO correlated evidence between Lean Thinking versus Course Planning and Delivery Process.
Lean Thinking relationship [C8] - 5 Lean Principles 4 Wastes	C8.1 Identify Value C8.2 Value Stream C8.3 Create Flow C8.4 Establish Pull C8.5 Pursue Perfection C8.6 People Wastes C8.7 Process Wastes C8.8 Information Wastes C8.9 Assets Wastes	• C1 Course Resources • C2 Course Contents • C3 Course Pedagogy • C4 Course Assessment • C5 Course Evaluation • C6 Course Refinement	

<table>
<tr><th>Dependent Variables</th><th>Attributes used in Survey Questionnaire</th><th>Independent Variables</th><th>Research Questions, Objectives and Hypotheses</th></tr>
<tr><td colspan="4">Key Performance Indicators (KPI)</td></tr>
<tr><td colspan="3">Q9: What is your current institute key performance level?</td><td rowspan="2"><u>Self-administered Likert scale questionnaires</u>

RQ3: HOW does current Lean Thinking practice influence Key Performance Indicators in SPHEIs?

RO3: To understand the current Lean Thinking practice that influences Key Performance Indicators in SPHEIs.

H03$_{(Null)}$: There is NO evidence showing the current Lean Thinking practice can influence Key Performance Indicators in SPHEIs.</td></tr>
<tr><td>Key Performance Indicators [C9]</td><td>C9.1 HE Performance
C9.2 HE Productivity
C9.3 HE Quality
C9.4 Delivery Values
C9.5 Remove Wastes
C9.6 Student Satisfaction
C9.7 Student Development</td><td>• C1 to C6
• C7.1 to C7.8
• C8.1 to C8.9</td></tr>
<tr><td colspan="4">Self-Administered Open-Structure Questions</td></tr>
<tr><td colspan="2">C10.1 What are the main current problems in the Course Planning and Delivery Process?</td><td>Relate to C1 to C6</td><td rowspan="5"><u>Self-administered open-structure questions</u>

RQ4: HOW do SPEHIs deploy Lean Thinking practice to Kaizen academic processes?

RO4: To understand how SPEHIs deploy Lean Thinking practice to Kaizen academic processes.</td></tr>
<tr><td colspan="2">C10.2 Is there any other element that is important in the Course Planning and Delivery Process?</td><td>Relate to C1 to C6</td></tr>
<tr><td colspan="2">C10.3 How much do you know about Lean Thinking (add values and reduce wastes) in Higher Education?</td><td>Relate to C7</td></tr>
<tr><td colspan="2">C10.4 Do you believe Lean Thinking practice can improve the Course Planning and Delivery Process in your institutes?</td><td>Relate to C8</td></tr>
<tr><td colspan="2">C10.5 Do you see Lean Thinking practice link the strategic planning and transformation in your institutes?</td><td>Relate to C9</td></tr>
</table>

5.4 Data Triangulation

The researcher conducted AD, LE, and ST surveys from selected SPHEI shown in *Figure 5.38.* . The online survey tool (formerly BOS) is a powerful, easy to use tool for creating online surveys, and over 300 different organisations use it in the UK and internationally.

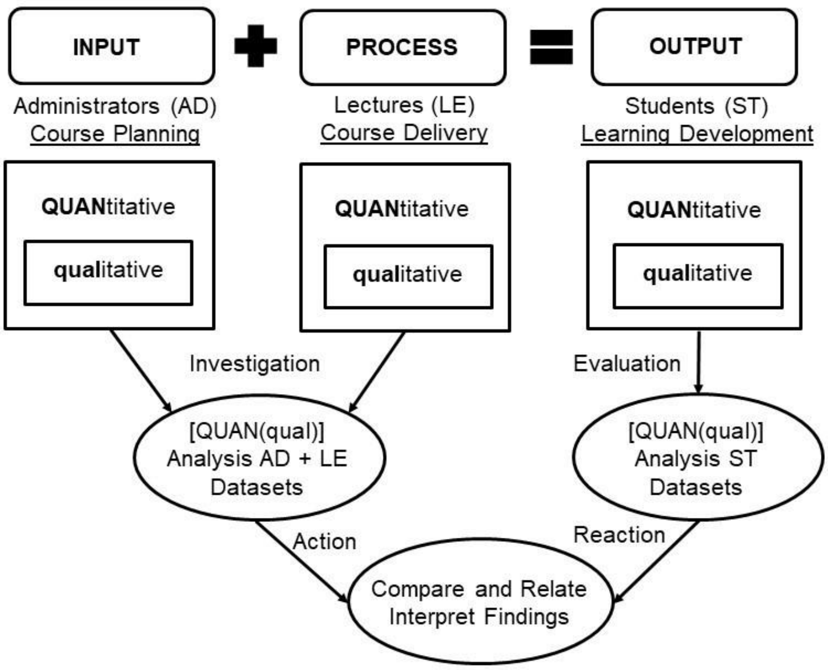


Figure 5.38 - Data Triangulation Mixed-Methods Collection (Source: Author)

The researcher used an online survey website (https://onlinesurveys.ac.uk), which the university recommended, to collect the data. The researcher collected data from two (2) SPHEIs. Since each SPHEI has three (3) datasets (Administrators, Lecturers and Students), there was a total of six (6) datasets. Datasets would be combined and analysed as cross-case, shown in *Table 5.43*.

Table 5.43 - Data Triangulation Mixed-Methods Sample Size (Source: Author)

Process Flow	Triangulation Data	SPHEIs-A	SPHEIs-B	Combined Dataset	Sample Size
Input	Administrators (AD) Course Planning	Dataset A1	Dataset B1	Dataset A1+ B1+ A2 + B2	N = 34
Process	Lecturers (LE) Course Delivery	Dataset A2	Dataset B2		
Output	Students (ST) Learning Development	Dataset A3	Dataset B3	Dataset A3 + B3	N = 303

The researcher classified the groups and sample size into the respective survey questions. The quantitative data used SPSS to process, interpret, and analyse the numerical data statistically. The qualitative data used NVivo/Excel to process code and theme analysis and Microsoft Excel to present graphs and charts.

5.5 Rating Scale Mean Range Assessment Rubric

According to Brookhart and Chen (2015), the assessment rubric is part of a collection of the criteria expressly refers to "levels of performance quality on the criteria". Ghalib and Al-Hattami (2015) claimed that a holistic rubric examines an assignment as a whole rather than breaking it down into specific assessment criteria. Dawson (2017) used fourteen rubric design elements to investigate assessment rubrics. With the present study, the researcher created the assessment rubric to translate the mean range meaning for the level of evidence-practice, competency, relationship and performance presented in Table 5.44. The attributes in the rubrics are measured using the rating scales, and the five-point Likert scale (Likert, 1936) was used.

The five-point Likert scale (Likert, 1936) is considered an interval scale. To calculate the Likert Scale Interval is (5 – 1)/4 = 0.8. The mean range is very significant.

- From 1.00 to 1.80, it means *not at all* or *very unlikely* or *very poor*.
- From 1.81 to 2.60, it means *very little* or *not likely* or *poor*.
- From 2.61 to 3.40, it means *somewhat* or *neutral* or *average*.

- From 3.41 to 4.20, it means *moderately* or *likely* or *good*.
- From 4.21 to 5.00, it means a *large extent* or *very likely* or *excellent*.

Table 5.44 - Rating Scale Mean Range Assessment Rubric (Source: Author)

<table>
<tr><td colspan="6">Level of Lean Thinking practice (C1 - C6)
RQ1: WHAT is the current level of Lean Thinking evidence practice in SPHEIs for the CP&DP?
H01$_{(Null)}$: There is NO evidence showing SPHEIs deploy Lean Thinking practice in the CP&DP.</td></tr>
<tr><td colspan="6">Level of Evidence-Practice Assessment Rubric</td></tr>
<tr><td>Rating Scale</td><td>Not at all (1)</td><td>Very Little (2)</td><td>Somewhat (3)</td><td>Moderately (4)</td><td>Large Extent (4)</td></tr>
<tr><td>Mean Range</td><td>1.00 – 1.80</td><td>1.81 – 2.60</td><td>2.61 – 3.40</td><td>3.41 – 4.20</td><td>4.21 – 5.00</td></tr>
<tr><td>C1 Course Resources
C2 Course Contents
C3 Course Pedagogy
C4 Course Assessment
C5 Course Evaluation
C6 Course Refinement</td><td>SPHEIs have no Lean Thinking evidence practice for CP&DP.</td><td>SPHEIs start to show some initial evidence of progress in some areas of CP&DP.</td><td>SPHEIs are developing good practice evidence in specific areas of CP&DP.</td><td>SPHEIs have good practice evidence and performance in many variables of CP&DP.</td><td>SPHEIs demonstrate excellent institute-wide Lean Thinking evidence practice for CP&DP.</td></tr>
<tr><td colspan="6">Level of Lean Tools competency (C7)
RQ1: WHAT is the current level of Lean Thinking evidence practice in SPHEIs for the CP&DP?
H01$_{(Null)}$: There is NO evidence showing SPHEIs deploy Lean Thinking practice in the CP&DP.</td></tr>
<tr><td colspan="6">Level of Competency Assessment Rubric</td></tr>
<tr><td>Rating Scale</td><td>Very Unlikely (1)</td><td>Not Likely (2)</td><td>Neutral (3)</td><td>Likely</td><td>Very Likely (4)</td></tr>
<tr><td>Mean Range</td><td>1.00 – 1.80</td><td>1.81 – 2.60</td><td>2.61 – 3.40</td><td>3.41 – 4.20</td><td>4.21 – 5.00</td></tr>
<tr><td>C7.1 Hoshin Kanri
C7.2 5S
C7.3 PDCA
C7.4 Poka-Yoke
C7.5 Muda (Waste)
C7.6 Muri (Overburden)
C7.7 Mura (Unevenness)
C7.8 VSM</td><td>SPHEIs need Lean Tools training at the early stage.</td><td>SPHEIs require help to find correct information at the Lean Tools essential stage.</td><td>SPHEIs can find required information with minimal Lean Tools support.</td><td>SPHEIs have a good understanding and practice of the Lean Tools.</td><td>SPHEIs are highly knowledgeable, proficient, excellent command of the Lean Tools.</td></tr>
<tr><td colspan="6">Level of Lean Thinking relationship (C8)
RQ2: WHAT is the relationship between Lean Thinking versus the CP&DP?
H02$_{(Null)}$: There is NO correlated evidence between Lean Thinking versus CP&DP.</td></tr>
<tr><td colspan="6">Level of Relationship Assessment Rubric</td></tr>
<tr><td>Rating Scale</td><td>Not at all (1)</td><td>Very Little (2)</td><td>Somewhat (3)</td><td>Moderately (4)</td><td>Large Extent (4)</td></tr>
<tr><td>Mean Range</td><td>1.00 – 1.80</td><td>1.81 – 2.60</td><td>2.61 – 3.40</td><td>3.41 – 4.20</td><td>4.21 – 5.00</td></tr>
<tr><td>C8.1 Identify Value
C8.2 Value Stream
C8.3 Create Flow
C8.4 Establish Pull
C8.5 Pursue Perfection
C8.6 People Wastes
C8.7 Process Wastes
C8.8 Information Wastes
C8.9 Assets Wastes</td><td>SPHEIs do not prove Lean Thinking related to CP&DP.</td><td>SPHEIs start to show some initial Lean Thinking related to CP&DP.</td><td>SPHEIs are appearing and delivering good Lean Thinking related to CP&DP.</td><td>SPHEIs have good practice evidence and performance Lean Thinking related to CP&DP.</td><td>SPHEIs demonstrate excellent institute-wide evidence-practice Lean Thinking related to CP&DP.</td></tr>
<tr><td colspan="6">Level of Key Performance Indicators (C9)
RQ3: HOW does current Lean Thinking practice influence KPI in SPHEIs?
H03$_{(Null)}$: There is NO evidence showing the current Lean Thinking practice can influence KPI in SPHEIs.</td></tr>
<tr><td colspan="6">Level of Performance Assessment Rubric</td></tr>
<tr><td>Rating Scale</td><td>Very Poor (1)</td><td>Poor (2)</td><td>Average (3)</td><td>Good (4)</td><td>Excellent (4)</td></tr>
<tr><td>Mean Range</td><td>1.00 – 1.80</td><td>1.81 – 2.60</td><td>2.61 – 3.40</td><td>3.41 – 4.20</td><td>4.21 – 5.00</td></tr>
<tr><td>C9.1 HE Performance
C9.2 HE Productivity
C9.3 HE Quality
C9.4 Delivery Values
C9.5 Remove Wastes
C9.6 Student Satisfaction
C9.7 Student Development</td><td>SPHEIs do not prove Lean Thinking practice influences KPI.</td><td>SPHEIs are weak to show some initial Lean Thinking practice influences KPI.</td><td>SPHEIs have satisfactory delivery Lean Thinking practice influences KPI.</td><td>SPHEIs have outstanding performance Lean Thinking practice influences KPI.</td><td>SPHEIs demonstrate excellent institute-wide Lean Thinking practice influences KPI.</td></tr>
</table>

5.6 Sample Characteristics

Collecting online survey data started in Jun 2020, and it took several months due to the COVID19 lockdown ("circuit breaker") in Singapore since Apr 2020. By the end of 31 Dec 2020, 34 of the AD and LE respondents, expected 80 responses from two SPHEIs, completed the online survey had returned, representing a valid response rate of 43%. In contrast, 303 of the ST respondents, who expected 400 responses from two SPHEIs, completed the online survey had returned, representing a valid response rate of 76%. Comparing the target to collect 370 sample size (See Chapter 4) has contributed 82% return.

Table 5.45 presents the characteristics of AD and LE respondents. Among the respondents, a large majority are highly experienced, with ten years (38%) and twenty (24%) years of work experience, respectively. Moreover, most respondents teach in Engineering (49%) and Business (29%) faculty. Respondents of these two groups have a good understanding of academic processes and can thus provide a reliable answer to the questionnaires.

Table 5.45 - Characteristics of the AD and LE Respondents (Source: Author)

Category	Description	Number	Percentage
Group (N = 34)	Administrators (AD)	11	32.4
	Lecturers (LE)	23	67.6
Gender (N = 34)	Male	24	70.6
	Female	10	29.4
Age (N = 34)	25 - 29	4	11.8
	30 - 39	11	32.4
	40 - 49	6	17.6
	50 - 59	7	20.6
	>= 60	6	17.6
Position held (N = 32)	Professional	17	50.0
Missing system (2)	Manager	4	11.8
	Executive	11	32.4
Job Role (N = 34)	Administrative Staff	11	32.4
	Full-Time Lecturer	6	17.6
	Part-Time Lecturer	17	50.0
Working experience (N = 34)	< 5	5	14.7
	5 -10	5	14.7
	11 - 20	13	38.2
	21 - 30	8	23.5
	> 30	3	8.8
Working/Teaching Faculty	Engineering	20	48.7
(Choose more than one choice)	Business	12	29.3
	Life Science	2	4.9
	Postgraduate	7	17.1
Supporting level	Diploma	16	29.1
(Choose more than one choice)	Degree	24	43.6
	Master	9	16.5
	Doctorate	3	5.4
	Others	3	5.4

Table 5.46 shows the characteristics of the ST respondents. Most of the respondents are from Singapore (54%), and the rest are from other countries (46%). Moreover, a majority of the respondents are studying in Engineering (67%) and Business (30%) faculty that met the stratified sampling strategy (See Chapter 4). Respondents have an excellent CP&DP experience during their study and can thus provide a reliable answer to the questionnaires.

Table 5.46 - Characteristics of the ST Respondents (Source: Author)

Category	Description	Number	Percentage
Gender (N = 295)	Male	218	71.5
Missing system (10)	Female	77	25.2
Age (N = 294)	< 25	120	120.0
Missing system (11)	25 - 29	85	85.0
	30 - 39	55	55.0
	40 - 49	30	30.0
	>= 50	4	4.0
Study Faculty (N=295)	Engineering	203	66.6
Missing system (10)	Business	91	29.8
	Life Science	1	0.3
Study Level (N=293)	Bachelor	221	72.5
Missing system (12)	Master	72	23.6
Duration of Study N=295)	<= 2 year	141	46.2
Missing system (10)	2 years	89	29.2
	3 years	56	18.4
	4 Years	4	1.3
	>= 5 Years	5	1.6
Current year of study (N=290)	1st year	115	37.7
Missing system (15)	2nd year	102	33.4
	3rd year	62	20.3
	4th year	7	2.3
	>= 5th year	4	1.3
Current semester or trimester (N=288)	1st	73	23.9
Missing system (17)	2nd	78	25.6
	3rd	43	14.1
	4th	94	30.8
Nationality (N=305)	Singapore	164	54.0
	Malaysia	34	11.0
	Myanmar	29	10.0
	China	26	9.0
	India	16	5.0
	*Other Countries	36	12.0

*Other countries are Bangladesh, Indonesia, Korea, Austrian, Cambodia, Philippines, Thailand, Australia, Brunei, Nepal, Sri Lankan, Vietnam.

5.7 Reliability Tests

Reliability is the degree to which the research instrument produces consistent results (Cohen, 2017). Such measures are necessary to ensure the same results will consistently be reproduced in subsequent administrations of the tools. Cronbach's alpha coefficient is the reliability indicator. The higher the coefficient (e.g. 0.8 or 0.9), the stronger the linear relationship of the items is correlated and the higher the internal consistency (Taherdoost, 2018b). The scale reliability is high, as shown in *Table 5.47*. The adopted Lean Thinking (principles, wastes, tools) exceeded the usual alpha = 0.7 to establish the scale's internal consistency.

Table 5.47 - Scale Reliability Cronbach's Alpha (Source: Author)

Scale Reliability	N of Sub-Items	Cronbach's Alpha	Summary Item Statistics - Mean		
			Item Means	Item Variances	Inter-Item Correlations
C1. Course Resources (N=334)	5	0.814	4.195	0.908	0.478
C2. Course Contents (N=334)	5	0.854	4.310	0.665	0.546
C3. Course Pedagogy (N=335)	5	0.868	4.153	0.757	0.576
C4. Course Assessment (N=335)	5	0.847	4.334	0.845	0.570
C5. Course Evaluation (N=334)	5	0.901	4.211	0.613	0.648
C6. Course Refinement (N=337)	5	0.899	4.116	0.730	0.650
C7. Lean Tools competency (N=32)	8	0.953	3.680	0.954	0.718
C8. Lean Thinking practice (N=32)	9	0.915	3.962	4.677	0.547
C9. Key Performance Indicators (N=33)	7	0.953	3.827	0.564	0.750

5.8 Nonparametric Tests

- Mann-Whitney U Test

  A U Statistic is the outcome of doing a Mann Whitney U Test (Field, 2017). The Mann-Whitney U test is "a nonparametric equivalent of the two-sample t-test" and is "used when the data does not meet the assumptions required by the independent samples t-test". The most popular scenario is testing a small sample size not normally distributed, and it is used to compare differences between two independent groups. The null hypothesis of the Mann-Whitney U test is two independent samples selected from populations that have a similar distribution.

- Wilcoxon Signed-Ranks Test

  The Wilcoxon Signed-Rank test or the Wilcoxon Signed Rank-Sum test is "a non-parametric data comparison test". A non-parametric test indicates that "the population data is not normally distributed". The Wilcoxon Signed-Rank test should be employed "if the differences between pairs of data are not normally distributed" (Field, 2017). The Wilcoxon Signed-Rank test "compares the sample median against a hypothetical median". The medians of the two samples are equal due to the null hypothesis.

- Spearman Correlation

  Spearman Correlation is "to determine the degree of association between two variables in a non-parametric test". The assumptions of Spearman Correlation are "the data must be at least ordinal, and the scores on one variable must be related to scores on the other variable monotonically" (Field, 2017). To determine "the strength of the correlation association and the direction of the relationship between two variables" is a bivariate analysis. The strength of the correlation coefficient relationship ranges between +1 and –1. The two variables are perfectly associated and have a value of 1. The relationship between the two variables reduces as the correlation coefficient value approaches zero. The coefficient sign indicates the direction of the association; a positive relationship has a plus (+) sign, and a negative relationship has a minus (–) sign.

5.9 Quantitative Analysis for Research Question 1

5.9.1 Background

Research question 1 and the null hypothesis are:

RQ1: WHAT is the current level of Lean Thinking evidence practice in SPHEIs for the CP&DP?

$H01_{(Null)}$: There is **NO** evidence showing SPHEIs deploy Lean Thinking practice in the CP&DP.

Lean Thinking has three (3) components: Lean Principles, Lean Waste and Lean Tools shown in *Figure 5.37.* For the first six (6) questions, each question has five (5) attributes. Each attribute is aligned with the 5 Lean Principles and 4 Lean Wastes shown in *Table 5.42.* The respondents are AD, LE and ST for these first six questions. They asked about the current level of Lean Thinking practice in the CP&DP in their institutes. Question 7 has eight (8) attributes, shown in *Table 5.42.* Only AD and LE were asked about their Lean Tools competency in the CP&DP in their institutes. The researcher classified the grouping and sample size according to the respective survey questions shown in *Table 5.48*.

Table 5.48 - Survey Questions 1 to 7 and Sample Size (Source: Author)

Survey Questionnaires	No of Items	Grouping Sample Size
Q1: How do you plan (know) the course resources used?	5	AD + LE + ST (N = 337)
Q2: How do you plan (know) the course contents of each module?	5	
Q3: How do you plan (know) the course pedagogy of each module?	5	
Q4: How do you plan (know) the course assessment of each module?	5	
Q5: How do you analyse (feedback) the course evaluation of each module?	5	
Q6: How do you enhance (improve) the course refinement of each module?	5	
Q7: What are the Lean Tools used in the Course Planning and Delivery process?	8	AD + LE (N = 34)

5.9.2 Descriptive Statistics

- ***Level of Lean Thinking practice (C1 to C6)***

The mean values of the Lean Thinking evidence-practice level in CP&DP under C1 to C6 were rated highly by responding institutes in terms of two groupings AD + LE and ST. For the AD + LE group, as depicted in *Table 5.49*, all attributes have been "moderately" or "large extent" (average mean ≥ 4) practised by the responding institutes. Among these, "*Course Contents*" (C2) stood out with the highest score received (*m* = 4.75), following was, "*Course Pedagogy* (*m* = 4.62)" (C3), "*Course Assessment* (*m* = 4.54)" (C4) and "*Couse Evaluation* (*m* = 4.41)" (C5) as shown in *Figure 5.39*. The top-rated attribute (C2) reveals that the responding institutes greatly emphasise students' requirements. It is parallel to the main target of Lean Thinking practice, which is to value stream for the student ("customer"). For the ST group, it is clear that the respondents placed a high degree of evidence-practice on all the attributes. As can be seen from *Table 5.49*, the mean value of the level of Lean Thinking practice ranges from 4.09 to 4.31. Strongly supported attributes such as "*Course Assessment* (*m* = 4.31)" (C4) and "*Course Contents* (*m* = 4.26)" (C2) were important attributes among the ST respondents. Compared to the AD + LE group, the mean value ranges from 4.38 to 4.75. There are gaps between the AD + LE and ST. It indicates that the responding institutes have room to improve student satisfaction continually.

Grouping the attributes based on the independent variables, the mean values of the Lean Principles and Lean Wastes evidence practices in CP&DP under C1 to C6 were rated highly by responding institutes in terms of two groupings AD + LE and ST as shown in *Table 5.50*. All independent variables have been practised either "moderately" or to a "large extent" (average mean ≥ 4) indirectly by the responding institutes. The independent variables such as: "*Lean Principle* (*m* = 4.64)", "*Process Waste*s (*m* = 4.56)", "*People Wastes* (*m* = 4.39)", "*Assets Wastes* (*m* = 4.52)" and "*Information Wastes* (*m* = 4.51)", shown *Figure 5.40,* have significant evidence and quality. All attributes have been "moderately" (4.19 ≤ average mean ≤ 4.52) practised Lean Thinking in CP&DP indirectly, as depicted in *Table 5.49* and *Table 5.50.* It means "*SPHEIs demonstrate excellent institute-wide Lean Thinking evidence practice for CP&DP"* (See *Table 5.44*).

Table 5.49 - Lean Thinking practice Mean and Standard Deviation (Source: Author)

Lean Thinking practice [C1 - C6] N=337 (AD[1] + LE[1] + ST[1])	AD[1] + LE[1] (N = 34)			ST[1] (N = 303)			Asymp. Sig. p-value
	Mean	S.D.	Rank	Mean	S.D.	Rank	
C1.1 Cohort (Process Wastes)	4.24	0.741	4	4.08	0.982	2	0.624
C1.2 Lecturers (People Wastes)	4.50	0.749	3	3.98	1.187	1	0.014
C1.3 Facilities (Assets Wastes)	4.68	0.589	5	4.23	0.921	3	0.004
C1.4 Timetable (Information Wastes)	4.38	1.045	1	4.43	0.783	5	0.613
C1.5 Overall (Identify Value)	4.38	0.888	2	4.13	0.885	4	0.055
[C1] Course Resources Average	***4.44***	***0.80***	-	***4.17***	***0.95***	-	-
C2.1 Syllabus (Information Wastes)	4.85	0.436	1	4.32	0.778	2	0.000
C2.2 Objectives (Process Wastes)	4.88	0.409	2	4.33	0.749	1	0.000
C2.3 Materials (Assets Wastes)	4.53	0.706	3	4.24	0.882	3	0.053
C2.4 Outcomes (People Wastes)	4.71	0.629	5	4.32	0.785	2	0.001
C2.5 Overall (Value Stream)	4.79	0.410	4	4.07	0.927	4	0.000
[C2] Course Contents Average	***4.75***	***0.52***	-	***4.26***	***0.82***	-	-
C3.1 Lectures (Process Wastes)	4.74	0.511	1	4.27	0.772	1	0.000
C3.2 Tutorials (Assets Wastes)	4.71	0.524	2	3.90	1.000	5	0.000
C3.3 Practical (Information Wastes)	4.44	0.894	5	4.19	0.888	2	0.046
C3.4 Consultation (People Wastes)	4.56	0.613	4	4.04	0.896	4	0.001
C3.5 Overall (Create Flow)	4.65	0.485	3	4.12	0.809	3	0.000
[C3] Course Pedagogy Average	***4.62***	***0.61***	-	***4.10***	***0.87***	-	-
C4.1 Attendance (People Wastes)	4.06	1.278	5	4.18	1.189	4	0.642
C4.2 Tests/Quizzes (Information Wastes)	4.65	0.691	3	4.38	0.814	2	0.028
C4.3 Coursework (Process Wastes)	4.71	0.629	1	4.49	0.700	1	0.036
C4.4 Examination (Assets Wastes)	4.59	1.019	4	4.30	0.943	3	0.009
C4.5 Overall (Create Flow)	4.68	0.843	2	4.21	0.852	5	0.000
[C4] Course Assessment Average	***4.54***	***0.89***	-	***4.31***	***0.90***	-	-
C5.1 Reaction (Information Wastes)	4.38	0.697	3	4.11	0.818	5	0.066
C5.2 Learning (Process Wastes)	4.44	0.660	2	4.25	0.747	1	0.144
C5.3 Behaviour (People Wastes)	4.21	0.914	5	4.14	0.817	4	0.471
C5.4 Results (Assets Wastes)	4.32	0.768	4	4.23	0.808	3	0.522
C5.5 Overall (Establish Pull)	4.68	0.535	1	4.24	0.738	2	0.001
[C5] Course Evaluation Average	***4.41***	***0.71***	-	***4.19***	***0.79***	-	-
C6.1 Engagement (Assets Wastes)	4.26	0.790	5	4.07	0.823	1	0.202
C6.2 Experience (Process Wastes)	4.32	0.843	3	3.90	1.019	4	0.011
C6.3 Satisfaction (Information Wastes)	4.38	0.652	2	4.17	0.816	1	0.192
C6.4 Achievement (People Wastes)	4.29	0.760	4	4.13	0.847	3	0.326
C6.5 Overall (Pursue Perfection)	4.65	0.485	1	4.16	0.793	2	0.000
[C6] Course Refinement Average	***4.38***	***0.71***	-	***4.09***	***0.86***	-	-
Average Mean and S.D.	***4.52***	***0.71***	-	***4.19***	***0.87***	-	-

Asymptotic significances are displayed. The significance level is .050.

[1] AD denoted as Administrators, LE denoted as Lecturers, ST denoted as Students.

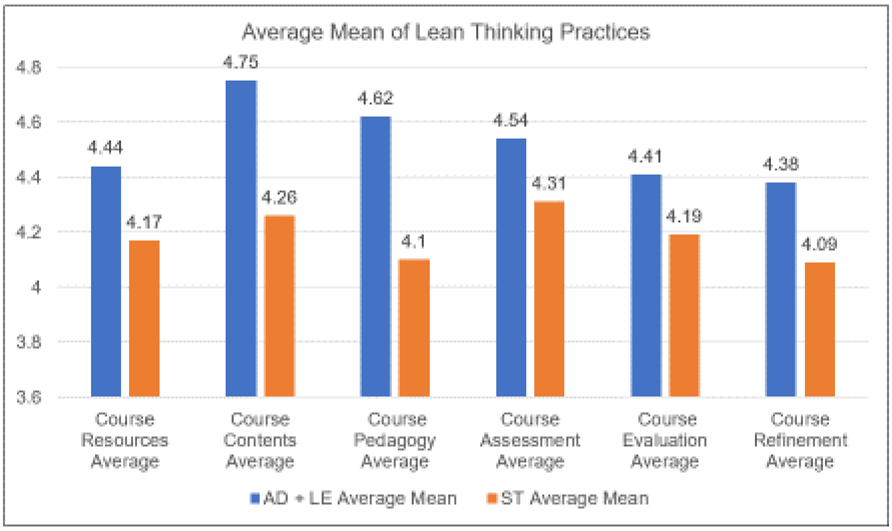


Figure 5.39 - Average Mean of Lean Thinking Practices (Source: Author)

Table 5.50 - Lean Principles and Wastes Mean and Standard Deviation (Source: Author)

Categories	Lean Principles and Wastes [C1 - C6] N=337 (AD[1] + LE[1] + ST[1])	AD[1] + LE[1] (N = 34) Mean	S.D.	Rank	ST[1] (N = 303) Mean	S.D.	Rank	Asymp. Sig. p-value
[C1] Course Resources	C1.5 Overall (Identify Value)	4.38	0.888	4	4.13	0.885	4	0.055
[C2] Course Contents	C2.5 Overall (Value Stream)	4.79	0.410	1	4.07	0.927	6	0.000
[C3] Course Pedagogy	C3.5 Overall (Create Flow)	4.65	0.485	3	4.12	0.809	5	0.000
[C4] Course Assessment	C4.5 Overall (Create Flow)	4.68	0.843	2	4.21	0.852	2	0.000
[C5] Course Evaluation	C5.5 Overall (Establish Pull)	4.68	0.535	2	4.24	0.738	1	0.001
[C6] Course Refinement	C6.5 Overall (Pursue Perfection)	4.65	0.485	3	4.16	0.793	3	0.000
	Lean Principles Average	***4.64***	***0.61***	-	***4.16***	***0.83***	-	-
[C1] Course Resources	C1.1 Cohort (Process Wastes)	4.24	0.741	6	4.08	0.982	6	0.624
[C2] Course Contents	C2.2 Objectives (Process Wastes)	4.88	0.409	1	4.33	0.749	2	0.000
[C3] Course Pedagogy	C3.1 Lectures (Process Wastes)	4.74	0.511	2	4.27	0.772	3	0.000
[C4] Course Assessment	C4.3 Coursework (Process Wastes)	4.71	0.629	3	4.49	0.700	1	0.036
[C5] Course Evaluation	C5.2 Learning (Process Wastes)	4.44	0.660	4	4.25	0.747	4	0.144
[C6] Course Refinement	C6.2 Experience (Process Wastes)	4.32	0.843	5	3.90	1.019	5	0.011
	Process Wastes Average	***4.56***	***0.63***	-	***4.22***	***0.83***	-	-
[C1] Course Resources	C1.2 Lecturers (People Wastes)	4.50	0.749	3	3.98	1.187	4	0.014
[C2] Course Contents	C2.4 Outcomes (People Wastes)	4.71	0.629	1	4.32	0.785	1	0.001
[C3] Course Pedagogy	C3.4 Consultation (People Wastes)	4.56	0.613	2	4.04	0.896	6	0.001
[C4] Course Assessment	C4.1 Attendance (People Wastes)	4.06	1.278	6	4.18	1.189	2	0.642
[C5] Course Evaluation	C5.3 Behaviour (People Wastes)	4.21	0.914	5	4.14	0.817	3	0.471
[C6] Course Refinement	C6.4 Achievement (People Wastes)	4.29	0.760	4	4.13	0.847	5	0.326
	People Wastes Average	***4.39***	***0.82***	-	***4.13***	***0.95***	-	-
[C1] Course Resources	C1.3 Facilities (Assets Wastes)	4.68	0.589	2	4.23	0.921	3	0.004
[C2] Course Contents	C2.3 Materials (Assets Wastes)	4.53	0.706	4	4.24	0.882	2	0.053
[C3] Course Pedagogy	C3.2 Tutorials (Assets Wastes)	4.71	0.524	1	3.90	1.000	5	0.000
[C4] Course Assessment	C4.4 Examination (Assets Wastes)	4.59	1.019	3	4.30	0.943	1	0.009
[C5] Course Evaluation	C5.4 Results (Assets Wastes)	4.32	0.768	5	4.23	0.808	3	0.522
[C6] Course Refinement	C6.1 Engagement (Assets Wastes)	4.26	0.790	6	4.07	0.823	4	0.202
	Assets Wastes Average	***4.52***	***0.73***	-	***4.16***	***0.90***	-	-
[C1] Course Resources	C1.4 Timetable (Info[2] Wastes)	4.38	1.045	4	4.43	0.783	1	0.613
[C2] Course Contents	C2.1 Syllabus (Info[2] Wastes)	4.85	0.436	1	4.32	0.778	3	0.000
[C3] Course Pedagogy	C3.3 Practical (Info[2] Wastes)	4.44	0.894	3	4.19	0.888	4	0.046
[C4] Course Assessment	C4.2 Tests/Quizzes (Info[2] Wastes)	4.65	0.691	2	4.38	0.814	2	0.028
[C5] Course Evaluation	C5.1 Reaction (Info[2] Wastes)	4.38	0.697	4	4.11	0.818	6	0.066
[C6] Course Refinement	C6.1 Satisfaction (Info[2] Wastes)	4.38	0.652	4	4.17	0.816	5	0.192
	Information Wastes Average	***4.51***	***0.74***	-	***4.27***	***0.82***	-	-
	Average Mean & S.D.	***4.52***	***0.71***	-	***4.19***	***0.87***	-	-

Asymptotic significances are displayed. The significance level is .050.
[1] AD denoted as Administrators, LE denoted as Lecturers, ST denoted as Students. [2] Information Wastes.

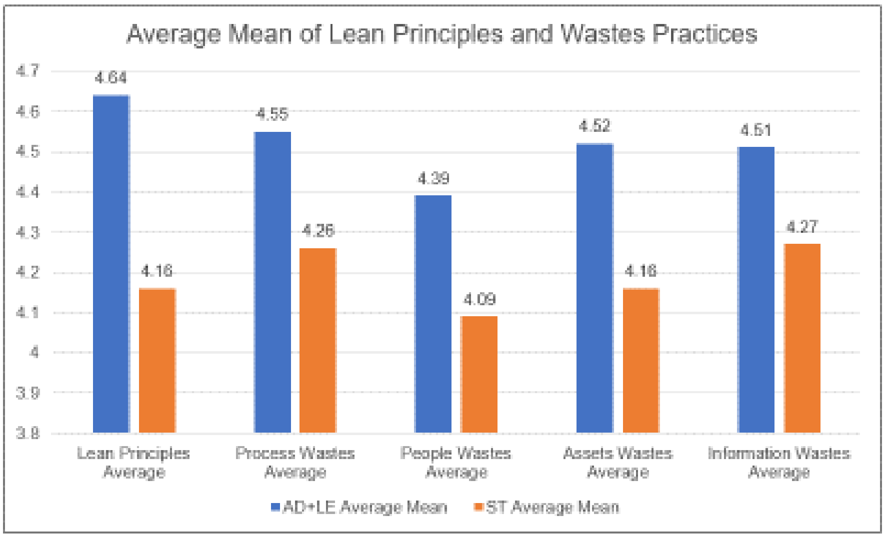


Figure 5.40 - Average Mean of Lean Principles and Wastes Practices (Source: Author)

- ***Level of Lean Tools Competency (C7)***

The mean values of the level of competency in Lean Tools under C7 were rated highly by responding institutes in terms of two groupings, AD and LE. All attributes have been "likely" (3.72 ≤ average mean ≤ 3.66) applied Lean Tools competency in the CP&DP indirectly, as depicted in *Table 5.51*. It means "*SPHEIs have a good understanding and practice of the Lean Tools*" (See *Table 5.44*).

Table 5.51 - Lean Tools competency Mean and Standard Deviation (Source: Author)

Lean Tools Competency [C7]	AD[1] (N = 11)			LE[1] (N = 23)			Exact Sig. p-value
	Mean	S.D.	Rank	Mean	S.D.	Rank	
C7.1 Policy Deployment (Hoshin Kanri)	4.00	0.632	1	3.91	0.996	1	.942[a]
C7.2 5S[2]	3.64	0.674	3	3.35	1.152	7	.537[a]
C7.3 Plan Do Check Act (PDCA)	4.00	0.775	1	3.87	1.058	2	1.000[a]
C7.4 Error Proofing (Poka-Yoke)	3.73	0.467	2	3.74	1.096	3	.586[a]
C7.5 Waste (Muda)	3.64	0.674	3	3.91	1.125	1	.243[a]
C7.6 Overburden (Muri)	3.45	0.522	5	3.52	1.078	5	.558[a]
C7.7 Unevenness (Mura)	3.55	0.688	4	3.61	1.076	4	.561[a]
C7.8 Value Stream Mapping (VSM)	3.73	0.647	2	3.39	1.158	6	.561[a]
Average Mean and S.D.	***3.72***	***0.635***	-	***3.66***	***1.092***	-	-

Asymptotic significances are displayed. The significance level is .050.
a. Exact significance is displayed for this test.
[1] AD denoted as Administrators, LE denoted as Lecturers. [2] Sort, Set in Order, Shine, Standardise, Sustain.

5.9.3 Nonparametric Compare Group

- ***Lean Thinking practice (C1 to C6)***

The information presented above reveals the current situation at the responding institutes adopting Lean Thinking practice. It shows that "*SPHEIs demonstrate excellent institutes-wide Lean Thinking evidence practice for CP&PD*" (Likely) (See Table 5.44). The level of Lean Thinking evidence-practice in CP&DP has an average mean of 4.52 for AD + LE and 4.19 for ST, respectively.

Independent-Samples Mann-Whitney U Test Approach

The Independent-Samples Mann-Whitney U Test determines any significant difference between groups. This non-parametric test for the significance between attributes is the most appropriate because attributes are on a Likert Scale (ordinal). The hypothesis was formulated to test the significant difference between AD + LE and ST samples, and a 5% level of significance was to test the formulated hypothesis:

$H01\text{-}1_{(Null)}$: The distribution of <attribute> is **the same** across categories of Group.

$H01\text{-}1_{(Alt)}$: The distribution of <attribute> is **not the same** across categories of Group.

The right column of *Table 5.49* and *Table 5.50* show the calculated p-values. There is a significant difference if the p-value is less than .05 (not the same). There is no significant difference if the p-value is more than .05 (same). *Table 5.52* shows the decision to retain or reject the hypothesis between AD + LE and ST groups. A total of 18 (white cells) out of 30 attributes (60%) a rejection of the null hypotheses, whereas 12 (yellow cells) out of 30 attributes (40%) showed retention of the null hypothesis. Three attributes have the highest p-value:

- C4.1 - Attendance (People Wastes) (p = .642)
  "E-attendance, compare to manual attendance, is effectively implemented."
- C1.1 - Corhort (Process Wastes) (p = .624)
  "The team optimizes roll-in the new/previous cohort with an existing/current cohort that studies the same module."
- C1.4 – Timetable (Information Wastes) (p = .613)
  "The team optimizes the timetable planning to make sure there is no crash with other teaching modules and exam day."

It implies that the responding institutes are aware of Lean Thinking but are unaware of the whole spectrum of its implementation and practices. Their lack of understanding of what is needed for the Lean Thinking practice might affect their focus and thus their current level of evidence-practice.

Mann-Whitney U test Approach

The Mann-Whitney U test is the non-parametric alternative to the independent-sample t-test to test for differences between two independent groups on an ordinal/continuous measure. Instead of comparing the means of two groups, as in the case of the t-test, the Mann-Whitney U test compares medians. It then evaluates whether the ranks of the two groups differ significantly (Field, 2017). *Table 5.53* shows the scores converted to ranks; the actual distribution of the scores does not matter.

Table 5.52 - Mann-Whitney U Test Hypothesis for Lean Thinking practice (Source: Author)

Lean Thinking practice [C1 - C6] N=337 (AD[1] + LE[1] vs ST[1])	Independent-Samples Mann-Whitney U Test Null Hypothesis	Asymp. Sig. p-value	Decision H_0
[C1] Course Resources			
C1.1 Cohort (Process Wastes)	The distribution of Cohorts (Process Wastes) is the same across categories of Group.	0.624	Retain
C1.2 Lecturers (People Wastes)	The distribution of Lecturers (People Wastes) is the same across categories of Group.	0.014	Reject
C1.3 Facilities (Assets Wastes)	The distribution of Facilities (Assets Wastes) is the same across categories of Group.	0.004	Reject
C1.4 Timetable (Information Wastes)	The distribution of Timetable (Information Wastes) is the same across categories of Group.	0.613	Retain
C1.5 Overall (Identify Value)	The distribution of Overall (Identify Value) is the same across categories of Group.	0.055	Retain
[C2] Course Contents			
C2.1 Syllabus (Information Wastes)	The distribution of Syllabus (Information Wastes) is the same across categories of Group.	0.000	Reject
C2.2 Objectives (Process Wastes)	The distribution of Objectives (Process Wastes) is the same across categories of Group.	0.000	Reject
C2.3 Materials (Assets Wastes)	The distribution of Materials (Assets Wastes) is the same across categories of Group.	0.053	Retain
C2.4 Outcomes (People Wastes)	The distribution of Outcomes (People Wastes) is the same across categories of Group.	0.001	Reject
C2.5 Overall (Value Stream)	The distribution of Overall (Value Stream) is the same across categories of Group.	0.000	Reject
[C3] Course Pedagogy			
C3.1 Lectures (Process Wastes)	The distribution of Lectures (Process Wastes) is the same across categories of Group.	0.000	Reject
C3.2 Tutorials (Assets Wastes)	The distribution of Tutorials (Assets Wastes) is the same across categories of Group.	0.000	Reject
C3.3 Practical (Information Wastes)	The distribution of Practical (Information Wastes) is the same across categories of Group.	0.046	Reject
C3.4 Consultation (People Wastes)	The distribution of Consultation (People Wastes) is the same across categories of Group.	0.001	Reject
C3.5 Overall (Create Flow)	The distribution of Overall (Create Flow) is the same across categories of Group.	0.000	Reject
[C4] Course Assessment			
C4.1 Attendance (People Wastes)	The distribution of Attendance (People Wastes) is the same across categories of Group.	0.642	Retain
C4.2 Tests/Quizzes (Information Wastes)	The distribution of Tests/Quizzes (Information Wastes) is the same across categories of Group.	0.028	Reject
C4.3 Coursework (Process Wastes)	The distribution of Coursework (Process Wastes) is the same across categories of Group.	0.036	Reject
C4.4 Examination (Assets Wastes)	The distribution of Examination (People Wastes) is the same across categories of Group.	0.009	Reject
C4.5 Overall (Create Flow)	The distribution of Overall (Create Flow) is the same across categories of Group.	0.000	Reject
[C5] Course Evaluation			
C5.1 Reaction (Information Wastes)	The distribution of Reaction (Information Wastes) is the same across categories of Group.	0.066	Retain
C5.2 Learning (Process Wastes)	The distribution of Learning (Process Wastes) is the same across categories of Group.	0.144	Retain
C5.3 Behaviour (People Wastes)	The distribution of Behaviour (People Wastes) is the same across categories of Group.	0.471	Retain
C5.4 Results (Assets Wastes)	The distribution of Results (Assets Wastes) is the same across categories of Group.	0.522	Retain
C5.5 Overall (Establish Pull)	The distribution of Overall (Establish Pull) is the same across categories of Group.	0.001	Reject
[C6] Course Refinement			
C6.1 Engagement (Assets Wastes)	The distribution of Engagement (Assets Wastes) is the same across categories of Group.	0.202	Retain
C6.2 Experience (Process Wastes)	The distribution of Experience (Process Wastes) is the same across categories of Group.	0.011	Reject
C6.3 Satisfaction (Information Wastes)	The distribution of Satisfaction (Information Wastes) is the same across categories of Group.	0.192	Retain
C6.4 Achievement (People Wastes)	The distribution of Achievement (People Wastes) is the same across categories of Group.	0.326	Retain
C6.5 Overall (Pursue Perfection)	The distribution of Overall (Pursue Perfection) is the same across categories of Group.	0.000	Reject

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Independent Samples→Automatically compare distribution across groups
Asymptotic significances are displayed. The significance level is .050.
[1] AD denoted as Administrators, LE denoted as Lecturers, ST denoted as Students.

Effect size is a statistical concept quantifies the strength of a relationship between two variables. The statistical effect size determines whether the difference is real or the result of a change in factors. The effect size, power, sample size, and critical significance level are related to hypothesis testing (Cohen, 1992).

SPSS does not provide an effect size statistic, but the value of Z reported in that output be used to calculate an appropriate value of r.

$$r = \frac{Z}{\sqrt{N}}$$

Table 5.53 - Mann-Whitney U Test Ranks for Lean Thinking practice (Source: Author)

Lean Thinking practice [C1 - C6] N=337 (AD[1] + LE[1] vs ST[1])	AD[1] + LE[1] (N = 34)			ST[1] (N = 303)		
	Median	Mean Rank	Sum of Ranks	Median	Mean Rank	Sum of Ranks
C1.1 Cohort (Process Wastes)	4.00	176.26	5993.00	4.00	168.18	50960.00
C1.2 Lecturers (People Wastes)	5.00	204.26	6945.00	4.00	163.90	49335.00
C1.3 Facilities (Assets Wastes)	5.00	210.50	7157.00	4.00	163.77	49459.00
C1.4 Timetable (Information Wastes)	5.00	174.50	5933.00	4.00	166.71	50012.00
C1.5 Overall (Identify Value)	5.00	197.24	6706.00	4.00	165.83	50247.00
[C1] Course Resources Average	***4.80***	***192.55***	***6546.80***	***4.00***	***165.67***	***50002.60***
C2.1 Syllabus (Information Wastes)	5.00	230.03	7821.00	4.00	161.57	48795.00
C2.2 Objectives (Process Wastes)	5.00	232.78	7914.50	4.00	161.26	48701.50
C2.3 Materials (Assets Wastes)	5.00	196.56	6683.00	4.00	165.34	49933.00
C2.4 Outcomes (People Wastes)	5.00	213.60	7262.50	4.00	162.85	49017.50
C2.5 Overall (Value Stream)	5.00	238.71	8116.00	4.00	160.01	48164.00
[C2] Course Contents Average	***5.00***	***222.34***	***7559.40***	***4.00***	***162.21***	***48922.20***
C3.1 Lectures (Process Wastes)	5.00	219.90	7476.50	4.00	162.14	48803.50
C3.2 Tutorials (Assets Wastes)	5.00	241.81	8221.50	4.00	160.83	48731.50
C3.3 Practical (Information Wastes)	5.00	198.12	6736.00	4.00	165.73	50217.00
C3.4 Consultation (People Wastes)	5.00	218.51	7429.50	4.00	163.44	49523.50
C3.5 Overall (Create Flow)	5.00	224.59	7636.00	4.00	162.76	49317.00
[C3] Course Pedagogy Average	***5.00***	***220.59***	***7499.90***	***4.00***	***162.98***	***49318.50***
C4.1 Attendance (People Wastes)	5.00	161.85	5503.00	5.00	169.25	51113.00
C4.2 Tests/Quizzes (Information Wastes)	5.00	198.79	6759.00	5.00	164.52	49521.00
C4.3 Coursework (Process Wastes)	5.00	197.15	6703.00	5.00	165.27	49913.00
C4.4 Examination (People Wastes)	5.00	205.54	6988.50	5.00	164.33	49627.50
C4.5 Overall (Create Flow)	5.00	225.12	7654.00	4.00	162.13	48962.00
[C4] Course Assessment Average	***5.00***	***197.69***	***6721.50***	***4.80***	***165.12***	***49827.30***
C5.1 Reaction (Information Wastes)	4.50	195.50	6647.00	4.00	165.46	49969.00
C5.2 Learning (Process Wastes)	5.00	189.47	6442.00	4.00	166.14	50174.00
C5.3 Behaviour (People Wastes)	4.00	178.51	6069.50	4.00	166.81	50210.50
C5.4 Results (Assets Wastes)	4.50	177.85	6047.00	4.00	167.45	50569.00
C5.5 Overall (Establish Pull)	5.00	217.68	7401.00	4.00	162.39	48879.00
[C5] Course Evaluation Average	***4.60***	***191.80***	***6521.30***	***4.00***	***165.65***	***49960.30***
C6.1 Engagement (Assets Wastes)	4.00	187.87	6387.50	4.00	166.88	50565.50
C6.2 Experience (Process Wastes)	4.50	206.79	7031.00	4.00	164.76	49922.00
C6.3 Satisfaction (Information Wastes)	4.00	188.03	6393.00	4.00	166.86	50560.00
C6.4 Achievement (People Wastes)	4.00	183.41	6236.00	4.00	167.38	50717.00
C6.5 Overall (Pursue Perfection)	5.00	221.21	7521.00	4.00	163.14	49432.00
[C6] Course Refinement Average	***4.30***	***197.46***	***6713.70***	***4.00***	***165.80***	***50239.30***

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Legacy Dialogs→2 Independent Samples
[1] AD denoted as Administrators, LE denoted as Lecturers, ST denoted as Students.

The Z is the statistic, and N is the number of cases. For example, the sample value of Z is -0.490 (C1.1), the value of r is calculated as follows:

$$r = \frac{-0.490}{\sqrt{337}} = -0.03$$

Cohen (1992) defined a small effect size as the value of r varying around 0.1, a medium effect size as the value of r varying around 0.3, and a large effect size as the value of r varying more than 0.5. *Table 5.54* shows the Mann-Whitney U test statistics for the CP&DP.

Table 5.54 - Mann-Whitney U Test Statistics for Lean Thinking practice (Source: Author)

Lean Thinking practice [C1 - C6] N=337 (AD[1] + LE[1] vs ST[1]) [a]	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. p-value	r
[C1] Course Resources					
C1.1 Cohort (Process Wastes)	4904.000	50960.000	-0.490	0.624	-0.03
C1.2 Lecturers (People Wastes)	3884.000	49335.000	-2.461	0.014	-0.13
C1.3 Facilities (Assets Wastes)	3706.000	49459.000	-2.910	0.004	-0.16
C1.4 Timetable (Information Wastes)	4862.000	50012.000	-0.506	0.613	-0.03
C1.5 Overall (Identify Value)	4191.000	50247.000	-1.921	0.055	-0.10
[C2] Course Contents					
C2.1 Syllabus (Information Wastes)	3042.000	48795.000	-4.335	0.000	-0.24
C2.2 Objectives (Process Wastes)	2948.500	48701.500	-4.519	0.000	-0.25
C2.3 Materials (Assets Wastes)	4180.000	49933.000	-1.936	0.053	-0.11
C2.4 Outcomes (People Wastes)	3566.500	49017.500	-3.206	0.001	-0.17
C2.5 Overall (Value Stream)	2713.000	48164.000	-4.824	0.000	-0.26
[C3] Course Pedagogy					
C3.1 Lectures (Process Wastes)	3352.500	48803.500	-3.613	0.000	-0.20
C3.2 Tutorials (Assets Wastes)	2675.500	48731.500	-4.862	0.000	-0.26
C3.3 Practical (Information Wastes)	4161.000	50217.000	-1.992	0.046	-0.11
C3.4 Consultation (People Wastes)	3467.500	49523.500	-3.340	0.001	-0.18
C3.5 Overall (Create Flow)	3261.000	49317.000	-3.805	0.000	-0.21
[C3] Course Pedagogy					
C4.1 Attendance (People Wastes)	4908.000	5503.000	-0.465	0.642	-0.03
C4.2 Tests/Quizzes (Information Wastes)	4070.000	49521.000	-2.200	0.028	-0.12
C4.3 Coursework (Process Wastes)	4160.000	49913.000	-2.100	0.036	-0.11
C4.4 Examination (People Wastes)	3874.500	49627.500	-2.625	0.009	-0.14
C4.5 Overall (Create Flow)	3209.000	48962.000	-3.907	0.000	-0.21
[C5] Course Evaluation					
C5.1 Reaction (Information Wastes)	4216.000	49969.000	-1.841	0.066	-0.10
C5.2 Learning (Process Wastes)	4421.000	50174.000	-1.461	0.144	-0.08
C5.3 Behaviour (People Wastes)	4759.500	50210.500	-0.721	0.471	-0.04
C5.4 Results (Assets Wastes)	4816.000	50569.000	-0.641	0.522	-0.03
C5.5 Overall (Establish Pull)	3428.000	48879.000	-3.461	0.001	-0.19
[C6] Course Refinement					
C6.1 Engagement (Assets Wastes)	4509.500	50565.500	-1.277	0.202	-0.07
C6.2 Experience (Process Wastes)	3866.000	49922.000	-2.541	0.011	-0.14
C6.3 Satisfaction (Information Wastes)	4504.000	50560.000	-1.304	0.192	-0.07
C6.4 Achievement (People Wastes)	4661.000	50717.000	-0.981	0.326	-0.05
C6.5 Overall (Pursue Perfection)	3376.000	49432.000	-3.586	0.000	-0.20

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Legacy Dialogs→2 Independent Samples
r can be calculated by dividing Z by the square root of N.
a. Grouping Variable: Group
[1] AD denoted as Administrators, LE denoted as Lecturers, ST denoted as Students.

From *Table 5.53 a*nd *Table 5.54,* the results show:

Example 1:

Mann-Whitney U Test indicated the distribution of Cohorts (Process Wastes) was same across categories of group AD + LE (Median = 4, N = 34) and ST (Median = 4, N = 303), U = 4904.0, Z = - 0.490, p = 0.624, r = - 0.03. Hence failed to reject the null hypothesis.

Example 2:

Mann-Whitney U Test indicated the distribution of Lecturer (People Wastes) was not the same across categories of group AD + LE (Median = 5, N = 34) and ST (Median = 4, N = 303), U = 3884.0, Z = - 2.461, p = 0.014, r = - 0.13. Hence reject the null hypothesis.

- ***Lean Tools Competency (C7)***

Regarding the level of Lean Tools Competency in CP&DP has an average mean of 3.72 for AD and 3.66 for LE, respectively. It shows "*SPHEIs have a good understanding and practice of the Lean Tools*" (Likely) (See *Table 5.44*).

<u>*Independent-Samples Mann-Whitney U Test Approach*</u>

The hypothesis was formulated to test the significant difference between AD and LE samples. A 5% level of significance was to test the formulated hypothesis:

H01-1$_{(\text{Null})}$: The distribution of <attribute> is **the same** across categories of Group.

H01-1$_{(\text{Alt})}$: The distribution of <attribute> is **not the same** across categories of Group.

The right column of *Table 5.51* shows the calculated p-values. To retain or reject the hypothesis between AD and LE was shown in *Table 5.55*. A total of 8 attributes (yellow cells) (100%) from "*Lean Tools Competency* (C7)" the null hypotheses have been retained. Three attributes have the highest p-value:

- C7.3 - Plan Do Check Act (PDCA) (*p* = 1.000)

  "Do you implement PDCA iterative method for your work improvement?"
- C7.1 - Policy Deployment (Hoshin Kanri) (*p* = .942)

"Do you align the goals of your institute (strategy) with the plans of middle management (tactics) and work performed on the institute floor (action)?"

- C7.4 Error Proofing (Poka-Yoke) (p = .586)

  "Do you achieve zero defects/errors in your work delivery process?"

One possible explanation for this is that both AD and LE are aware of these standard Lean Tools and have high significant distribution to adopt them in the CP&DP indirectly. However, the attribute "C7.5 Waste (Muda): *Do you practice removing no value-added in academic processes?*" has the lowest p-value of .243, showing AD and LE have minimal significant distribution to identify there are wastes in the academic processes.

Table 5.55 - Mann-Whitney U Test Hypothesis for Lean Tools competency (Source: Author)

Lean Tools Competency [C7] N=34 (AD[1] vs LE[1])	**Independent-Samples Mann-Whitney U Test Null Hypothesis**	**Exact Sig. p-value**	**Decision H_0**
C7.1 Policy Deployment (Hoshin Kanri)	The distribution of Policy Deployment (Hoshin Kanri) is the same across categories of Group.	.942[a]	Retain
C7.2 5S[2]	The distribution of 5S is the same across categories of Group.	.537[a]	Retain
C7.3 Plan Do Check Act (PDCA)	The distribution of PDCA is the same across categories of Group.	1.000[a]	Retain
C7.4 Error Proofing (Poka-Yoke)	The distribution of Error Proofing (Poka-Yoke) is the same across categories of Group.	.586[a]	Retain
C7.5 Waste (Muda)	The distribution of Waste (Muda) is the same across categories of Group.	.243[a]	Retain
C7.6 Overburden (Muri)	The distribution of Overburden (Muri) is the same across categories of Group.	.558[a]	Retain
C7.7 Unevenness (Mura)	The distribution of Unevenness (Mura) is the same across categories of Group.	.561[a]	Retain
C7.8 Value Stream Mapping (VSM)	The distribution of Value Stream Mapping (VSM) is the same across categories of Group.	.561[a]	Retain

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Independent Samples→Automatically compare distribution across groups
Asymptotic significances are displayed. The significance level is .050.
a. Exact significance is displayed for this test.
[1] AD denoted as Administrators, LE denoted as Lecturers. [2] Sort, Set in Order, Shine, Standardise, Sustain.

Mann-Whitney U test Approach

Table 5.56 shows the Mann-Whitney U mean rank and sum of ranks for Lean Tools competency, whereas *Table 5.57* shows Mann-Whitney U Test Statistics for Lean Tools competency. The p-value shown is the same as in *Table 5.55*.

Table 5.56 - Mann-Whitney U Test Ranks for Lean Tools competency (Source: Author)

Lean Tools Competency [C7] N=34 (AD[1] vs LE[1])	AD[1] (N = 11)			LE[1] (N = 23)		
	Median	Mean Rank	Sum of Ranks	Median	Mean Rank	Sum of Ranks
C7.1 Policy Deployment (Hoshin Kanri)	4.00	17.27	190.00	4.00	17.61	405.00
C7.2 5S[2]	4.00	19.05	209.50	4.00	16.76	385.50
C7.3 Plan Do Check Act (PDCA)	4.00	17.55	193.00	4.00	17.48	402.00
C7.4 Error Proofing (Poka-Yoke)	4.00	16.09	177.00	4.00	18.17	418.00
C7.5 Waste (Muda)	4.00	14.55	160.00	4.00	18.91	435.00
C7.6 Overburden (Muri)	3.00	15.14	166.50	4.00	17.21	361.50
C7.7 Unevenness (Mura)	3.00	16.00	176.00	4.00	18.22	419.00
C7.8 Value Stream Mapping (VSM)	3.00	18.95	208.50	4.00	16.80	386.50

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Legacy Dialogs→2 Independent Samples
[1] AD denoted as Administrators, LE denoted as Lecturers. [2] Sort, Set in Order, Shine, Standardise, Sustain.

Table 5.57 - Mann-Whitney U Test Statistics for Lean Tools competency (Source: Author)

Lean Tools Competency [C7] N=34 (AD[1] vs LE[1]) [a]	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. p-value	Exact Sig. p-value	r
C7.1 Policy Deployment (Hoshin Kanri)	124.000	190.000	-0.102	0.919	.942 [b]	-0.02
C7.2 5S[2]	109.500	385.500	-0.654	0.513	.537 [b]	-0.11
C7.3 Plan Do Check Act (PDCA)	126.000	402.000	-0.020	0.984	1.000 [b]	0.00
C7.4 Error Proofing (Poka-Yoke)	111.000	177.000	-0.642	0.521	.586 [b]	-0.11
C7.5 Waste (Muda)	94.000	160.000	-1.262	0.207	.243 [b]	-0.22
C7.6 Overburden (Muri)	100.500	166.500	-0.646	0.518	.558 [b]	-0.11
C7.7 Unevenness (Mura)	110.000	176.000	-0.651	0.515	.561 [b]	-0.11
C7.8 Value Stream Mapping (VSM)	110.500	386.500	-0.632	0.527	.561 [b]	-0.11

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Legacy Dialogs→2 Independent Samples.
r can be calculated by dividing Z by the square root of N.
a. Grouping Variable: Group.
b. Not corrected for ties.
[1] AD denoted as Administrators, LE denoted as Lecturers. [2] Sort, Set in Order, Shine, Standardise, Sustain.

An asymptotic significance calculated using an approximation to the truth distribution is called an asymptotic p-value. The asymptotic significance is on the assumption that the data set is large. An exact significance calculated using the actual distribution calls an exact p-value. The exact significance is on the assumption that the data set is small. For large sample sizes, the asymptotic and exact p-values are very similar. For small samples sizes, the asymptotic and exact p-values can be quite different (Field, 2017).

5.9.4 Nonparametric Correlations

Investigating the relationship between Lean Tools Competency and CP&DP can at least prove a snapshot of the relationships between the two grouping AD and LE in SPHEIs.

Spearman's rho correlation Approach

Spearman's rho correlation analysis accesses the relationship between the various practices of Lean Tools competency in CP&DP. Spearman's rho is a suitable method for determining the strength and direction of a linear relationship between two variables because of the ordinal nature of data. The null hypothesis (H_0) sets no correlation between the two variables. The alternative hypothesis (H_1) sets a correlation between the two variables. If the $p < 0.01$ or $p < 0.05$, there is very strong evidence for rejecting H_0. If the $p > 0.01$ or $p > 0.05$, it is failed to reject the H_0.

Table 5.58 shows the findings of Spearman's rho correlation analysis. All the correlation coefficients, r, are positive. It indicates that CP&DP is associated with more extensive use of the Lean Tools. There are 4 coefficients highly significant at $p < 0.01$ (with **) and 6 coefficients significant at $p < 0.05$ (with *). Examining the individual correlations from Table 5.58 shows that 2 out of 48 correlations between Lean Tools Competency and CP&DP measure above 0.5. These denoted as high correlation (H) (yellow cells). Two highest correlation is between "*Policy Deployment (Hoshin Kanri)* (C7.1)" and one of the following CP&DP:

- C5 - Course Evaluation ($r = .530$, $p < 0.01$)
- C6 - Course Refinement ($r = .551$, $p < 0.01$)

Additionally, correlation coefficients between 0.3 and 0.5 are denoted as medium (M) (green cells), while correlation coefficients below 0.3 are classified as low (L) (white cells). In contrast, among the 48 possible correlations, the "*Plan Do Check Act (PDCA)* (C7.3)" is found to be insignificantly correlated with "*Course Assessment* (C4)" ($r = .037$, $p = .836$) and "*Course Refinement* (C6)" ($r = .036$, $p = .840$). It is worth noting that these are the only two correlation coefficients below 0.1 and whose p-values are greater than 0.05.

Table 5.58 - Correlations between Lean Tools and Lean Thinking (Source: Author)

Lean Tools competency [C7] N=34 (AD[1] vs LE[1])	Spearman's Rho Correlations Lean Thinking practice [C1 -C6] in Course Planning and Delivery Process					
	[C1] Course Resources	[C2] Course Contents	[C3] Course Pedagogy	[C4] Course Assessment	[C5] Course Evaluation	[C6] Course Refinement
C7.1 Policy Deployment (Hoshin Kanri)	.463** (M) (p = 0.006)	.416* (M) (p = 0.014)	.354* (M) (p = 0.040)	.270 (L) (0.122)	.530** (H) (p = 0.001)	.551** (H) (p = 0.001)
C7.2 5S[1]	.192 (L) (0.277)	.334 (M) (p = 0.053)	.249 (L) (0.155)	.294 (L) (0.092)	.272 (L) (0.120)	.250 (L) (0.154)
C7.3 Plan Do Check Act (PDCA)	.067 (L) (0.705)	.107 (L) (0.547)	.196 (L) (0.266)	.037 (L) (p = 0.836)	.155 (L) (0.380)	.036 (L) (p = 0.840)
C7.4 Error Proofing (Poka-Yoke)	.136 (L) (0.443)	.128 (L) (0.470)	.271 (L) (0.121)	.309 (M) (p = 0.075)	.257 (L) (0.143)	.175 (L) (0.324)
C7.5 Waste (Muda)	.207 (L) (0.241)	.191 (L) (0.280)	.424* (M) (p = 0.012)	.168 (L) (0.343)	.293 (L) (0.093)	.288 (L) (0.099)
C7.6 Overburden (Muri)	.296 (L) (0.100)	.365* (M) (p = 0.040)	.270 (L) (0.134)	.258 (L) (0.153)	.406* (M) (p = 0.021	.254 (L) (0.160)
C7.7 Unevenness (Mura)	.236 (L) (0.179)	.219 (L) (0.213)	.317 (M) (p = 0.068)	.178 (L) (0.314)	.482** (M) (p = 0.004)	.375* (M) (p = 0.029)
C7.8 Value Stream Mapping (VSM)	.091 (L) (0.610)	.208 (L) (0.237)	.201 (L) (0.255)	.271 (L) (0.121)	.286 (L) (0.102)	.190 (L) (0.281)

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
[1] AD denoted as Administrators, LE denoted as Lecturers. [2] Sort, Set in Order, Shine, Standardise, Sustain.

5.10 Quantitative Analysis for Research Question 2

5.10.1 Background

Research question 2 and the null hypothesis are:

RQ2: WHAT is the relationship between Lean Thinking versus the CP&PD?

$H02_{(Null)}$: There is **NO** correlated evidence between Lean Thinking versus CP&DP.

Lean Thinking has three (3) components: Lean Principles, Lean Waste and Lean Tools shown in *Figure 5.37*. It examines the significant influence and correlation between independent variables (Lean Principles and Wastes) and dependent variables (course resources, contents, pedagogy, assessment, evaluation, and refinement). Survey question 8 has eight (8) attributes to address the second research question. The respondents are AD and LE for question 8. The researcher classified the grouping and sample size into the respective survey questions shown in *Table 5.59*.

Table 5.59 - Survey Questions 8 and Sample Size (Source: Author)

Survey Questionnaires	N of Items	Grouping Sample Size
Q8: What are the possibilities to use Lean Thinking in the Course Planning and Delivery Process?	8	AD+LE N = 34

5.10.2 Descriptive Statistics

The mean values of Lean Thinking related to CP&DP under C8 were rated highly by responding institutes in terms of two groupings, AD and LE. For the AD group, as depicted in *Table 5.60,* all attributes have “moderately” or “large extent” (average mean ≥ 3) been practised by the responding institutes. Among these, “*Strive for perfection*” (C8.5) stood out with the highest score received (m = 4.73), followed by was “*Eliminate people waste* (m = 4.18)” (C8.6), “*Eliminate process waste* (m = 4.09)” (C8.7) and “*Identify Values* (m = 4.00)” (C8.9). The top-rated attribute (C8.5) reveals that the responding institutes place the most significant emphasis on continuous improvement and respect for people. It is parallel to the main target of Lean Thinking practice, which is to motivate and inspire aiming for excellence in CP&DP.

For the LE group, it is evident that the respondents placed a high degree of Lean Thinking related to CP&DP. As can be seen from *Table 5.60*, the mean value ranges from 3.39 to 4.04. Strongly supported attributes such as “*Strive for perfection* (m = 4.22)” (C8.5), “*Identify value* (m = 4.04)” (C8.1) and “*Value Stream* (m = 4.04)” (C8.2) were important attributes among the LE respondents. Compared to the AD group, the mean value ranges from 2.82 to 4.73, whereas the LE group has a mean range from 3.39 to 4.04. There are gaps between AD and LE. It indicated that the responding institutes have room to improve the workflow in the CP&DP.

Table 5.60 - Lean Thinking relationship Mean and Standard Deviation (Source: Author)

Lean Thinking relationship [C8] N = 34 (AD[1] + LE[1])	AD[1] (N = 11)			LE[1] (N = 23)			Exact Sig.
	Mean	S.D.	Rank	Mean	S.D.	Rank	p-value
C8.1 Identify value	4.00	1.949	4	4.04	2.383	2	.955[a]
C8.2 Value stream	3.36	2.336	7	4.04	2.364	2	.589[a]
C8.3 Create continuous flow	2.82	2.136	9	3.91	2.334	3	.345[a]
C8.4 Establish the “pull” system	3.55	2.464	6	3.57	2.446	6	.795[a]
C8.5 Strive for perfection	4.73	2.054	1	4.22	2.354	1	.509[a]
C8.6 Eliminate people waste	4.18	2.562	2	3.83	2.406	4	.562[a]
C8.7 Eliminate process waste	4.09	2.300	3	3.39	2.445	7	.235[a]
C8.8 Eliminate information waste	3.18	2.401	8	3.61	2.426	5	.826[a]
C8.9 Eliminate assets waste	3.82	2.272	5	3.61	2.426	5	.589[a]
Average Mean & S.D.	***3.75***	***2.27***	-	***3.80***	***2.40***	-	

Asymptotic significances are displayed. The significance level is .050.
a. Exact significance is displayed for this test.
[1] AD denoted as Administrators, LE denoted as Lecturers.

5.10.3 Nonparametric Compare Group

The level of Lean Thinking related to CP&DP has an average mean of 3.75 for AD and 3.80 for LE. It means “*SPHEIs have good practice evidence and performance Lean Thinking related to CP&DP*” (Moderately) (See *Table 5.44*).

Independent-Samples Mann-Whitney U Test Approach

The hypothesis was formulated to test the significant difference between AD + LE and ST samples. A 5% level of significance was to test the formulated hypothesis:

H02-1$_{(Null)}$: The distribution of <attribute> is **the same** across categories of Group.

H02-1$_{(Alt)}$: The distribution of <attribute> is **not the same** across categories of Group.

The right column of *Table 5.60* shows the calculated p-values. *Table 5.61 shows* the decision to retain or reject the hypothesis between AD and LE. A total of 9 attributes (yellow cells) (100%) from “*Lean Thinking Relationship* (C8)” have retained the null hypotheses. Three attributes have the highest p-value:

- C8.1 - Identify value (p = .955)

  “From the student point of view, seeking to add more value by reducing waste.”
- C8.8 - Eliminate information waste (p = .826)

  “Refers to information is being deficient for supporting academic processes.”
- C8.4 - Establish the “pull” system (p = .795)

  “Let downstream (student) pull value from the next upstream (school) activity.”

One possible explanation for this is that both AD and LE are aware of these common Lean Principles and Wastes and have high significant distribution related to CP&DP indirectly. However, the lowest p-value of .235 is the attribute "C8.7 - Eliminate process waste: *Refers to shortcomings in the academic processes*" shows AD and LE have minimal significant distribution to identify wastes in the various academic processes.

Table 5.61 - Mann-Whitney U Test Hypothesis for Lean Thinking relationship (Source: Author)

Lean Thinking relationship [C8] N = 34 (AD[1] + LE[1])	**Independent-Samples Mann-Whitney U Test Null Hypothesis**	**Exact Sig. p-value**	**Decision H_0**
C8.1 Identify value	The distribution of Identify value is the same across categories of Group.	.885[a]	Retain
C8.2 Value stream	The distribution of Value stream is the same across categories of Group.	.468[a]	Retain
C8.3 Create continuous flow	The distribution of Create continuous flow is the same across categories of Group.	.291[a]	Retain
C8.4 Establish the "pull" system	The distribution of Establish the "pull" system is the same across categories of Group.	.971[a]	Retain
C8.5 Strive for perfection	The distribution of Strive for perfection is the same across categories of Group.	.717[a]	Retain
C8.6 Eliminate people waste	The distribution of Eliminate people waste is the same across categories of Group.	.744[a]	Retain
C8.7 Eliminate process waste	The distribution of Eliminate process waste is the same across categories of Group.	.403[a]	Retain
C8.8 Eliminate information waste	The distribution of Eliminate information waste is the same across categories of Group.	.690[a]	Retain
C8.9 Eliminate assets waste	The distribution of Eliminate assets waste is the same across categories of Group.	.772[a]	Retain

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Independent Samples→Automatically compare distribution across groups
Asymptotic significances are displayed. The significance level is .050.
a. Exact significance is displayed for this test.
[1] AD denoted as Administrators, LE denoted as Lecturers.

Mann-Whitney U test Approach

Table 5.62 shows the Mann-Whitney U mean rank and sum of ranks for the Lean Thinking relationship, whereas *Table 5.63* shows Mann-Whitney U Test Statistics for the Lean Thinking relationship. The p-value shown in *Table 5.63* is the same as in *Table 5.61*.

For example, Mann-Whitney U test indicated that the distribution of Identify value is the same across categories of Group AD (Median = 3, N = 11) and LE (Median = 6, N = 23), U = 122.5, Z = - 0.161, p = 0.885, r = - 0.03. Hence failed to reject the null hypothesis.

Table 5.62 - Mann-Whitney U Test Ranks for Lean Thinking relationship (Source: Author)

Lean Thinking relationship [C8] N = 34 (AD[1] + LE[1])	AD[1] (N = 11)			LE[1] (N = 23)		
	Median	Mean Rank	Sum of Ranks	Median	Mean Rank	Sum of Ranks
C8.1 Identify value	3.00	17.86	196.50	6.00	17.33	398.50
C8.2 Value stream	3.00	15.68	172.50	6.00	18.37	422.50
C8.3 Create continuous flow	2.00	14.82	163.00	6.00	18.78	432.00
C8.4 Establish the "pull" system	3.00	17.59	193.50	3.00	17.46	401.50
C8.5 Strive for perfection	6.00	18.45	203.00	6.00	17.04	392.00
C8.6 Eliminate people waste	6.00	18.32	201.50	6.00	17.11	393.50
C8.7 Eliminate process waste	6.00	19.64	216.00	3.00	16.48	379.00
C8.8 Eliminate information waste	3.00	16.45	181.00	3.00	18.00	414.00
C8.9 Eliminate assets waste	3.00	18.23	200.50	3.00	17.15	394.50

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Legacy Dialogs→2 Independent Samples
[1] AD denoted as Administrators, LE denoted as Lecturers. [2] Sort, Set in Order, Shine, Standardise, Sustain.

Table 5.63 - Mann-Whitney U Test Statistics for Lean Thinking relationship (Source: Author)

Lean Thinking relationship [C8] N = 34 (AD[1] + LE[1]) [a]	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. p-value	Exact Sig. p-value	r
C8.1 Identify value	122.500	398.500	-0.161	0.872	.885[b]	-0.03
C8.2 Value stream	106.500	172.500	-0.792	0.428	.468[b]	-0.14
C8.3 Create continuous flow	97.000	163.000	-1.148	0.251	.291[b]	-0.20
C8.4 Establish the "pull" system	125.500	401.500	-0.039	0.969	.971[b]	-0.01
C8.5 Strive for perfection	116.000	392.000	-0.443	0.658	.717[b]	-0.08
C8.6 Eliminate people waste	117.500	393.500	-0.368	0.713	.744[b]	-0.06
C8.7 Eliminate process waste	103.000	379.000	-0.925	0.355	.403[b]	-0.16
C8.8 Eliminate information waste	115.000	181.000	-0.450	0.653	.690[b]	-0.08
C8.9 Eliminate assets waste	118.500	394.500	-0.314	0.753	.772[b]	-0.05

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Legacy Dialogs→2 Independent Samples
r can be calculated by dividing Z by the square root of N.
a. Grouping Variable: Group
b. Not corrected for ties.
[1] AD denoted as Administrators, LE denoted as Lecturers.

5.10.4 Nonparametric Correlations

Investigating the relationship between Lean Thinking and CP&DP can prove a snapshot of the relationships between the two grouping AD and LE in SPHEIs. Spearman's rho correlation analysis access the relationship between five (5) Lean Principles and four (4) Lean Wastes in CP&DP.

Spearman's rho correlation Approach

Table 5.64 displays the findings of Spearman's rho correlation analysis. All the correlation coefficients are positive. It indicates that CP&DP is related to adopting the Lean Principles and Lean Wastes. There are 54 coefficients highly significant at $p < 0.01$ (with **) and 2 coefficients significant at $p < 0.05$ (with *). By examining the individual correlations from *Table 5.64*, one can observe that 44 out of 54 correlations between Lean Thinking and CP&DP measure above 0.5. These denoted is a high correlation (H) (yellow cells). The highest correlation is between "*Course Evaluation* (C5)", "*Course Refinement* (C6)" and one of the following Lean Principles and Wastes:

- C8.3 - Create continuous flow ($r = .763, p < 0.01$)
- C8.8 - Eliminate information waste ($r = .711, p < 0.01$)
- C8.7 - Eliminate process waste ($r = .693, p < 0.01$)

The correlation coefficients between 0.3 and 0.5 are denoted as medium (M) (green cells), while correlation coefficients below 0.3 are classified as low (L) (white cells). None of the 54 correlations has a low coefficient. The lowest correlation coefficient is between "*Course Content* (C2)", "*Course Refinement* (C6) and one of the following Lean Principles and Wastes:

- C8.2 - Value stream ($r = .372, p = .030$)
- C8.9 - Eliminate assess waste ($r = .429, p = .011$)

Table 5.64 - Correlations between Lean Thinking and CP&DP (Source: Author)

Lean Thinking relationship [C8] N = 34 (AD[1] + LE[1])	**Spearman's Rho Correlations Course Planning and Delivery Process (CP&DP)**					
	[C1] Course Resources	**[C2] Course Contents**	**[C3] Course Pedagogy**	**[C4] Course Assessment**	**[C5] Course Evaluation**	**[C6] Course Refinement**
C8.1 Identify value	.615** (H) (0.000)	.451** (M) (p = 0.007)	.592** (H) (0.000)	.574** (H) (0.000)	.538** (H) (0.001)	.671** (H) (0.000)
C8.2 Value stream	.569** (H) (0.000)	.372* (M) (p = 0.030)	.614** (H) (0.000)	.602** (H) (0.000)	.569** (H) (0.000)	.446** (M) (p = 0.008)
C8.3 Create continuous flow	.647** (H) (0.000)	.476** (M) (p = 0.004)	.600** (H) (0.000)	.661** (H) (0.000)	.609** (H) (0.000)	.763** (H) (p = 0.000)
C8.4 Establish the "pull" system	.593** (H) (0.000)	.561** (H) (0.001)	.580** (H) (0.000)	.633** (H) (0.000)	.678** (H) (0.000)	.567** (H) (0.000)
C8.5 Strive for perfection	.525** (H) (0.001)	.463** (M) (p = 0.006)	.464** (M) (p = 0.006)	.490** (M) (p = 0.003)	.525** (H) (0.001)	.503** (H) (0.002)
C8.6 Eliminate people waste	.512** (H) (0.002)	.541** (H) (0.001)	.463** (M) (p = 0.006)	.548** (H) (0.001)	.587** (H) (0.000)	.585** (H) (0.000)
C8.7 Eliminate process waste	.610** (H) (0.000)	.448** (M) (p = 0.008)	.590** (H) (0.000)	.633** (H) (0.000)	.678** (H) (0.000)	.693** (H) (p = 0.000)
C8.8 Eliminate information waste	.646** (H) (0.000)	.554** (H) (0.001)	.609** (H) (0.000)	.664** (H) (0.000)	.711** (H) (p = 0.000)	.608** (H) (0.000)
C8.9 Eliminate assets waste	.605** (H) (0.000)	.638** (H) (0.000)	.555** (H) (0.001)	.631** (H) (0.000)	.677** (H) (0.000)	.429* (M) (p = 0.011)

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
[1] AD denoted as Administrators, LE denoted as Lecturers.

5.11 Quantitative Analysis for Research Question 3

5.11.1 Background

Research question 3 and the null hypothesis are:

RQ3: HOW does current Lean Thinking practice influence KPI in SPHEIs?

$H03_{(Null)}$: There is **NO** evidence showing the current Lean Thinking practice can influence KPI in SPHEIs.

Lean Thinking has three (3) components: Lean Principles, Lean Waste and Lean Tools shown in *Figure 5.37*. Survey question 9 has seven (7) attributes to address the second research question. The respondents are AD and LE for question 9. It investigates the current KPI for the current Lean Thinking practice in SPHEIs. The significant influence and correlation between CP&DP (C1 to C6) versus KPI (C9), Lean Tools competency (C7) versus KPI (C9) and Lean Thinking relationship (C8) versus KPI (C9). The researcher classified the grouping and sample size into the survey questions shown in *Table 5.65*.

Table 5.65 - Survey Questions 9 and Sample Size (Source: Author)

Survey Questionnaires	**N of Items**	**Grouping Sample Size**
Q9: What is your current institute key performance level?	7	AD+LE N = 34

5.11.2 Descriptive Statistics

Different indicators evaluate the key performance of the institute shown in *Table 5.66.* The highest scores are allocated to "*Higher Education Performance* (C9.1)" for AD (m = 4.10) and LE (m = 4.09), followed by "*Delivery Values* (C9.4)" for AD (m = 4.00) and LE (m = 3.87). On the contrary, "*Remove Wastes* (C9.5)" (AD m = 3.60; LE m = 3.57) and "*Student Development* (C9.7)" (AD m = 3.70; LE m = 3.57) are rated lowest. All these indicators are what Lean Thinking strives to improve in the educational process. It implies that there is much room for improvement in these areas if Lean Thinking is implemented.

Table 5.66 - KPI Mean and Standard Deviation (Source: Author)

Key Performance Indicators [C9] N = 34 (AD[1] + LE[1])	AD[1] (N = 11)			LE[1] (N = 23)			Exact Sig.
	Mean	S.D.	Rank	Mean	S.D.	Rank	p-value
C9.1 Higher Education Performance	4.10	0.568	1	4.09	0.668	1	.985[a]
C9.2 Higher Education Productivity	4.10	0.568	1	3.87	0.920	2	.603[a]
C9.3 Higher Education Quality	3.80	0.632	3	3.87	0.869	2	.630[a]
C9.4 Delivery Values	4.00	0.471	2	3.87	0.815	2	.862[a]
C9.5 Remove Wastes	3.60	0.516	5	3.57	0.992	4	.893[a]
C9.6 Student Satisfaction	4.00	0.632	2	3.78	0.736	3	.612[a]
C9.7 Student Development	3.70	0.483	4	3.57	0.788	4	.743[a]
Average mean & S.D.	***3.90***	***0.553***	-	***3.08***	***0.827***	-	-

Asymptotic significances are displayed. The significance level is .050.
a. Exact significance is displayed for this test.
[1] AD denoted as Administrators, LE denoted as Lecturers.

5.11.3 Nonparametric Compare Group

The level of KPI has an average mean of 3.90 for AD shows *"SPHEIs have outstanding performance Lean Thinking practice influences KPI"* (Good). In contrast, an average mean of 3.08 for LE shows *"SPHEIs have satisfactory delivering Lean Thinking practice influences KPI"* (Average) (See *Table 5.44*).

Independent-Samples Mann-Whitney U Test Approach

The hypothesis was formulated to test the significant difference between AD and LE samples. A 5% level of significance was to test the formulated hypothesis:

H03-1$_{(Null)}$: The distribution of <attribute> is **the same** across categories of Group.

H03-1$_{(Null)}$: The distribution of <attribute> is **not the same** across categories of Group.

The right column of *Table 5.66* shows the calculated p-values. *Table 5.67 shows* the decision to retain or reject the hypothesis between AD and LE. A total of 7 attributes (yellow cells) (100%) from "*Key Performance Indicators* (C9)" have retained the null hypotheses. Three attributes have the highest p-value:

- C9.1 - Higher Education Performance (*p* = .985)
- C9.5 - Remove Wastes (*p* = .893)
- C9.4 - Delivery Values (*p* = .862)

Both AD and LE have high significant distribution to agree that removing wastes and delivery values impact Higher Education performance. However, the lowest indicators, "*Higher Education Productivity* (C9.2)", has a p-value of .603 and "*Student Satisfaction* (C9.6)", has a p-value of .862, shows AD and LE have low significant distribution to identify productivity and student satisfaction in their respondent institutes.

Table 5.67 - Mann-Whitney U Test Hypothesis for KPI (Source: Author)

Key Performance Indicators [C9] N = 34 (AD[1] + LE[1])	Independent-Samples Mann-Whitney U Test Null Hypothesis	Exact Sig. p-value	Decision H_0
C9.1 Higher Education Performance	The distribution of Higher Education Performance is the same across categories of Group.	.985[a]	Retain
C9.2 Higher Education Productivity	The distribution of Higher Education Productivity is the same across categories of Group.	.603[a]	Retain
C9.3 Higher Education Quality	The distribution of Higher Education Quality is the same across categories of Group.	.630[a]	Retain
C9.4 Delivery Values	The distribution of Delivery Values is the same across categories of Group.	.862[a]	Retain
C9.5 Remove Wastes	The distribution of Remove Wastes is the same across categories of Group.	.893[a]	Retain
C9.6 Student Satisfaction	The distribution of Student Satisfaction is the same across categories of Group.	.612[a]	Retain
C9.7 Student Development	The distribution of Student Development is the same across categories of Group.	.743[a]	Retain

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Independent Samples→Automatically compare distribution across groups
Asymptotic significances are displayed. The significance level is .050.
a. Exact significance is displayed for this test.
[1] AD denoted as Administrators, LE denoted as Lecturers.

Mann-Whitney U test Approach

Table 5.68 shows the Mann-Whitney U mean rank and sum of ranks for KPI, whereas *Table 5.69* shows Mann-Whitney U Test Statistics for KPI. The p-value shown in *Table 5.69* is the same as in *Table 5.67*.

Table 5.68 - Mann-Whitney U Test Ranks for KPI (Source: Author)

Key Performance Indicators [C9] N = 34 (AD[1] + LE[1])	AD[1] (N = 11)			LE[1] (N = 23)		
	Median	Mean Rank	Sum of Ranks	Median	Mean Rank	Sum of Ranks
C9.1 Higher Education Performance	4.00	17.05	170.50	4.00	16.98	390.50
C9.2 Higher Education Productivity	4.00	18.35	183.50	4.00	16.41	377.50
C9.3 Higher Education Quality	4.00	15.70	157.00	4.00	17.57	404.00
C9.4 Delivery Values	4.00	17.50	175.00	4.00	16.78	386.00
C9.5 Remove Wastes	4.00	16.60	166.00	4.00	17.17	395.00
C9.6 Student Satisfaction	4.00	18.82	207.00	4.00	16.87	388.00
C9.7 Student Development	4.00	17.85	178.50	4.00	16.63	382.50

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Legacy Dialogs→2 Independent Samples
[1] AD denoted as Administrators, LE denoted as Lecturers.

Table 5.69 - Mann-Whitney U Test Statistics for KPI (Source: Author)

Key Performance Indicators [C9] N = 34 (AD[1] + LE[1]) [a]	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. p-value	Exact Sig. p-value	r
C9.1 Higher Education Performance	114.500	390.500	-0.022	0.982	.985[b]	0.00
C9.2 Higher Education Productivity	101.500	377.500	-0.593	0.553	.603[b]	-0.10
C9.3 Higher Education Quality	102.000	157.000	-0.582	0.560	.630[b]	-0.10
C9.4 Delivery Values	110.000	386.000	-0.250	0.802	.862[b]	-0.04
C9.5 Remove Wastes	111.000	166.000	-0.171	0.864	.893[b]	-0.03
C9.6 Student Satisfaction	112.000	388.000	-0.690	0.490	.612[b]	-0.12
C9.7 Student Development	106.500	382.500	-0.387	0.699	.743[b]	-0.07

Nonparametric Independent-Samples Mann-Whitney U Test.
SPSS→Analyse→Nonparametric Tests→Legacy Dialogs→2 Independent Samples
r can be calculated by dividing Z by the square root of N.
a. Grouping Variable: Group
b. Not corrected for ties.
[1] AD denoted as Administrators, LE denoted as Lecturers.

5.11.4 Nonparametric Correlations

A correlation determines the inter-relationship between CP&DP (C1 to C6) versus KPI (C9); Lean Tools competency (C7) versus KPI (C9); and Lean Thinking relationship (C8) versus KPI (C9).

Spearman's rho correlation Approach

Spearman's rho correlation analysis results are shown in *Table 5.70*, *Table 5.71* and *Table 5.72*. All the correlation coefficients are positive. The coefficients highly significant at $p < 0.01$ (with **) and significant at $p < 0.05$ (with *). The correlation coefficients measure above 0.5, denoted as high (H) (yellow cells). The correlation coefficients between 0.3 and 0.5 are referred to as medium (M) (green cells), while correlation coefficients below 0.3 are referred to as low (L) (white cells).

By examining the individual correlations as shown in *Table 5.70,* one can observe that 1 out of 42 correlations between KPI and CP&DP measure above 0.5, 14 out of 42 have found medium significant correlation. It is important to note that these are the only two correlation coefficients, between "*Course Assessment* (C4)" and one of the following KPI, has below 0.1 whose p-values are more significant than 0.05.

- C9.5 - Remove Wastes ($r = .040$, $p = .824$)
- C9.6 - Student Satisfaction ($r = .040$, $p = .983$)

Table 5.70 - Correlations between Lean Thinking practice versus KPI (Source: Author)

Lean Thinking practice [C1 – C6] N = 34 (AD[1] + LE[1])	Spearman's Rho Correlations Key Performance Indicators (KPI) [C9]						
	Higher Education Performance C9.1	Higher Education Productivity C9.2	Higher Education Quality C9.3	Delivery Value C9.4	Remove Wastes C9.5	Student Satisfaction C9.6	Student Development C9.7
C1 Course Resources	0.262 (L) (0.141)	0.137 (L) (0.448)	.353* (M) (p = 0.044)	.344* (M) (p = 0.050)	.450** (M) (p = 0.009)	0.232 (L) (0.187)	.509** (H) (p = 0.002)
C2 Course Contents	0.086 (L) (0.634)	0.190 (L) (0.289)	0.213 (L) (0.234)	.357* (M) (p = 0.042)	0.330 (M) (0.061)	0.162 (L) (0.359)	.379* (M) (p = 0.029)
C3 Course Pedagogy	0.074 (L) (0.684)	0.101 (L) (0.574)	0.283 (L) (0.111)	0.252 (L) (0.158)	0.195 (L) (0.276)	.365* (M) (p = 0.034)	.383* (M) (p = 0.028)
C4 Course Assessment	0.072 (L) (0.692)	0.148 (L) (0.413)	0.081 (L) (0.652)	0.190 (L) (0.289)	0.040 (L) (p = 0.824)	0.004 (L) (p = 0.983)	0.257 (L) 0.149
C5 Course Evaluation	.360* (M) (p = 0.040)	0.211 (L) (0.239)	.384* (M) (p = 0.027)	.413* (M) (p = 0.017)	0.272 (L) (0.126)	0.265 (L) (0.130)	.358* (M) (p = 0.041)
C6 Course Refinement	0.178 (L) (0.321)	0.196 (L) (0.274)	.364* (M) (p = 0.037)	0.341 (L) (0.052)	0.251 (L) (0.159)	.373* (M) (p = 0.030)	.499** (M) (p = 0.003)

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
[1] AD denoted as Administrators, LE denoted as Lecturers.

From *Table 5.71,* one can observe that 13 out of 56 correlations between KPI and Lean Tools competency measure above 0.5, 28 out of 56 have medium significant correlated. The lowest correlation, below 0.1, whose p-values are greater than 0.05, is between "*Plan Do Check Act* (C7.3)" and one of the following KPI:

- C9.1 - Higher Education Performance (r = .224, p = .210)
- C9.7 - Student Development (r = .194, p = .279)

There are 6 out of 63 correlations between KPI and Lean Thinking measure above 0.5, 20 out of 63 have found to be medium significant correlated shown in *Table 5.72*. There are also two correlation coefficients, "*Eliminate Wastes* (C9.8)" and one of the following KPI, below 0.1, whose p-values are more than 0.05.

- C9.1 - Higher Education Performance (r = .136, p = .450)
- C9.2 - Higher Education Productivity (r = .106, p = .556)

Table 5.71 - Correlations between Lean Tools competency versus KPI (Source: Author)

Lean Tools Competency [C7] N = 34 (AD[1] + LE[1])	Spearman's Rho Correlations Key Performance Indicators (KPI) [C9]						
	Higher Education Performance C9.1	Higher Education Productivity C9.2	Higher Education Quality C9.3	Delivery Value C9.4	Remove Wastes C9.5	Student Satisfaction C9.6	Student Development C9.7
C7.1 Policy Deployment[2]	.600** (H) (p = 0.000)	.523** (H) (p = 0.002)	.623** (H) (p = 0.000)	.729** (H) (p = 0.000)	0.534** (H) (p = 0.001)	0.540** (H) (p = 0.001)	0.634** (H) (p = 0.000)
C7.2 5S[3]	0.255 (L) (0.153)	0.228 (L) (0.201)	.370* (M) (p = 0.034)	.435* (M) (p = 0.011)	.379* (M) (p = 0.030)	.424* (M) (p = 0.013)	.432* (M) (p = 0.012)
C7.3 Plan Do Check Act (PDCA)	0.224 (L) (p = 0.210)	0.239 (L) (0.180)	0.246 (L) (0.168)	0.288 (L) (0.104)	0.271 (L) (0.127)	.347* (M) (p = 0.044)	0.194 (L) (p = 0.279)
C7.4 Error Proofing (Poka-Yoke)	0.336 (M) (0.056)	0.311 (M) (0.078)	.451** (M) (p = 0.009)	.473** (M) (p = 0.005)	.495** (M) (p = 0.003)	.347* (M) (p = 0.044)	.441* (M) (p = 0.010)
C7.5 Waste (Muda)	.491** (M) (p = 0.004)	.410* (M) (p = 0.018)	.532** (H) (p = 0.001)	.568** (H) (p = 0.001)	.392* (M) (p = 0.024)	.386* (M) (p = 0.024)	.472** (M) (p = 0.006)
C7.6 Overburden (Muri)	.361* (M) (p = 0.046)	.418* (M) (p = 0.019)	.418* (M) (p = 0.019)	.567** (H) (p = 0.001)	.495** (M) (p = 0.005)	.383* (M) (p = 0.031)	.452* (M) (p = 0.011)
C7.7 Unevenness (Mura)	.460** (M) (p = 0.007)	0.305 (M) 0.085	.531** (H) (p = 0.001)	.601** (H) (p = 0.000)	.423* (M) (p = 0.014)	.427* (M) (p = 0.012)	.472** (M) (p = 0.006)
C7.8 Value Stream Mapping (VSM)	.419* (M) (p = 0.015)	.468** (M) (p = 0.006)	0.325 (M) (0.065)	.540** (H) (p = 0.001)	0.247 (L) (0.166)	0.331 (M) (0.056)	0.260 (L) (0.144)

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
[1] AD denoted as Administrators, LE denoted as Lecturers. [2] Hoshin Kanri. [3] Sort, Set in Order, Shine, Standardise, Sustain.

Table 5.72 - Correlations between Lean Thinking relationship versus KPI (Source: Author)

Lean Thinking relationship [C8] N = 34 (AD[1] + LE[1])	Spearman's Rho Correlations Key Performance Indicators (KPI) [C9]						
	Higher Education Performance C9.1	Higher Education Productivity C9.2	Higher Education Quality C9.3	Delivery Value C9.4	Remove Wastes C9.5	Student Satisfaction C9.6	Student Development C9.7
C8.1 Identify value	0.333 (M) (0.059)	0.157 (L) (0.383)	.509** (H) (p = 0.003)	.487** (M) (p = 0.004)	.535** (H) (p = 0.001)	.553** (H) (p = 0.001)	.649** (H) (p = 0.000)
C8.2 Value stream	.415* (M) (p = 0.016)	.354 (M)* (p = 0.043)	0.312 (M) (0.078)	.547** (H) (p = 0.001)	.392* (M) (p = 0.024)	.359* (M) (p = 0.037)	0.267 (L) (0.133)
C8.3 Create continuous flow	0.331 (M) (0.060)	0.260 (L) (0.145)	0.304 (M) (0.085)	.408* (M) (p = 0.018)	0.192 (L) (0.285)	0.192 (L) (0.276)	0.331(M) (0.060)
C8.4 Establish the “pull” system	0.328 (M) (0.062)	0.142 (L) (0.432)	.364* (M) (p = 0.037)	0.254 (L) (0.155)	0.260 (L) (0.145)	0.267 (L) (0.127)	.365* (M) (p = 0.036)
C8.5 Strive for perfection	.410* (M) (p = 0.018)	.393* (M) (p = 0.024)	.507** (M) (p = 0.003)	.444** (M) (p = 0.010)	0.203 (L) 0.258	.365* (M) (p = 0.034)	.492** (M) (p = 0.004)
C8.6 Eliminate people waste	0.229 (L) (0.200)	0.267 (L) (0.133)	0.318 (M) (0.072)	.378* (M) (p = 0.030)	0.277 (L) (0.118)	0.211 (L) (0.231)	.442** (M) (p = 0.010)
C8.7 Eliminate process waste	0.164 (L) (0.362)	0.228 (L) (0.201)	0.240 (L) (0.178)	0.339 (M) (0.054)	0.237 (L) (0.185)	0.204 (L) (0.247)	0.330 (M) (0.061)
C8.8 Eliminate information waste	0.228 (L) (0.201)	0.161 (L) (0.370)	.418* (M) (p = 0.016)	.422* (M) (p = 0.015)	0.329 (M) (0.062)	.402* (M) (p = 0.018)	.529** (H) (p = 0.002)
C8.9 Eliminate assets waste	0.136 (L) (p = 0.450)	0.106 (L) (p = 0.556)	0.302 (M) (0.088)	0.290 (L) (0.102)	0.304 (M) (0.086)	0.143 (L) (0.420)	.410* (M) (p = 0.018)

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
[1] AD denoted as Administrators, LE denoted as Lecturers.

5.12 Summary of Quantitative Analysis

The research null hypotheses are reviewed and summarized in this section.

$H01_{(Null)}$: There is **NO** evidence showing SPHEIs deploy Lean Thinking practice in the Course Planning and Delivery Process.

$H02_{(Null)}$: There is **NO** correlated evidence between Lean Thinking versus Course Planning and Delivery Process.

$H03_{(Null)}$: There is **NO** evidence showing the current Lean Thinking practice can influence Key Performance Indicators in SPHEIs.

From the above findings and analysis, there is highly significant evidence between two groups (AD + LE versus ST), showing that SPHEIs deploy Lean Thinking practice in the CP&DP indirectly. The AD + LE agreed and demonstrated that highly significant evidence is that Lean Thinking has correlated to CP&DP. Besides, there is a highly significant KPI influence and correlation between Lean Thinking Practise in CP&DP, Lean Tools competency and Lean Thinking relationship. In summary, these three null hypotheses were rejected.

5.13 Qualitative Analysis for Research Question 4

5.13.1 Background

In qualitative research methods study, open-ended questions are used frequently. Instead of providing participants with a predetermined collection of response options, open-ended questions encourage them to respond to their terms. In comparison to quantitative research, qualitative research usually requires a smaller sample size. However, sample sizes should be broad enough to collect enough data to fully describe the phenomenon of interest and answer the research questions (Creswell *et al.*, 2017).

Research question 4 is:

RQ4: HOW do SPEHIs deploy Lean Thinking practice to improve academic processes?

Lean Thinking has three (3) components: Lean Principles, Lean Waste and Lean Tools shown in *Figure 5.37*. There are five (5) self-administered open-structure questions for AD and LE respondents. It explored how SPHEIs deployed Lean

Thinking practice to Kaizen academics processes. The qualitative data were gathered in the form of words, analysed to discover the unifying code or theme that gave meaning to the data. The interpretation was to answer the research question (RQ4).

5.13.2 Analysis of the Self-Administered Open-Structure Question

The first self-administered open-structure question is:

C10.1 What are the main current problems in the Course Planning and Delivery Process?

Since qualitative research is concerned with meaning and creating meaning, interpretation is at the core of the process (Willig, 2017). 24 out of 33 AD and LE completed the first self-administered open-structure question, representing a valid response rate of 72%. *Figure 5.41* shows the full-screen capture of the AD + LE reply. The researcher interpreted the meaning of the AD + LE replies and classified them into different categories, then calculated the total number for every category.

Item Response Rate = 24/33

	What are the main current problem in the course planning and delivery process?	Code	Relate to	Category	Attribute
1	Last minute changes	Lack of communication	Information Wastes	Course Resources	Time Table
2					
3	-				
4					
5	Confirmation of timetable delay as there is delay in confirming the lecturer appointment and	Lack of communication	Information Wastes	Course Resources	Time Table
6	We are packing students with shorter course time, so that they can progress to the next level. I think it will be disadvantage the weaker students resulting in their progress to be delayed and demotivating the course of student. More consideration should be put in place for weaker student	Lack of student ability focus	Identify Value	Course Pedagogy	Consulation
7	Lacking in students' engagement.	Lack of student engagement	Establish Pull	Course Refinement	Engagement
8	Lack of communication with different departments that are involved in the course planning and delivery process	Lack of communication	Establish Pull	Course Resources	Time Table
9					
10					
11	Do not received the relevant information on time	Lack of relevant information	Information Wastes	Course Resources	Time Table
12	Number of students vs number of tutorial/lab sessions.	Lack of equal distribution of lessons	Value Stream	Course Resources	Facilities
13	Part time lecturer might not have full access to the course syllabus, hence affect the planning	Lack of access right resources	Information Wastes	Course Resources	Time Table
14	Not up-to-date	Lack of irrelevant contents		Course Resources	Time Table
15	Traditional ways. Can strive for creative learning.	Lack of creative learning	Create Flow	Course Pedagogy	Lecture
16					
17	Consideration for cross modules assignment, quiz and activities to maximize impact to student	Lack of optimise student learning	Create Flow	Course Assessment	Coursework
18	no issues on the planning and delivery currently	No Problem		Course Resources	Time Table
19	students of differing abilities, in a cohort.	Lack of student different ability focus	Establish Pull	Course Evaluation	Results
20					
21	Limited time.	Lack of time to cover many topics	Process Wastes	Course Resources	Time Table
22	Not involved	Lack of involvement in CP&DP		Miscellaneous	
23					
24	Too many topics to be covered within a limited time given	Lack of time to cover many topics	Process Wastes	Course Pedagogy	Lecture
25	Syllabus is defined by module, course planning and delivery process are defined in advance .	CP&DP is defined in advance	Information Wastes	Course Contents	Syllabus
26	Due to current situation, students are learning mostly online from home, the Lab sessions required them to have the software but there is a license issue so students needs to use the free/trial license which has restrictions.	Lack of resources avaailabilty	Assets Waste	Course Pedagogy	Practical
27	Lots of disruption and uncertainties due to COVID-19 situation.	Lack of smooth process due to Covid-19	Process Wastes	Miscellaneous	
28					
29	Students' expectation can be ridiculous	Ridiculous expectation	Establish Pull	Course Evalation	Behaviour
30	Not enough time for student recall on previous topics	Lack of time for revision	Process Wastes	Course Pedagogy	Lecture
31	lack of support from management	Lack of support from management	People Wastes	Miscellaneous	
32	Coherence beetween the different components	Logic and consistent in components	Assets Waste	Miscellaneous	
33	directives from partner universities	Different directives from partner universities	Information Wastes	Course Pedagogy	Lecture

Figure 5.41 - Interpretation of Question C10.1 (AD + LE) (Source: Author)

For question C10.1 (AD + LE), the researcher interpreted qualitative descriptions and presented the findings in *Figure 5.42*.

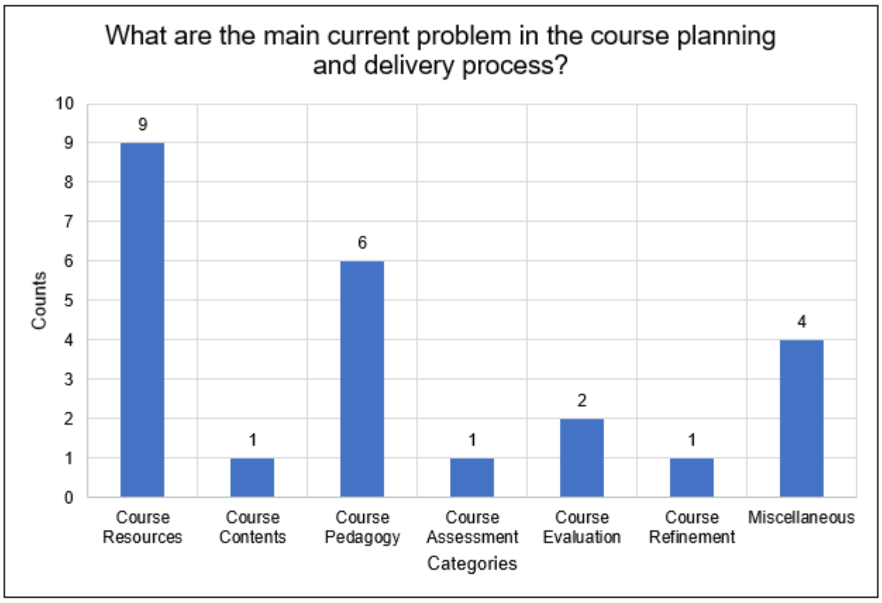


Figure 5.42 - Qualitative Result for Question C10.1 (AD + LE) (Source: Author)

The above chart shows that the Course Resources and Course Pedagogy are two main problems reflected by the AD + LE.

In contrast, 183 out of 305 of the ST answer the self-administered open-structure question representing a valid response rate of 60%. *Figure 5.43* shows the partial screen capture of the ST reply.

Item Response Rate = 183/305

	What are the main current problems in the course planning and delivery process?	Code	Count	Category
159	Very irresponsible admin service	Administrative issues		Admin Problem
164	Administration need to improve. For example, the reply should be faster instead need to wait for 2 - 3	Administrative issues		Admin Problem
72	As part timers, it could be hard to juggle work life balance with course schedules at time.	Balance work life and study		Course Resources
199	Sometimes, weekend class might crash with work. Also the exam schedule sometimes eat into business hour. which will need to take leave. i think it is better to hold after working hours.	Balance work life and study		Course Resources
10	Due to the Covid-19, communication between group member its quite troublesome	Communication between group		Course Pedagogy
35	Course duration per semester is short for many topics	Course duration is too short		Course Pedagogy
193	Covid issue and working hour	Covid issue		Miscellaneous
65	Delay in the provision of time table for new trimester. Need the time table to plan work schedule and	Delay in timetable		Course Resources
192	module as the assignment dates are always one or two weeks before a major exam. therefore, the way i cope with this is to start revision for exams at the very start of the semester but it is tough as many topics are not yet being taught. however, i also understand why the school have this structure as during the start of the semester, there are lesser topics being taught therefore the assignments have to be pushed behind to cover on the later topics.	Delivery issues	1	Course Pedagogy
232	It's always rushing. lack of explanation on how to derive the equations. need to slow down when going through questions. try not to keep switching between pages, make us giddy.	Delivery issues	2	Course Pedagogy
241	Too many topics, too little time for the lecturer to cover. resulting having to rush every lesson. and the student not being able to understand fully.	Delivery issues	3	Course Pedagogy
275	There is no clear understanding through this online system. I understand this pandemic but there should be some consideration in subject weight. Lot of stress everyday for part time people. More pressure and more stress on subject weight age and assignment quantity. we are first batch and each group have 2 people still the quantity of assignment is very high.	Delivery issues	4	Course Pedagogy
284	All assignment objectives/areas must be taught in lesson prior to an assignment submission. Some of the modules required students to integrate 'Theory A', however 'Theory A' was never taught in class until the day for assignment deadline. This is the main issue many students struggled with.	Delivery issues	5	Course Pedagogy
286	for postgraduate, learners are professionals but are treated like college students by UC in the	Delivery issues	6	Course Evaluation
289	Student with different personality having different learning style and preference. Different assessment should be considered according to the students personalities. Example, student who sees themselves are more extrovert, group presentation maybe better for them, on the other hand, students who are more introvert, likely to prefer space and time for self reflection activities/paper.	Delivery issues	7	Course Assessement
293	I felt if there are more indepth applications would be better.	Delivery issues	8	Course Pedagogy
302	New adjustments, everything is virtual.	Delivery issues	9	Course Pedagogy
303	Too rush and too pack.	Delivery issues	10	Course Pedagogy
304	Time management is a bit difficult but i am getting hang of it slowly. And the assignment questions are a bit too much for few subjects, which makes it difficult to complete on time with my office work.	Delivery issues	11	Course Pedagogy
254	an ideal for part time student because need to spend time with the group mates and ensure all the members are doing their own part but sometimes it will have conflict because of the expectation on the team members.	Delivery issues	12	Course Pedagogy

Figure 5.43 - Interpretation of Question C10.1 (ST) (Source: Author)

For question C10.1 (ST), the researcher interpreted qualitative descriptions and presented the findings in *Figure 5.44*.

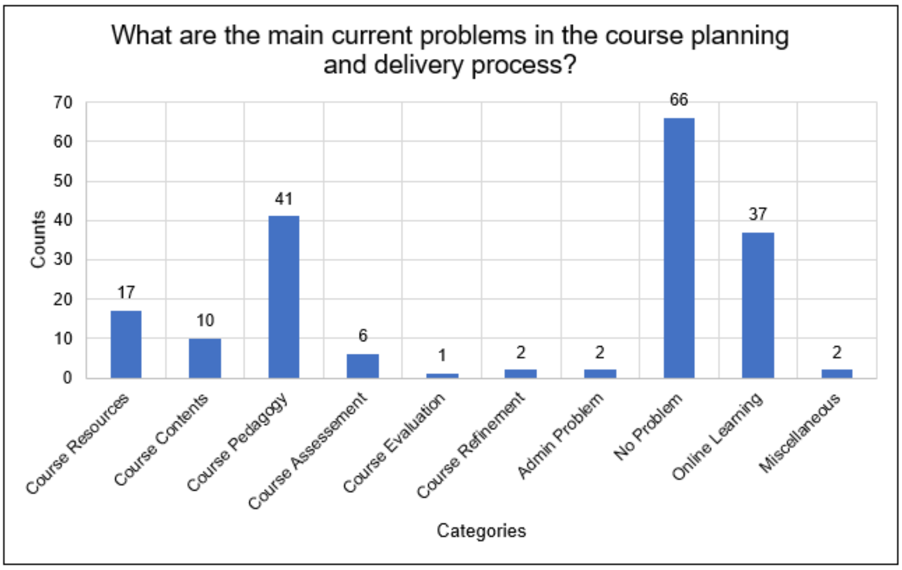


Figure 5.44 - Qualitative Result for Question C10.1 (ST) (Source: Author)

In contrast, ST has 36% (66 "no problem" out of 184), which shows the satisfaction of current CP&DP. However, ST is more concerned about the Course Pedagogy and Online Learning problem in *Table 5.73*.

Table 5.73 - AD, LE and ST Quotes for Question C10.1 (Source: Author)

Problem Concern	AD + LE Quotes	ST Quotes
Course Resources	*"Confirmation of timetable delay as there is a delay in confirming the lecturer appointment and facilities."* *"Lack of communication with different departments that are involved in the course planning and delivery process."* *"The part-time lecturer might not have full access to the course syllabus, hence affecting the planning process."*	*"In the past, before bidding for the class, timetables included the lecturers' name. Current practice does not include the Lecturer's name before bidding."* *"There should have a way to give read receipt or acknowledgement mail by the school when it conducts an online exam."*
Course Pedagogy	*"We are packing students with shorter course time so that they can progress to the next level. It will be a disadvantage for the weaker students resulting in their progress being delayed and demotivating their course. More consideration should be put in place for the weaker student."* *"Traditional ways. Can strive for creative learning."*	*"The pace of the course is too slow at the start of each module and to rush towards the end of each module as the assignment dates are always one or two weeks before a major exam. Therefore, I cope with this is to starting revision for exams at the start of the semester, but it is tough as many topics are not yet being taught. However, I also understand why the school has this structure. Fewer topics are being taught during the start of the semester; therefore, the assignments have to be pushed behind to cover the later topics."* *"There is no clear understanding of this online system. I understand this pandemic, but there should be some consideration in subject weight. Lots of stress every day for part-time people. More pressure and more stress on subject weightage and assignment quantity. We are*

	"Too many topics to be covered within a limited time given." *"Not enough time for student recall on previous topics."*	*the first batch, and each group have two peoples. The quantity of assignment is still very high."*
Online Learning	*"Lots of disruption and uncertainties due to COVID19 situation."* *"Due to the current situation (Covid-19), students are learning mostly online from home; the Lab sessions required them to have the software, but there is a license issue, so students need to use the free/trial license, which has restrictions."*	*"The planning is fine except for one issue, which is the online exam timing. Due to COVID19, the exam will be an exam and be taken at any date and time. However, the exam timing is 8:30 am which even the real exam never started so early before. It discourages and disallows students to have physically prepared even though it is an open book. As for lesson wise, it will depend on how lecturers been delivered during lessons. I think as most students are working adults and we will like the lesson to conduct fast instead of long-winded and draggy and give more live examples that able to link to our real-life instead of by book or schedule."* *"Given the COVID19 situation and remote-learning, the syllabus should be planned according to the situation. Having group work/forming a group without seeing the person is inefficient. For part-time students who works full time, the only time to discuss group work effectively is during a physical class, and remote-learning is challenging in producing the same outcome."* *"Some activities truly needs face to face, and Online makes it difficult to interact. In some cases, they are not recorded for a revisit; in some, mike was completely disabled, some lecturers are not competent in using tools etc. Online also created problems in lecturers families. We can hear the child crying or distracting him from performing optimally."*

In summary, the following are the current main problems in the CP&DP:

- Lack of resource availability.
- Lack of communication and support from management.
- Lack of relevant information or content.
- Lack of smooth process due to COVID19.
- Lack of time for revision because of coverage of too many topics.
- Lack of student engagement.
- Lack of student ability needs and focus.
- Lack of meeting student expectations.
- Lack of optimising and creative student learning.

The second self-administered open-structure question is:

C10.2 Is there any other element that is important in the Course Planning and Delivery Process?

24 out of 33 AD and LE completed the first self-administered open-structure question, representing a valid response rate of 72%. *Figure 5.45* shows the full-screen capture of the AD + LE reply.

Item Response Rate = 24/33

	Is there any other element that is important in the course planning and delivery process?	Code	Attribute	Category
1	nil	No comment		None
2				
3	Alignment of lecturers delivery to students and course planning	Alignment in CP&DP	Value stream	Course Contents
4				
5	Academic staffs with their expertise in the field, industry experience and teaching skills.	Experise, Industry experise and teaching skill	Value stream	Course Pedagogy
6	The timing and mode of delivery is one element that we look at.	Timing and mode of delivery	Process Wastes	Course Pedagogy
7	Lab and software requirements for specific modules.	Software requirement	Assets Wastes	Course Assessment
8	Time	Timing and mode of delivery	Process Wastes	Course Resources
9				
10				
11	Consider students' background	Student background	Establish Pull	Course Pedagogy
12	Teaching plan.	Teaching plan	Information Wastes	Course Resources
13	Accessibility to all materials.	Accessibility to all materials.	Assets Wastes	Course Contents
14	more practicals needed	More practice needed	Identify value	Course Pedagogy
15	NA	No comment		None
16				
17	Consideration of students preparedness prior to session to achieve optimum level of learning for the student.	Student prepardness	Identify value	Course Pedagogy
18				
19	to have enough time. and to have advanced knowledge of the students' abilities and background knowledge.	Student abilities and background knowledge	Identify value	Course Pedagogy
20				
21	Different foundations from students.	Student foundations	Identify value	Course Pedagogy
22	n.a.	No comment		None
23				
24	More sessions	More sessions	Process Wastes	Course Pedagogy
25	Industry feedback should form a close loop during revision of course planning and delivery process.	Industry feedback	Establish Pull	Course Pedagogy
26	We need to provide learning experience for students especially in practical skills, which is somehow still lacking, to be good engineer, one must be practically well trained and can solve problem independently, not just only the theory.	Practical skills	Create Flow	Course Pedagogy
27	Communication between the institute and lecturers.	Communication	Information Wastes	Course Resources
28				
29	Contents and time	Course content and delivery tme	Information Wastes	Course Contents
30	The student pre acquired knowledge	Student knowledge	Establish Pull	Course Pedagogy
31	trust in the academics	Trust in the academics	People wastes	Course Resources
32	Pedagogic approaches	Pedagogic approaches	Value stream	Course Pedagogy
33	localising content	Contexture content	Information Wastes	Course Contents

Figure 5.45 - Interpretation of Question C10.2 (AD + LE) (Source: Author)

For question C10.2 (AD + LE), the researcher interpreted qualitative descriptions and presented the findings in Figure 5.46. The researcher analysed the meaning of the AD + LE replies and classified them into different categories, then calculated the total number for every category. The chart shows that the Course Pedagogy is the main concerns element reflected by the AD + LE.

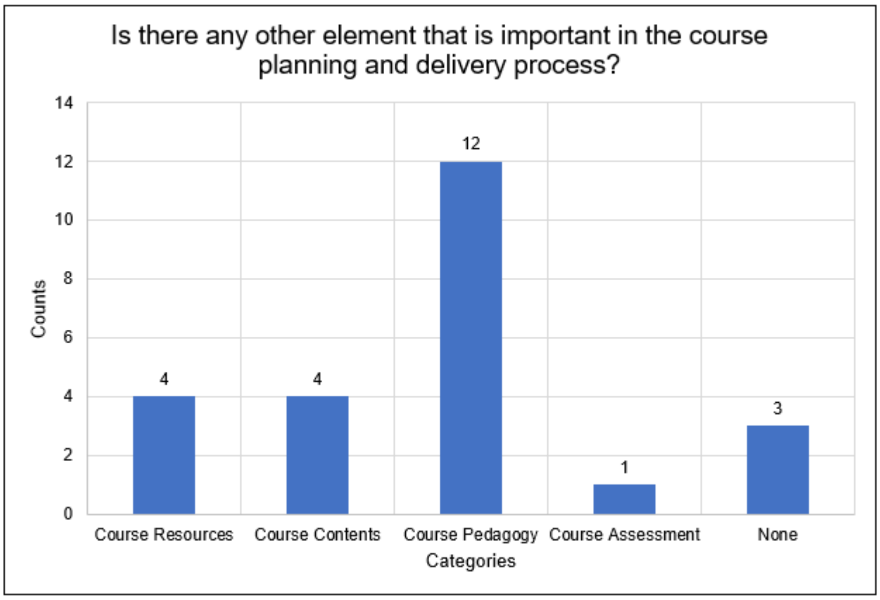


Figure 5.46 - Qualitative Result for Question C10.2 (AD + LE) (Source: Author)

In contrast, 160 out of 305 of the ST answered the self-administered open-structure question representing a valid response rate of 53%. *Figure 5.47* shows the partial screen capture of the ST reply.

Item Response Rate = 160/305

	Is there any other element that is important in the course planning and delivery process?	Code	Count	Category
159	Admin have be right in what they say	Administrative issue		Administrative
15	Detailed and clear assignment brief, in order to explain to students the knowledge points needed	Clear in assignment brief		Course Assessment
30	Yes. Delivery process on how, what, whether the lecturer have the appropriate resources.	Delivery process	1	Course Pedagogy
102	half credit modules can be shortened to half the term such that 2 half credit modules can be done in one term in succession	Delivery process	2	Course Pedagogy
108	Follow the lecture's instructions. Self-management and time management.	Delivery process	3	Course Pedagogy
109	Follow the lecture, take note and listen carefully.	Delivery process	4	Course Pedagogy
121	it will be better to give a brief summary of the prerequisites to refresh the memory of the student for each module.	Delivery process	5	Course Pedagogy
152	the detail information and discussion	Delivery process	6	Miscellanous
154	Some constraints	Delivery process	7	Course Resources
155	Time frame is essential to get in preparation of assignments for part.time students.	Delivery process	8	Course Pedagogy
156	Not clear instruction or guideline.	Delivery process	9	Course Pedagogy
162	may explore curriculum to be more inclusive to other trades rather than manufacturing.	Delivery process	10	Course Pedagogy
165	Accessibility of lecturer to consult on something after the lecturer is only through emails, hence have to wait for a reply and not able to get a quicker response.	Delivery process	11	Course Pedagogy
182	Spreading out assignments from different modules	Delivery process	12	Course Assessment
183	The quality of the teaching staff	Delivery process	13	Miscellanous
185	Time planning for assessments.	Delivery process	14	Course Assessment
190	Some tools to help any elderly teacher to help them can teach smoothly	Delivery process	15	Miscellanous
192	another issue I faced during this course is the assignment question paper being released only or two weeks before the actually submission date. This issue causes us students to rush the assignments thus having not enough time to study/revise. I believed that this can be prevented by maybe teaching the topics that the assignment would fall under and opening up the assignment at the start of semester. So that we can have a gauge of the assignment and start earlier. This part falls on the respective lecturers to set the assignment question paper earlier.	Delivery process	16	Course Assessment
193	Hope there is still online recording to view the lecture	Delivery process	17	Course Pedagogy
195	Is important to arrange the proper module sequence rather than to meet the different cohort student to study	Delivery process	18	Course Pedagogy
196	More tutorials for us to prepare for examination	Delivery process	19	Course Assessment
198	More Refreshment on Fundamental.	Delivery process	20	Course Pedagogy
200	Current covid situation where it could be periodiccaly schedule class at home and school.	Delivery process	21	Miscellanous
204	solution of past year paper and more pervious years of pervious test paper for student to practice will be good	Delivery process	22	Course Assessment
207	transfer of information to students	Delivery process	23	Course Pedagogy
208	For the course planning, for part time students many are working full time, recording classes for future semesters will be great	Delivery process	24	Course Resources
	it will be better if there is more qus solved with ans for better learning of the probelms. with steps for qus so that			

Figure 5.47 - Interpretation of Question C10.2 (ST) (Source: Author)

The researcher interpreted the meaning of the ST replies and classified them into different categories, then calculated the total number of each category. For question C10.2 (ST), the researcher interpreted qualitative descriptions and presented the findings in *Figure 5.48*.

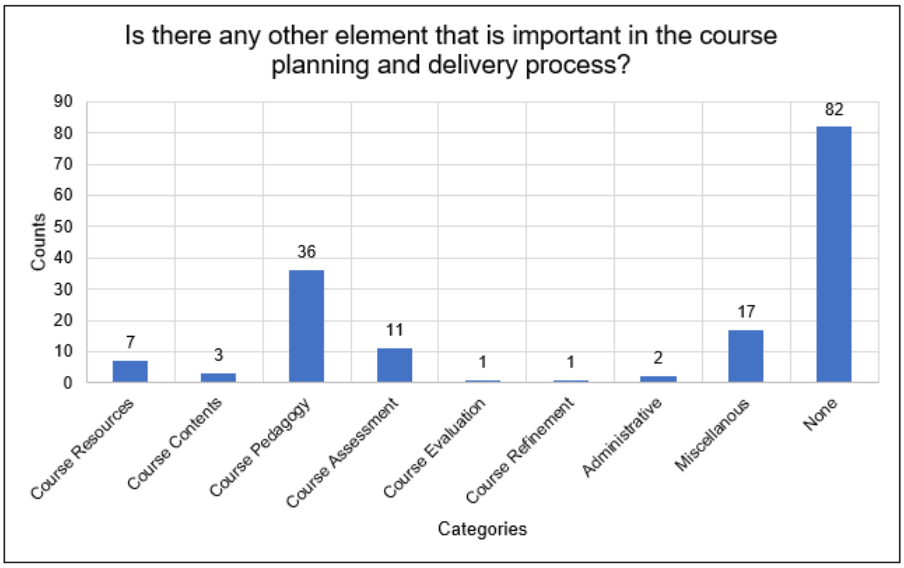


Figure 5.48 - Qualitative Result for Question C10.2 (ST) (Source: Author)

In contrast, ST has 45% (82 "none" out of 184) showed no other essential elements in the CP&DP. However, ST is also concerned about other important factors in the Course Pedagogy, shown in *Table 5.74*.

Table 5.74 - AD, LE and ST Quotes for Question C10.2 (Source: Author)

Problem Concern	AD + LE Quotes	ST Quotes
Course Pedagogy	*"We need to provide a learning experience for students, especially in practical skills, which is somehow still lacking. To be a good engineer, one must be practically well trained and can solve the problem independently, not just the theory."* *"Consideration of students preparedness before the session to achieve the optimum level of learning for the student."*	*"Summarising is one thing; simplifying is another thing. I think to be able to simplify your explanation and to be creative in your delivery are good skills to have. However, I understand it is not easy to be a prof. Thank you for becoming one nonetheless."* *"Should be more practical instead of academic. Yes, true academics can help us to increase our knowledge but to be honest, after graduation, you cannot remember the whole modules that you have learned, but practical is different. It is more to hands-on and experience it by yourself."*

In summary, the following are the other essential elements in the CP&DP:

- Industry expertise and teaching skills.
- Pedagogic approaches.
- Practical skills needed.
- Student preparedness and foundation.
- Student abilities and background knowledge.
- Accessibility to all materials and software.
- Contexture course content.

- Trust in the academics of the institute.
- Timing and mode of delivery.

These qualitative findings have supported the quantitative survey of Lean Thinking evidence-based practice in CP&DP (C1 to C6) results. The responding institutes (AD + LE) place the most significant emphasis on students' requirements, which indirectly specifies value and values stream for the student. By receiving qualitative feedback from the student (ST), the responding institutes have room to *pursue perfection* to meet student satisfaction continually.

The third self-administered open-structure question is:

C10.3 How much do you know about Lean Thinking (add values and reduce wastes) in Higher Education?

There are 26 out of 33 AD and LE who completed the first self-administered open-structure question, representing a valid response rate of 79%. *Figure 5.49* shows the full-screen capture of the AD + LE reply. The researcher interpreted the meaning of the AD + LE replies and classified them into different codes, then calculated the total number of each code.

	How much do you know about Lean Thinking (add value and reduce wastes) in higher education?	Item Response Rate = 26/33 Code
1	nil	Not at all
2		
3	I know little about it.	Very little
4		
5	Not sure	Not at all
6	Very little	Very little
7	Not sure.	Not at all
8	No idea	Not at all
9		
10		
11	No information at all	Not at all
12	From student centric learning.	Somewhat
13	Very minimal understanding	Not at all
14	not much	Not at all
15	Sufficient knowledge about lean thinking.	Moderate
16	Applying a lean principles involves by eliminating tasks that add no value to the subject mater.	Large Extent
17	N.A.	Not at all
18	infancy level	Not at all
19	nothing at all.	Not at all
20		
21	Moderate	Moderate
22	Zero	Not at all
23		
24	Moderate	Moderate
25	Not much, I am more involved in manufacturing lean practice.	Somewhat
26	hardly knows about this.	Not at all
27	Very limited.	Very little
28		
29	Nil	Not at all
30	Little	Very little
31	am aware but this is not practiced in Kaplan	Very little
32	Not much knowledge	Not at all
33	very little	Very little

Figure 5.49 - Interpretation of Question C10.3 (AD + LE) (Source: Author)

For question C10.3 (AD + LE), the researcher interpreted qualitative descriptions and presented the findings in *Figure 5.50*.

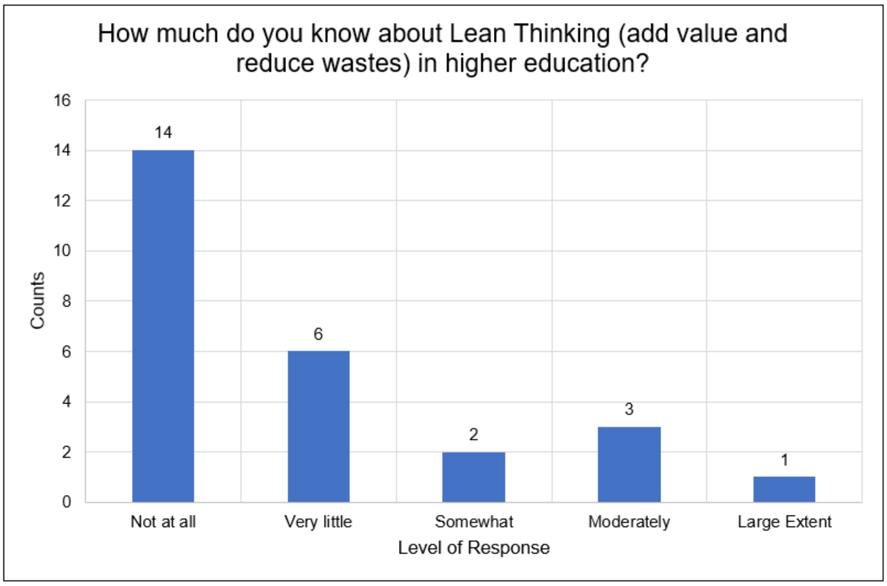


Figure 5.50 - Qualitative Result for Question C10.3 (AD + LE) (Source: Author)

From the chart, 54% of AD and LE demonstrated they do not know anything about Lean Thinking in Higher Education. A promising sign shows that 46% of AD and LE know very little to moderately about Lean Thinking. However, one of the respondents quoted: *"Applying Lean Principles involves eliminating tasks that add no value to the subject matter."*

These qualitative findings were as per the quantitative survey Lean Tools competency (C7) results. It indicates that the responding institutes require proper and relevant training in Lean Thinking in Higher Education, although they indirectly applied Lean Tools in CP&DP.

The fourth self-administered open-structure question is:

C10.4 Do you believe Lean Thinking practice can improve the Course Planning and Delivery Process in your institutes?

26 out of 33 AD and LE completed the first self-administered open-structure question, representing a valid response rate of 79%. *Figure 5.51* shows the full-screen capture of the AD + LE reply.

Item Response Rate = 26/33

	Do you believe Lean Thinking practice can improve the course planning and delivery process in your institutes?	Code
1	yes	Very Likely
2		
3	yes, it eliminates waste of resources and processes.	Very Likely
4		
5	Not sure	Netural
6	Yes. It gives students a purpose with them understanding values and with reducing waste, it eliminates and updates the course content and curriculum	Very Likely
7	Not sure.	Netural
8	I believe it can help to add value to the course planning and delivery process	Likely
9		
10		
11	Yes	Very Likely
12	Yes.	Very Likely
13	Yes.	Very Likely
14	yes	Very Likely
15	It depends. As it still depends on the course structure and delivery.	Likely
16	Yes, need to generate relevant teaching materials (lean thinking practices) that would help students to understand on specific subject matter.	Very Likely
17	Yes it should be able to.	Very Likely
18	yes	Very Likely
19	not sure, maybe.	Netural
20		
21	Yes, has to strike a balance from the Management policy.	Very Likely
22	no idea	Netural
23		
24	Depends	Netural
25	All processes are able to benefit through Lean Thinking practice.	Very Likely
26	nil.	Netural
27	Yes.	Very Likely
28		
29	Possible	Likely
30	Yes	Very Likely
31	definitely	Very Likely
32	A concept that could be explored	Likely
33	I suppose that it will	Likely

Figure 5.51 - Interpretation of Question C10.4 (AD + LE) (Source: Author)

The researcher interpreted the meaning of the AD + LE replies and classified them into different codes, then calculated the total number of each code. For question C10.4 (AD + LE), the researcher interpreted qualitative descriptions and presented the findings in *Figure 5.52*.

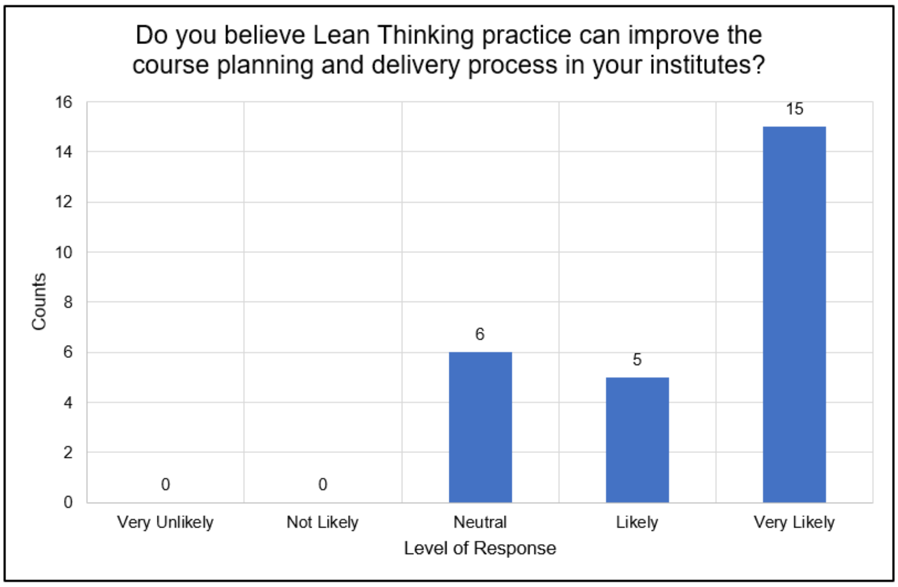


Figure 5.52 - Qualitative Result for Question C10.4 (AD + LE) (Source: Author)

From the chart, 77% of AD and LE, ranging from likely to very likely, demonstrated they believe that Lean Thinking practice can improve the CP&DP in their institutes.

Here are the two quotes:

Quote 1: *"Yes. It gives students a purpose with them understanding values and with reducing waste, it eliminates and updates the course content and curriculum."*

Quote 2: *"Yes, need to generate relevant teaching materials (Lean Thinking practice) that would help students to understand the specific subject matter."*

These qualitative findings have supported the quantitative survey of Lean Thinking (C8) related to CP&DP results. It indicates the responding institutes' motivation to aim for excellence in CP&DP.

The fifth self-administered open-structure question is:

C10.5 Do you see Lean Thinking practice link the strategic planning and transformation in your institutes?

There are 25 out of 33 Administrators (AD) and Lecturers (LE) who completed the first self-administered open-structure question, representing a valid response rate of 79%. *Figure 5.53* shows the full-screen capture of the AD + LE reply.

Item Response Rate = 25/33

	Do you see Lean Thinking practise link the strategic planning and transformation in your institutes?	Code
1	yes	Very Likely
2		
3	yes, as certain processes are eliminated or outsourced to avoid the overburden of resources.	Very Likely
4		
5		
6	Yes	Very Likely
7	Think so.	Neutral
8	Yes.	Very Likely
9		
10		
11	Maybe	Likely
12	Yes.	Very Likely
13	Yes.	Very Likely
14	yes	Very Likely
15	Depends on what is the direction of the Institute.	Likely
16	Yes, lean thinking is an important factor towards strategic planing. Lean application should be widely accepted within any organisation.	Very Likely
17	Possible.	Likely
18	Yet to observe the link	Neutral
19	not sure.	Neutral
20		
21	Yes, communication and understanding is very important.	Very Likely
22	no idea	Neutral
23		
24	No	Very Unlikely
25	The course has been refined over the years, The is an indication of lean process.	Very Likely
26	nil	Not Likely
27	No	Very Unlikely
28		
29	Possible	Likely
30	Yes	Very Likely
31	no	Very Unlikely
32	There is a possibility	Likely
33	I guess it can	Likely

Figure 5.53 - Interpretation of Question C10.5 (AD + LE) (Source: Author)

The researcher interpreted the meaning of the AD + LE replies and classified them into different codes, then calculated the total number of each code. For question C10.5 (AD + LE), the researcher interpreted qualitative descriptions and presented the findings in charts in *Figure 5.54.*

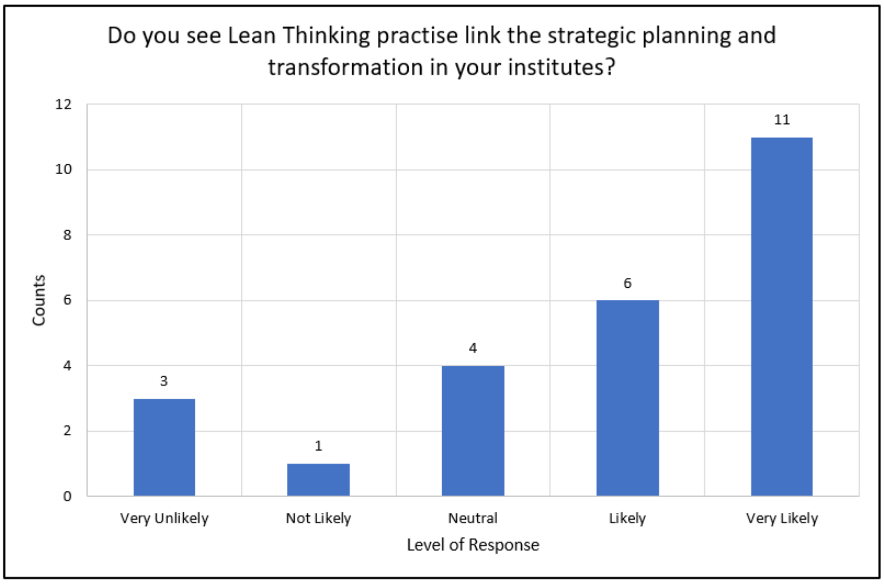


Figure 5.54 - Qualitative Result for Question C10.5 (AD + LE) (Source: Author)

From the chart, 65% of AD and LE, ranging from likely to very likely, demonstrated they foresee Lean Thinking practice link the strategic planning and transformation in their institutes.

Here are the two quotes.

Quote 1: *"Yes, as certain processes are eliminated or outsourced to avoid the overburden of resources."*

Quote 2: *"Yes, Lean Thinking is an important factor in strategic planning. The Lean application should be widely accepted within any organisation."*

These qualitative findings have supported the Key Performance Indicators (C9) quantitative survey. It indicates that the responding institutes are interested in implementing Lean Thinking in Higher Education.

5.14 Critical Discussion

5.14.1 Background

This study investigated the evidence-based Lean Thinking practice to improve CP&DP for SPHEIs, either directly or indirectly, to achieve student learning development and satisfaction. The research aims, objectives and hypotheses were identified and presented (See Chapter 1), and the study was conducted to achieve objectives (See Chapter 4 and 5). This section critically discusses (1) the significant findings of the study, (2) the meaning and importance of the findings, (3) related to the literature review, (4) unexpected findings, and (5) the relevance of findings.

The key findings demonstrated the level of Lean Thinking practice (C1 to C6), level of Lean Tools competency (C7), level of Lean Thinking relationship (C8) and level of Key Performance Indicators (C9) using five (5) Lean Principle, four (4) Lean Wastes and eight (8) Lean Tools. The stakeholder evidence-based Lean Thinking practice for this study is summarised in *Table 5.75*.

Table 5.75 - Stakeholder Evidence-Based Lean Thinking practice (Source: Author)

Evidence Requirement	Evidence Assessment	Lean Thinking evidence-based practice					
		Input (AD)		Process (LE)		Output (ST)	
		QUAN	Qual	QUAN	qual	QUAN	qual
Lean Thinking practice	C1 to C6	*m* = 4.52	Resources Pedagogy	*m* = 4.52	Resources Pedagogy	*m* = 4.19	Pedagogy Online
Lean Tools competency (C7)	C7.1 to C7.8	3.72	Not at all	3.66	Not at all	N.A.	N.A.
Lean Thinking relationship (C8)	C8.1 to C8.9	3.75	Very Likely	3.80	Very Likely	N.A.	N.A.
Key Performance Indicators (C8)	C9.1 to C9.7	3.90	Very Likely	3.08	Very Likely	N.A.	N.A.

5.14.2 Significant Findings of the Study

- ***The current level of Lean Thinking practice in CP&DP (RQ1 - C1 to C6)***

  According to Tatikonda (2007), the four critical features of any course are content (*what to teach*), pedagogy (*how to teach*), organisation (*how topics present*), and assessment (*how to evaluate student learning*) in the educational process. The researcher extended the CP&DP from these four critical features. The CP&DP consist of six dependent variables such as Course Resources (C1), Course Contents (C2), Course Pedagogy (C3), Course Assessment (C4), Course Evaluation (C5) and Course Refinement (C6).

Balzer (2010; 2020) has declared the Lean Higher Education principle as "*Define Value*, *Identify Value Stream*, *Make Value Flow*, *Pull system* and *Pursue perfection*". He has consolidated the eight forms of wastes into four types of waste as "*People Wastes, Process Wastes*, *Information Wastes* and *Asset wastes"* for Lean Higher Education. The researcher linked the CP&DP six independent variables (C1 to C6) to the dependent variables of five Lean Principles and four Lean Wastes.

The study is to determine the current level of Lean Thinking evidence practices in SPHEIs. The mean values of the Lean Thinking evidence-practice level in CP&DP under C1 to C6 were rated highly by responding institutes in terms of two groupings AD + LE and ST. The top-rated attribute "*Course Contents*" (C2) reveals that the responding institutes most emphasise students' requirements. It is parallel to the main target of Lean Thinking practice, which is to value stream for the student ("customer"). Although evidence shows that the ST respondents placed a high degree of evidence-practice on all the attributes, there is a significant difference between the two groups mean scores. It indicates that the responding institutes have room to improve to meet student satisfaction continually.

The qualitative findings (C10.1 and C10.2) have supported the quantitative survey of Lean Thinking evidence-based practice in CP&DP (C1 to C6) results. The responding institutes place the most significant emphasis on students' requirements, which practices indirectly *specify value* and *values stream* for the student. By receiving qualitative feedback from the student, the responding institutes have room to *pursue perfection to* meet student satisfaction.

The results showed a highly significant evidence level of Lean Thinking evidence practices in SPHEIs for CP&DP indirectly between the two groups. Thus, the first null hypothesis ($H01_{null}$) was rejected. It shows the "*SPHEIs demonstrate excellent institutes-wide Lean Thinking evidence practice for CP&DP"*(Large Extent).

- ***The current level of Lean Tools competency (RQ1 - C7)***

  Some of the standard Lean Tools are *Hoshin Kanri, 5S, PDCA, Poka-Yoke, Muda (Waste), Muri (Overburden), Mura (Unevenness)* and *Value Stream Mapping* (Womack and Jones, 2003; Womack *et al.*, 2007). The researcher integrated these eight (8) Lean Tools in this study.

  The study is to determine the current level of Lean Tools competency in SPHEIs. The mean values of the level of competency in Lean Tools under C7 were rated highly by responding institutes in terms of two groupings AD and LE.

  Further investigating the relationship between Lean Tools competency (C7) and CP&DP (C1 to C6) can at least prove a snapshot of what the relationships are between the two grouping AD and LE in SPHEIs. All the correlation coefficients are positive, and it indicates that CP&DP is associated with more extensive use of the Lean Tools.

  The qualitative findings (C10.3) have different outcomes than the quantitative survey Lean Tools competency (C7) results. It indicates that the responding institutes require proper and relevant training for Lean Thinking in Higher Education, although they demonstrated significant evidence that they indirectly applied Lean Tools in CP&DP.

  The results showed both AD and LE are aware of these standard Lean Tools and have high significant distribution to adopt them in the CP&DP indirectly. Thus, the first null hypothesis ($H01_{null}$) was rejected. It indirectly shows that "*SPHEIs have a good understanding and practice of the Lean Tools*" (Likely) in CP&DP.

- ***The current level of Lean Thinking Relate to CP&DP (RQ2 - C8)***

  The study determines the significant influence and correlation between independent variables (Lean Principles and four Wastes) and six dependent variables (C1 to C6).

The mean values of Lean Thinking related to CP&DP under C8 were rated highly by responding institutes in terms of two groupings AD and LE. For the AD group, the top-rated attribute (C8.5) reveals that the responding institutes place the greatest emphasis on continuous improvement and respect for people (Emiliani, 2015). For the LE group, it is evidence that the respondents placed a high degree of Lean Thinking relating to CP&DP. It is parallel to the main target of Lean Thinking practice, which is to motivate and inspire excellence in CP&DP. However, there are gaps between the AD and LE because there is a significant difference by comparing the two groups mean scores. It indicated that the responding institutes have room to improve the workflow in the CP&DP.

Further investigating the relationship between Lean Thinking and CP&DP and can at least prove a snapshot of what the relationships are between the two grouping AD and LE in SPHEIs. All the correlation coefficients are positive, and it indicates that CP&DP is related to the adoption of the Lean Principles and Lean Wastes.

The results showed both AD and LE are aware of these common Lean Principles and Wastes and have high significant distribution related to CP&DP indirectly. Thus, the second null hypothesis ($H02_{null}$) was rejected. It shows "*SPHEIs have good practice evidence and performance Lean Thinking relates to CP&DP*" (Moderately) by responding institutes. It indicates that the responding institutes motivate and inspire, aiming for excellence in CP&DP supported by qualitative findings (C10.4).

- ***The current level of Key Performance Indicators (RQ3 - C9)***

  Different indicators evaluate the key performance of the institute. All these indicators are what Lean Thinking strives to improve in the educational process, and it means that these areas have much space for improvement if Lean Thinking is implemented. Both AD and LE have high significant distribution to agree that removing wastes and delivery values impact Higher Education Performance.

There is a highly significant influence and correlation between CP&DP (C1 to C6) versus KPI (C9), Lean Tools competency (C7) versus KPI (C9) and Lean Thinking relationship (C8) versus KPI (C9). The level of KPI has an average mean of 3.90 for AD shows "*SPHEIs have outstanding performance Lean Thinking practice influences KPI*" (Good), whereas 3.08 for LE shows "*SPHEIs have satisfactory delivery Lean Thinking practice influences KPI*" (Average). Thus, the third null hypothesis (H03null) was rejected. It indicates that the responding institutes are interested in implementing Lean Thinking in Higher Education supported by qualitative findings (C10.5).

5.14.3 Meaning and Importance of the Findings

- ***What problems are SPHEIs trying to solve?***

  The finding showed that SPHEIs deploy Lean Thinking evidence practice in the CP&DP indirectly. SPHEIs demonstrated Lean Thinking practice in the CP&DP, which could be a source of competitive advantage. SPHEIs provided value-added service and cost reduction in the administration and academic processes. SPHEIs can provide better education in more efficient and effective ways to implement Lean Thinking practices.

- ***What management system do SPHEIs need?***

  SPHEIs adopted the five Lean Principles indirectly. *Define Value* from the student's point of view, seeking to add more value by reducing waste. *Identify Value Stream* mapping of materials and information, removing those activities that do not create value whenever possible. *Make Value Flow* standardised work by defining sequence smoothly toward the students. Conceiving a comprehensive direct *Pull system* for pulling services, letting the student pull value from the next upstream activity. As value is defined, value streams are found, wasted stages eliminated, flow and pull are added, and the process is repeated until a state of *Perfection* is pursued in which excellent value is created with no waste (Balzer, 2021; 2020).

As mentioned in the literature review, Shook (2020) supported that Lean is all about maximizing customer value while minimizing resources, time, energy, and effort. It is based on Purpose, Process, and Respect for People. These results are likely to be related to Lean Thinking practice, which assists the SPHEIs in becoming both innovative and competitive, allowing them to become sustainable.

- ***What are SPHEIs basic thinking and mindset?***

  SPHEIs have the fundamental thinking and mindset of four Lean Wastes. *People Wastes* refer to "the failure to capitalise on employers' knowledge skills and abilities". *Process Wastes* refer to "shortcomings in academic processes". *Information Wastes* refer to "information deficient in supporting academic processes". *Asset Wastes* refer to "not using resources most effectively" (Balzer, 2010; 2020).

  According to Shook (2020), the true secrets to Lean success lie in basic thinking. Everyone brings the essential thinking for each team, each task and each challenge to achieve the organisation's aims. Lean encourages employees at all levels of an organization to re-imagine services from the customer's perspective ("student"), reducing process activities that do not provide value and focusing on those activities that add the most value. The results from transforming the educational process as SPHEIs improve their work.

- ***How are SPHEIs improving the workflow?***

  The significant evidence showed that "*SPHEIs have a good understanding and practice of the Lean Tools*" and applied them in CP&DP indirectly. *Hoshin Kanri* is a strategic planning process that communicates and implements broad strategic goals (Emiliani, 2005). *5S* is "a method of organising spaces so that work can do efficiently, effectively, and safely" (Randhawa and Ahuja, 2017). *Plan-Do-Check-Act (PDCA)* is a basic simple four-stage approach that assists teams in preventing recurring errors and optimising processes (Suárez-Barraza and Rodríguez-González, 2015; Dinis-Carvalho and Fernandes, 2017; Tılfarlıoğlu and Anwer, 2017). *Poka-Yoke*, also known as mistake-proofing, is a Lean mechanism that assists an operator in avoiding mistakes (Sondermann *et al.*, 2018). *Muda* is a Japanese word that means "useless" or "waste", and it has eight forms. *Muri* is the overloading or overburdening of employees, machines, or processes. *Mura* is the unevenness, fluctuation, or variation in work or the workplace (Southworth, 2010). *Value Stream Mapping* is a technique for charting the process flow, identifying wastes in the flow, determining the root cause of wastes, and identifying ways to reduce or eliminate waste (Brouwer-Hadzialic and Wiegel, 2016; Dinis-Carvalho and Fernandes, 2017). As a result, the academic processes never degrades and continue to function efficiently and effectively in SPHEIs (Emiliani, 2005; Suárez-Barraza and Rodríguez-González, 2015; Kregel, 2019).

- ***How are SPHEIs current level of performance?***
  The findings have significant evidence and qualify *"SPHEIs have satisfactory delivering Lean Thinking practice influences KPI"* It means that these areas have much space for improvement. SPHEIs operate in a highly competitive SME business environment (Lo, 2014) with standard SME business paradigm shifts focus on problem-solving, quality enhancement, revenue generation, lowest cost, and driving profitable growth in market share. SPHEIs have established methods to generate savings focus on cost reduction and quality improvements for student satisfaction (Lo, 2014). If SPHEIs have the appropriate set of Lean Thinking practices, they can connect, track, monitor, analyse, measure, and expand their strategy, marketing, and operations.

- ***How are SPHEIs building capabilities?***
  According to Balzer (2016), Lean Higher Education is a powerful strategy supported by Lean Thinking. Lean Thinking is strategic planning that includes vision and values, alignment and leadership, aligned people and thinking, execution, and transformation. SPHEI strategic planning intertwines with marketing, operational decisions, and other issues. SPHEIs must transform to become more efficient and effective, and Lean Thinking can improve their academic processes to become sustainable SPHEIs.

5.14.4 Relate the Findings to Similar Studies

Several reports have shown that Lean Thinking in Higher Education. Pusca and Northwood (2016) demonstrated the use of the Lean Principle in an Engineering Design course, but they added three components: course content, instructional methods and assessment methods. They showed how Lean tools such as value stream mapping, root cause analysis, and Kaizen were used to identify problems and solutions for course improvement. Dinis-Carvalho and Fernandes (2017) observed using Lean concepts to teach and learn in student-centred learning environments. A pilot study was conducted as part of an engineering course at the University of Minho in Portugal. They reaffirmed the importance of the planning process, emphasising the importance of three components: learning outcome, teaching strategies and assessment methods.

As mentioned in the literature review, Mirth (2017) designed and delivered a traditional lecture-based Kinematics of Machines, Engineering course using Lean Management Principles and giving students more responsibility for defining their own uniform set of due dates for their assignments. According to Tatikonda (2007), educators can implement Lean Principles and techniques to improve course content, pedagogy, organisation, and assessment methods to help ensure that students gain the knowledge and skills that would make them most desirable to employers.

Prior studies have noted the importance of Lean Thinking practice. Smith (2015) found that the application of one specific Lean technique – one-piece flow – can be used in the undergraduate construction course and demonstrated student perceptions of what is known as “small batch size learning” or “one-piece informational flow”. Tılfarlıoğlu and Anwer (2017) emphasised that teachers can eliminate reasons that add no value and focus their efforts on advancing teaching and learning by applying a Lean methodology to teaching processes. According to Alves *et al.* (2017), Lean Thinking principles are applied to the teaching and learning process in the classroom by involving students in the improvement process and collecting continuous feedback.

In reviewing the literature, Emiliani (2004a) demonstrated how Lean Principles and practices are applied to a graduate course in leadership taken by part-time working professional students seeking MSc in management and MBA degrees in a classroom setting. The results showed higher student satisfaction, clearer expectations, less ambiguity regarding lectures and assignments, standard formats for projects, smoothing individual and team assignments over the semester, and better management of students' time in and outside class. Emiliani (2005) used Kaizen, a rapidly improving Lean-based experience, to improve the content of graduate business courses. The author concluded that Kaizen was a successful process for improving graduate business school courses and the value proposition for students.

According to Lawrence *et al.* (2019), Education 4.0 defines as "the use of technology in the teaching and learning contexts." Education 4.0 ends innovation by improving education and skills to make future learning more personal, super, intelligent, portable, global and virtual (Sharma, 2019). In addition, Halili (2019) pointed technological advancements in teaching and learning could enhance the teaching and learning process and create learners' interest in participating in the learning materials. Bittencourt *et al.* (2021) identified that Lean is seen as an essential agent in the performance of IR4.0, and Taghavi and Beauregard (2020) found that the integration of Lean and IR4.0 positively impacts companies. Sharma (2019) said IR4.0 brought about a state of change in education, and education requires relevant information and skills. However, Spiridonova *et al.* (2021) said HEIs are beginning to implement Lean practices to improve their processes. Lean can provide a significant positive synergetic effect reserve of resource-saving and labour productivity increase for the preparation and maintenance of the educational process. In other words, Lean Thinking in Higher Education can help to implement the Education 4.0 processes.

5.14.5 Explanation of Unexpected Findings

One unanticipated finding was that the responding institutes were aware of Lean Thinking but were not aware of the whole spectrum of its implementation and practices. Their lack of understanding of what is needed for the Lean Thinking practice might affect their focus and thus their current level of evidence-practice.

Surprisingly, one of the respondents quoted: "*Applying Lean Principles involves eliminating tasks that add no value to the subject matter.*"

What is surprising is that the attribute *Waste (Muda)* (C7.5) in Lean Tools competency and *Eliminate Process Waste* (C8.7) in Lean Thinking relationship shows low significant distribution to identify there are wastes in the academic processes. Moreover, the lowest KPI of "*Higher Education Productivity* (C9.2)" and "*Student Satisfaction* (C9.6)" have minimal significant distribution to identify productivity and student satisfaction in the respondent institutes. It implies that there is much room for improvement in these areas if Lean Thinking is implemented.

AD and LE identified the main current problems from qualitative findings: Course Resources and Course Pedagogy. However, ST is more concerned about the Course Pedagogy and Online Learning problem. The student brought out the Online Learning issues because of the COVID19 lockdown ("circuit breaker") in Singapore in April 2020. It is somewhat surprising that lecturers did not address the Online Learning issues.

5.14.6 Relevance of Findings

Six Sigma, Lean Six Sigma or Lean/Lean Thinking have been widely used for Higher Education across different countries. The majority of completed studies based in universities in the United States, the United Kingdom, and India showed significant benefits in Higher Education. It is the first time such research has been conducted on selected SPHEIs. SPHEIs recognise the significance of developing the best education process to gain a competitive advantage. Lean Thinking is not a new concept (Womack and Jones, 2003; Womack et al., 2007). However, SPHEIs have yet to fully explore and adopt Lean Thinking (Toh, 2012). These research questions are developed to understand better how SPHEIs use Lean Thinking in academic processes, either directly or indirectly. This study aims to bridge this gap by investigating, exploring, and proposing how evidence-based Lean Thinking practice in CP&DP, which are at the heart of any academic institute, can achieve student learning development and satisfaction.

A cross-sectional survey collected more facts about the context of the Lean Thinking practice in the SPHEIs. An empirical study was conducted, using triangulation embedded mixed-method, which combined quantitative and qualitative data, to address the research gap. Using five Lean Principles, four Lean Wastes, and eight Lean Tools, the questionnaire survey investigated: the level of Lean Thinking evidence practice, level of Lean Tools competency, level of Lean Thinking relationship, and level of KPI. Finally, Lean Thinking Kaizen Academic Process Canvas (See Chapter 6) form a complete "big picture" of "T" shape or foundation and "U" shape or methodology components from problem to solution. The self-explanation canvas improved educational processes for SPHEIs to transform, adopt a highly effective strategy planning, offer high value-added services through innovation and stay competitive.

5.15 Chapter Summary

The results indicated positive acceptance among the respondents as to the evidence-based practices of the various attributes, a highly positive significant test results between groups. The results of the inter-relationship between Lean Thinking practice in CP&DP versus KPI, Lean Tools competency versus KPI and Lean Thinking relationship versus KPI demonstrated a highly significant influence on one another. Thus, these three null hypotheses were rejected. Finally, qualitative data on how SPHEIs used the Lean Thinking practice in the CP&DP were analysed and addressed to understand the quantitative findings better as evidence-based strategies.

Chapter 6 – Conclusion, Contribution and Future Research

6 Conclusion, Contribution and Future Research

6.1 Introduction

This final chapter presents the closure of the research. It starts by realising how the aim and objectives of the research have been met. The quality of the study and the main contribution to theory, knowledge, professional practice are discussed. The limitations of the study, followed by future research that can help other researchers in this field to narrow the gaps in the current literature for the private Higher Education industry, are also presented.

6.2 The Realisation of the Aim and Objectives of the Research

A mixed-methods research study investigates the evidence-based Lean Thinking practice to improve the Course Planning and Delivery Process (CP&DP) for Singapore Private Higher Education Institutes (SPHEIs). *Figure 6.55* illustrates how the aim and objectives of the research were realised.

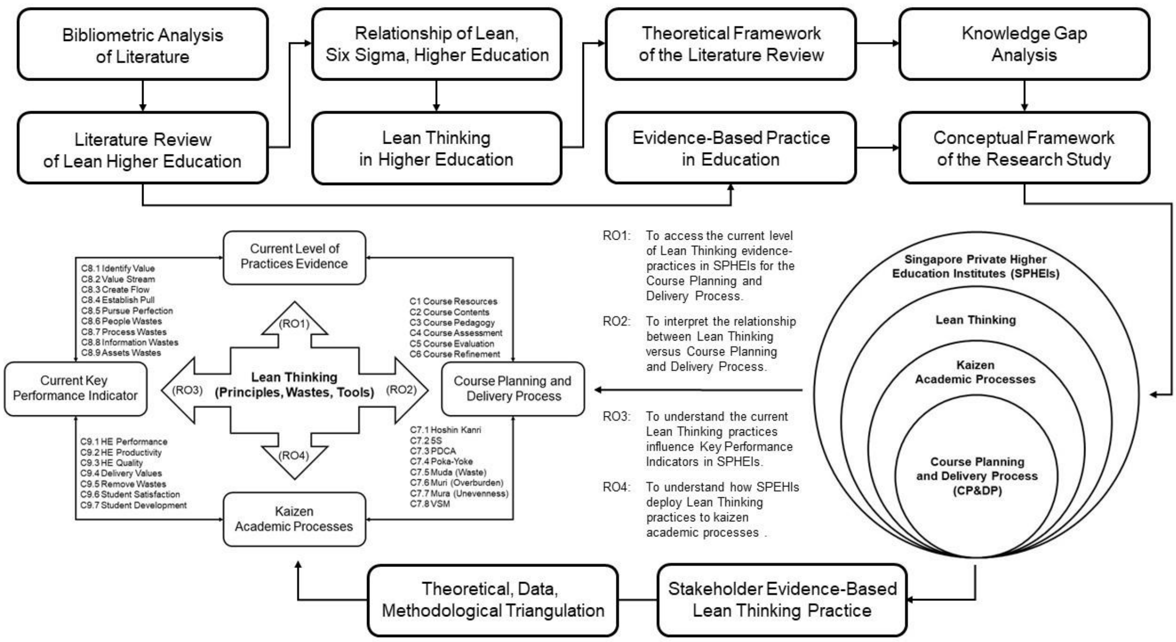


Figure 6.55 - Realisation of the Aim and Objectives of the Research (Source: Author)

6.2.1 Research Objective 1

RO1: To access the current level of Lean Thinking evidence practice in SPHEIs for CP&DP.

RQ1: WHAT are the current level of Lean Thinking evidence practice in SPHEIs for the CP&DP?

$H01_{(Null)}$: There is **NO** evidence showing SPHEIs deploy Lean Thinking practice in the CP&DP.

A summary of the findings:

- In the descriptive statistics, the mean values of the Level of Lean Thinking (C1 to C6) evidence practice for CP&DP were rated highly by responding institutes in terms of two groupings, AD + LE and ST. It means "*SPHEIs demonstrate excellent institute-wide Lean Thinking evidence practice for CP&PD*". The mean values of the Level of Lean Tools Competency under C7 were rated highly by responding institutes in terms of two groupings, AD and LE. It means "*SPHEIs have a good understanding and practice of the Lean Tools*". In summary, the respondents placed a high degree of evidence-practice on all the attributes by the responding institutes.

- For the nonparametric compare group analysis, the results showed that the responding institutes are aware of Lean Thinking but are unaware of the whole spectrum of its implementation and practices. However, their lack of understanding of what is needed for the Lean Thinking practice might affect their focus and current practice level. Also, the results showed that both AD and LE are aware of these standard Lean Tools and have high significant distribution to adopt them in the CP&DP indirectly.

- Spearman's rho correlation analysis showed that all the correlation coefficients are positive, indicating that CP&DP is associated with more extensive use of the Lean Tools.

Therefore, the first null hypothesis ($H01_{null}$) was rejected (See Chapter 5). It has achieved Research Objective 1 and answered Research Question 1.

6.2.2 Research Objective 2

RO2: To interpret the relationship between Lean Thinking versus CP&DP.

RQ2: WHAT is the relationship between Lean Thinking versus the CP&DP?

$H02_{(Null)}$: There is **NO** correlated evidence between Lean Thinking versus CP&DP.

A summary of the findings:

- In the descriptive statistics, the mean values of Lean Thinking related to CP&DP under C8 were rated highly by responding institutes in terms of two groupings, AD and LE. It means "*SPHEIs have good practice evidence and performance Lean Thinking relates to CP&DP*". It is parallel to the main target of Lean Thinking practice, which is to motivate and inspire aiming for excellence in CP&DP. However, there are gaps between the AD and LE. It indicated that the responding institutes have room to improve the workflow in the CP&DP.

- For the nonparametric compare group analysis, the results showed that both AD and LE are aware of these common Lean Principles and Wastes and have high significant distribution related to CP&DP indirectly.

- Spearman's rho correlation analysis showed that all the correlation coefficients are positive.

Therefore, the second null hypothesis ($H02_{null}$) was rejected (See Chapter 5). It has achieved Research Objective 2 and answered Research Question 2.

6.2.3 Research Objective 3

RO3: To understand the current Lean Thinking practice influences KPI in SPHEIs.

RQ3: HOW does current Lean Thinking practice influence KPI in SPHEIs?

$H03_{(Null)}$: There is **NO** evidence showing the current Lean Thinking practice can influence Key Performance Indicators in SPHEIs.

A summary of the findings:

- In the descriptive statistics, different indicators evaluate the KPI of the institute. The level of KPI has an average mean of 3.90 for AD, which shows "*SPHEIs have outstanding performance Lean Thinking practice influences KPI*". In contrast, an average mean of 3.08 for LE shows "*SPHEIs have satisfactory delivering Lean Thinking practice influences KPI*".

- For the nonparametric comparison group analysis, both AD and LE have a significant distribution to agree that removing wastes and delivery values impacts higher education performance. However, it has low significant distribution to identify productivity and student satisfaction in their respondent institutes.

- Spearman's rho correlation analysis showed that all the correlation coefficients are positive. All these indicators are what Lean Thinking strives to improve in the educational process, and it implies that there is much room for improvement in these areas if Lean Thinking is implemented.

Therefore, the third null hypothesis ($H03_{null}$) was rejected (See Chapter 5). It has achieved Research Objective 3 and answered Research Question 3.

6.2.4 Research Objective 4

RO4: To understand how SPEHIs deploy Lean Thinking practice to improve academic processes.

A summary of the findings:

- The qualitative findings (C10.1 to C10.2) have supported the quantitative survey of Lean Thinking evidence-based practice in CP&DP (C1 to C6) results. The responding institutes (AD + LE) place the most significant emphasis on students' requirements, which practice indirectly specify value and values stream for the student. By receiving qualitative feedback from the student (ST), the responding institutes have room to *pursue perfection* to meet student satisfaction continually.

- The qualitative findings (C10.3) have mapped against the quantitative survey Lean Tools competency (C7) results. It indicates that the responding institutes require proper and relevant training for Lean Thinking in Higher Education. However, they consciously demonstrated significant evidence indicating the indirectly applying Lean Tools in CP&DP.

- The qualitative findings (C10.4) have supported the quantitative survey of Lean Thinking related (C8) to CP&DP results. It indicates that the responding institutes motivate and for excellence in CP&DP.

- The qualitative findings (C10.5) have supported KPI (C9) quantitative survey. It indicates that the responding institutes are interested in implementing Lean Thinking in Higher Education.

It has achieved Research Objective 4 to understand the quantitative results better using qualitative data.

6.3 Research Quality

The mixed-methods design study addressed evidence-based Lean Thinking practice to improve CP&DP for SPHEIs. The reason for collecting both quantitative and qualitative data was to understand the quantitative results deeper using qualitative data. Both methods were equally crucial in answering the research questions. Next, the triangulation mixed-method was used to collect data from selected SPHEIs to ensure the process was valid and reliable. The validity and reliability of the instrument were ensured in this research as follows:

6.3.1 Validity

When the researcher created survey questions for this study, the questions should measure what the researcher wants them to calculate. Validity is defined as the extent to which a concept accurately measured in a quantitative study. Content validity is the matching between questionnaires and the content of the questions (Taherdoost, 2018b).

The questionnaire was created after the researcher studied a large amount of literature and was sent to the Lean Thinking practitioners and academic leaders in SPHEIs. They were asked for feedback on the survey instruments. Their thoughts regarding language, clarity, content, technical issues, missing points, and ability to answer the critical research questions were focused. The results of this exercise were then used to improve the questions by rewording, regrouping, rearrangement, and removal of unrelated questionnaires. As a result, the survey's content validity was ensured. The questionnaires for the survey were approved by the Research Ethics Committee (REC).

6.3.2 Reliability

Since it is not possible to give an exact calculation of reliability, an estimate of reliability through Cronbach’s alpha test. Cronbach’s alpha is the most used test to determine the internal consistency of survey questionnaires with more than two responses. This research work has multiple Likert questions in the survey questionnaires that form a scale. The researcher used Cronbach’s alpha coefficient as the reliability indicator, and Cronbach’s alpha result is a number between 0 and 1. The higher the coefficient (e.g. 0.8 or 0.9), the stronger the linear relationship of the items which correlated and the higher the internal consistency (Taherdoost, 2018b).

The result showed that respondents of these two groups (AD + LE and ST) have a good understanding of academic process works and can thus provide a reliable answer to the questionnaires. The scale reliability results ranged from Cronbach's alpha 0.814 to 0.953 for C1 to C9, exceeding the usual recommendation of alpha = 0.7, thus establishing the scale's internal consistency.

6.4 Research Contribution to Theory

This study found that SPHEIs used Lean Thinking practice in the CP&DP indirectly to achieve student learning development and satisfaction. The majority of previous studies conducted at universities in the United States, the United Kingdom, and India are different from what the researcher found. Theoretical implications impact the theories that the researcher has chosen in the study. It could come from the additional variables the researcher added to the original view shown in *Figure 6.56*. The new variable of the *Course Resources* can add to the *Administration and Operation*. The *Course Contents* can relate to *Curriculum Design and Delivery*; *Course Pedagogy* and *Assessment* can include in *Teaching and Learning*; *Course Evaluation* and *Refinement* can integrate into *Leadership and Sustainability,* and *Quality and Performance* that cover a broader perspective.

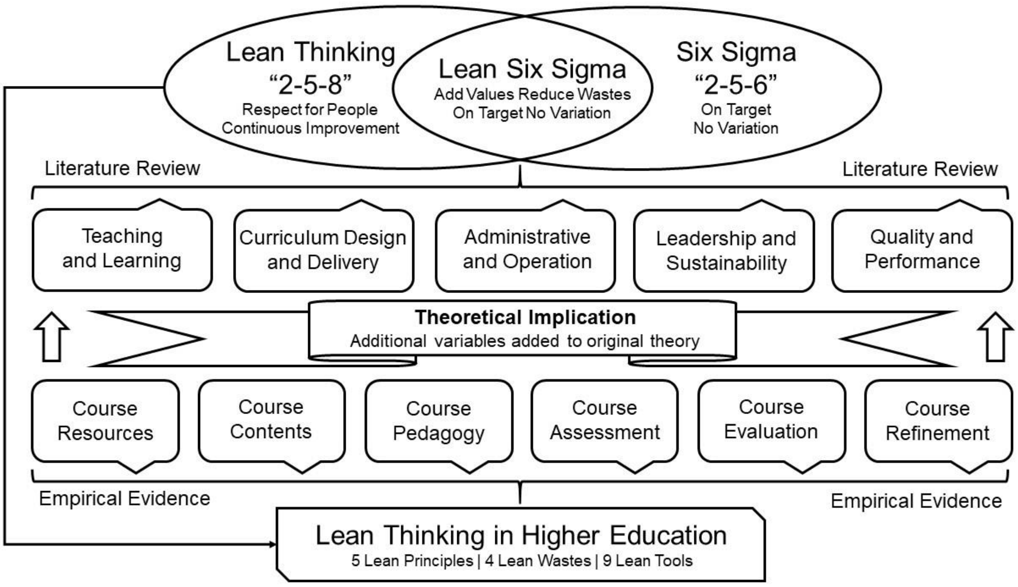


Figure 6.56 - Theoretical Implications of the Research (Source: Author)

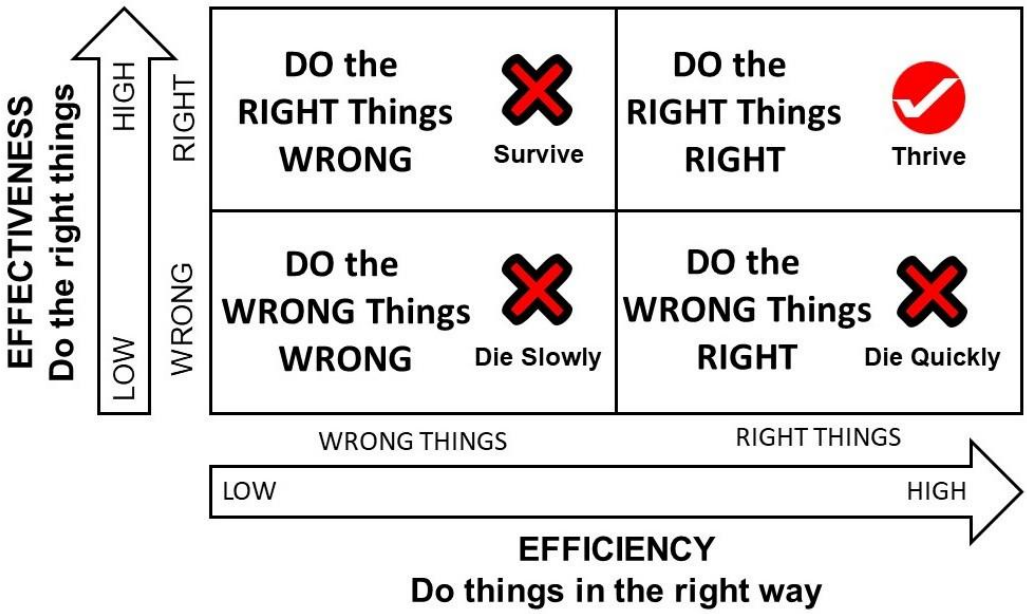
6.5 Research Contribution to Knowledge

Stack (2015) quoted Peter F. Drucker's *The Effective Executive* (Drucker, 2006), distinguishing between effective and efficient. Here is how Drucker differentiates two terms:

*"Effectiveness refers to successfully producing the expected or desired result; it is the degree to which you achieve your objectives, solve problems, and realise profits. In business, effectiveness is summed up by '**doing the right things**.'"*

*"Efficiency is accomplishing a job with the minimum expenditure of time, effort, and cost - the shortest distance between a goal and a checkmark. In business, efficiency is summed up by '**doing the things right**.'"*

The authors said that "anyone with the proper training or a good manual could do the right things, so can a robot. Alone, effectiveness is not enough to distinguish a good executive. When effectiveness lacks efficiency, it is often unproductive and can take months to complete." Bider *et al.* (2014) said effectiveness is to ***do the right things***, whereas efficiency is to ***do things in the right way***. If doing the right things the first time and all the time means aligning effectiveness and efficiency, businesses will thrive. Sutevski (2021) supported Bider *et al.* (2014) presented the efficiency and effectiveness matrix used for business life shown in *Figure 6.57*.



Source: Adapted from Bider *et al.* (2014); Sutevski (2021)

Figure 6.57 - Efficiency and Effectiveness Matrix

In any organisation, the wastage comes from three activities or processes (Bider *et al.*, 2014; Sutevski, 2021): (1) Do the right things wrong (Survive); (2) Do the wrong things right (Die Quickly); (3) Do the wrong things wrong (Die Slowly). Because of this wastage, activities or processes must rework, redo, resend, rebuild, resolve, rewrite, reprocess, resubmit, revisit, renegotiate, re-establish, and others. The researcher discovered that any of these three activities created 33% (1 out of 3) of wastages that the organisation may not know is internal wastages. Waste occurs because of human behaviour, mindset and thinking patterns (Charron *et al.*, 2014; Tay, H.L., Low, 2017). Therefore, do the things right to reduce the 33% internal wastage. If the activities or processes are doing the right things the first time and all the time, it contributes or adds a 67% value (100% - 33%) to increase the revenue stream.

The researcher developed the "Si Liang Bo Qian Jin" business profit mindset after comprehending the 33% internal wastage shown in *Figure 6.58*. Many business people can be cautious or mean with little money, yet wasteful and extravagant with large sums known as "Pennywise Pound Foolish". Pennywise refers to conservative money spending on small things, and Pound Foolish means wasting money, particularly more prominent spending. When combined, Pennywise and Pound Foolish may become a significant revenue drain and cause a company closure.

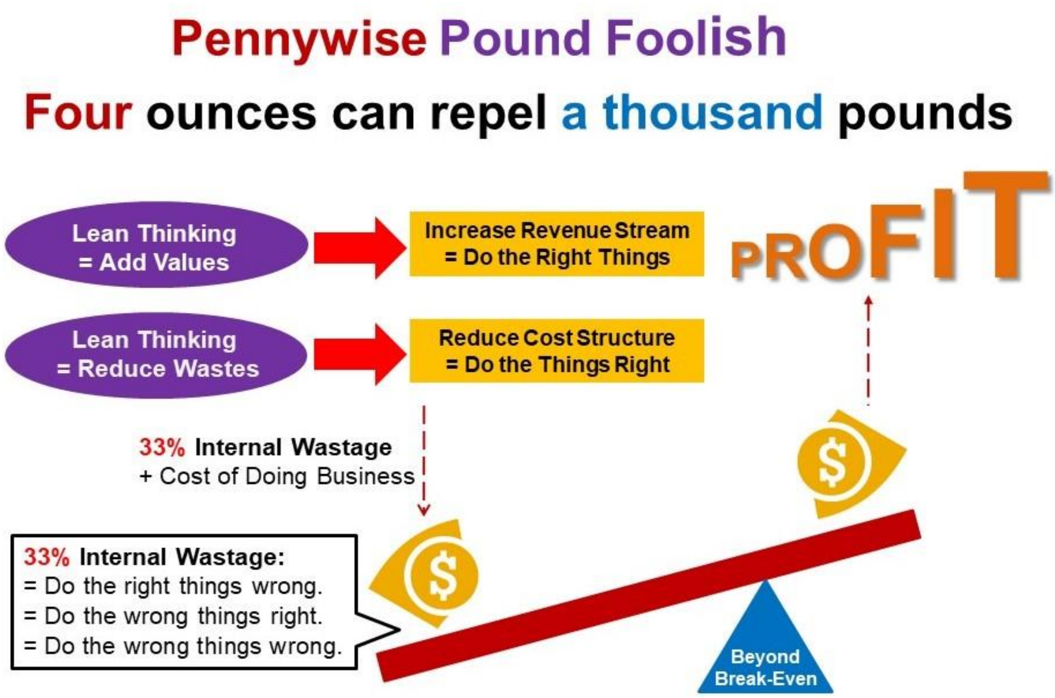


Figure 6.58 - Four Ounces can Repel a Thousand Pounds (Source: Author)

On the other hand, “Si Liang Bo Qian Jin” is a Chinese saying translated as “Four ounces can repel a thousand pounds”. When “Four ounces can repel a thousand pounds” to leverage Lean Thinking in the business processes, profits and productivity will come in gradually. The illustration shows how Lean Thinking “Do the things right - increase revenue stream” and “Do the right things - reduce the cost structure” can significantly widen the business profit gap. The survey results (See Chapter 5) of the inter-relationship between Lean Thinking practice in CP&DP versus KPI, Lean Tools competency versus KPI and Lean Thinking relationship versus KPI demonstrated a highly significant influence on one another. It demonstrated that SPHEIs know can not reduce the cost of doing business but can reduce 33% internal wastage if Lean Thinking is applied. Hence, Lean Thinking is a robust continuous improvement methodology that HEIs may leverage to improve administrative, academic and development processes by adding value and reducing wastes.

6.6 Research Contribution to Professional Practice

This study had addressed the CP&DP intending to enable a better understanding of Lean Thinking in the education industry. This research has made a significant contribution to Lean Thinking in Higher Education by identifying the fundaments, principles and wastes of Lean Thinking in the context of education. *Figure 6.59* shows the Lean Thinking Kaizen Academic Process Canvas.

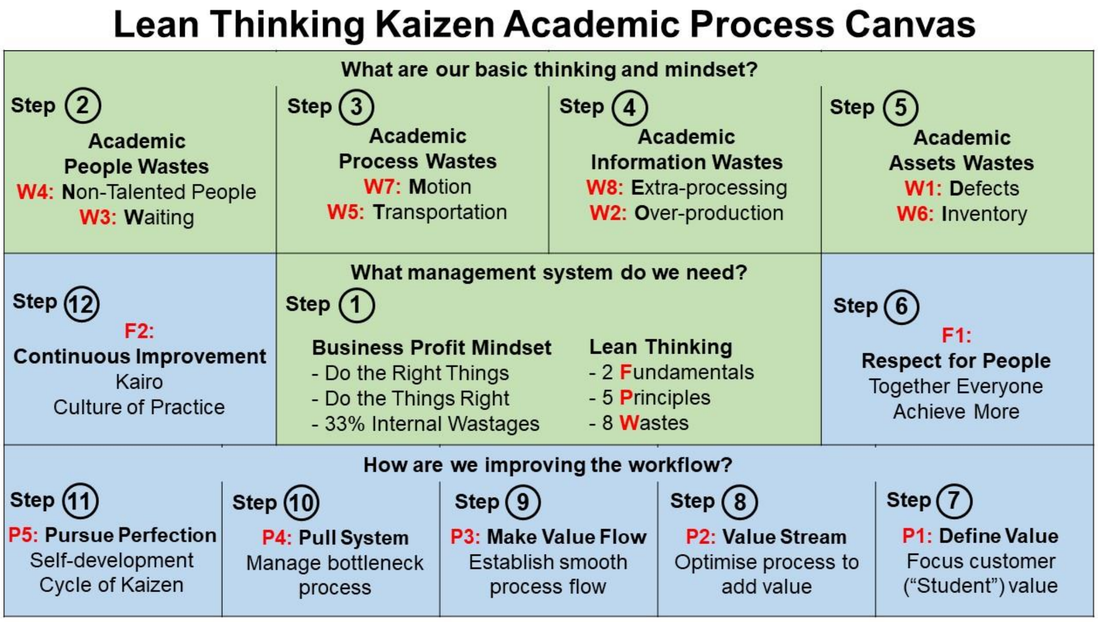


Figure 6.59 - Lean Thinking Kaizen Academic Process Canvas (Source: Author)

The Lean Thinking, 15 components (2 **F**undamentals, 5 **P**rinciples, 8 **W**astes), are present in a sequence, and implementing Lean Thinking in Higher Education is new in context. There are 12 steps with 15 components. The components are organised into two groups. The "T" shape or **foundation** (green cells) includes the Business Profit Mindset with Lean Thinking at Step 1 and eliminating Academic Wastes from Steps 2 to 5. Each Academic Waste has two types of wastes, in a total of eight wastes (W1 to W8). The "U" shape or **methodology** (blue cells) consists of Respect for People (F1) at Step 6, five Principles (P1 to P5) from Steps 7 to 11, and Pursue Perfection (F2) at Step 12. Implementing these 12 steps with 15 components will significantly widen the business profit gap and increase productivity. Below is the roadmap to implement Lean Thinking in HEIs:

Getting the "T" or foundation right (Step 1 to 5)

The organisation will often begin their cost of doing business by asking questions like, "How can we cut the business cost to gain more revenue?" It is the wrong way to start! To establish a solid **foundation ("T" shape)**, the organisations must identify non-value activities wastes and eliminate 33% of internal wastes.

- *What management system do we need?*

  Step 1: Business Profit Mindset and Lean Thinking

  Everyone in the organisation must have these three purposes in mind regardless of what activities everyone is doing: "I help the company do three things: increase revenue, reduce cost and widen profit gap." Therefore, everyone should "do the things right" (add customers values) and "do the right things" (reduce non-value activities wastes and eliminate 33% of internal wastes) for every process that can significantly widen the business profit gap. This business mindset training is required for everyone on the first day.

  The organisation has to comprehend the concept of Lean Thinking. The Lean Thinking (Womack and Jones, 2003) management philosophy emphasises "Respect for People" and "Continuous Improvement" (Womack *et al.*, 2007). Balzer (2010; 2020) has declared the Lean Higher Education principle as "*Define Value*, *Identify Value Stream*, *Make Value Flow*, *Pull system* and *Pursue perfection*". He has consolidated the eight wastes (DOWNTIME) classified into four Academic Wastes: "*People Wastes, Process Wastes*, *Information Wastes* and *Asset wastes"* for Lean Higher Education. Each type of Academic Wastes has two wastes. Lean Thinking training is required for everyone in the organisation.

- *What are our basic thinking and mindset?*

Step 2: Academic People Wastes (W4 and W3)

People Wastes are the wastes that happen when HEIs fail to make the most of the knowledge skills and abilities of the employers. *Non-talented people* (W4) and *Waiting* (W3) are the two out of eight forms of waste that belong to People Wastes. Assign the right employee to do the right job with inspiration, motivation and training, and reduce the idle waiting time of people, machines, services, resulting in short lead times in the organisation.

Step 3: Academic Process Wastes (W7 and W5)

Process Wastes result from defects in the design or execution of HEIs processes. These wastes include two of the eight types of waste: *Motion* (W7) and *Transportation* (W5). Create a well-designed process with less time for excess motions to handle the process. On the other hand, reduce the transportation of people, materials, and products, thus eliminating waste time and lowering organisational costs.

Step 4: Academic Information Wastes (W8 and W2)

Information Wastes are extra, over, or insufficient information available to support HEIs processes. *Extra-processing* (W8) and *over-production* (W2) are the two out of eight forms of waste that belong to Information Wastes. Organisations produce more information than is required or take a long time to process a piece of information, resulting in a poor flow of information. It is good to provide just adequate, easy access and standard and updated information in the organisation.

Step 5: Academic Assets Wastes (W1 and W6)

Asset wastes are when the HEIs do not use the resources most effectively. These wastes include two of the eight types of waste: *Defects* (W1) and *Inventory* (W6). Avoid frequent errors in paperwork, material, quality problems, resulting in scrap or rework and poor delivery performance. Fully utilise the excess inventory such as lecture theatre, tutorial room, laboratory, leading to a low holding cost and good customer service.

Getting the "U" or methodology right (Step 6 to 12)

Once the **foundation** is well developed, organisations should establish a smooth and stable workflow process (**methodology**) by adding customer ("student") value optimising resources based on actual customers demand.

- *How are we improving the workflow?*

  <u>Step 6: Respect for People (F1)</u>

  According to Emiliani (2015), the foundation and concepts of Lean Thinking is "Respect for People" and "Continuous Improvement", which is essential for the education approach. The author explained that "Respect for People" involves recognising and appreciating the value of each individual and what they provide to the team. Next, create and maintain an environment where it is safe to communicate worries and problems, knowing that others will listen. Third, create a problem-solving mindset, open to other people's ideas, and challenge others to improve.

  <u>Step 7: Define Value (P1)</u>

  The first principle of Lean Thinking involves defining what "value" means to the end "customer." Balzer (2010; 2020) suggested defining the value of the process from the beneficiary's perspective. However, in today's highly competitive higher education business, HEIs must go beyond academic quality to provide added value to their students to stand out. In terms of students, the potential values are from experiences during university and program selection; application, admissions processes and procedures; new student orientation; student life whilst studying; experience as alumni.

  <u>Step 8: Value Stream (P2)</u>

  Mapping out the process or value stream enables teams to see how value flows through an organization, whether by looking at the organization as a whole or individual operation. Balzer (2010; 2020) identified the process flow from both the beneficiary and the provider perspectives, looking at added value. While the mapping process is a simple way to view the current processes, it may be instrumental in identifying where adjustments may be required.

Step 9: Make Value Flow (P3)

According to Balzer (2010; 2020), it is essential to eliminate waste activities that add no value. Once organisations have mapped everything out and created value flow with a new process, they have a clear overview of the state of operations or chosen process. Organisations can then potentially have an idea of improving the current process and moving towards improvement.

Step 10: Pull System (P4)

The fourth principle is establishing or responding to a "pull" system. This principle defines the introduction of new processes and the subsequent evaluation of their performance using precise metrics. According to Balzer (2010; 2020), the process can be made to flow smoothly with activities “pulled” as needed by the beneficiary, not “pushed” by the provider. In other words, “deliver the right thing, of the right quantity and quality, at the right time, and in the right place”.

Step 11: Pursue Perfection (P5)

Kaizen defines it as “continuous self-development.” Everyone needs to develop a mindset of self-criticism, reflect on what is achieved so far and always look for the next highest peak to conquer. PDCA is the cycle of Kaizen activities, and establishing Kaizen culture is a continuous process. Balzer (2010; 2020) encourages perfection through continuous improvement and radical transformation.

Step 12: Continuous Improvement (F2)

“Continuous Improvement” is the second fundament for Lean Thinking, and "Kairyo” is the literal translation of continuous improvement. There is always room for improvement, no matter how perfect things may seem in Lean Thinking. There is always the chance to find new and more efficient ways of doing things. Ultimately, the goal is not perfection but a relatively continuous improvement. Emiliani (2015) quoted: “Respect for People enables Continuous Improvement, and Continuous Improvement does not enable Respect for People.”

This philosophy remains the guiding principle to support educational professionals in carrying out their work more effectively and efficiently, all in the interest of student development and satisfaction. Organisations must design and improve the systems that enable their people to do good work, and continuous improvement becomes an organisational capability rather than an individual commitment or effort. Therefore, developing Lean Thinking Kaizen Academic Process Canvas enables the whole organisation to maintain high standards and continually improve. The goal is to prepare the organisation to work effectively in teams and be equipped with the right skills. The organisation can learn and improve with colleagues from different disciplines and leverage their respective strengths.

The benefits of the canvas are: focused on activities that bring value; improving efficiency and effectiveness; establishing a more innovative process pull system and better use of resources. The twelve components of Lean Thinking Kaizen Academic Process Canvas form a complete "big picture" of "T" shape or **foundation** and "U" shape or **methodology** components from problem to solution. In summary, Lean Thinking creates value for the customer ("student") by optimising resources, and the principles create a stable workflow based on actual customer's demand. Continuous improvement ensures that every employee is involved in the process of improving. The above self-explanation canvas improved educational processes for SPHEIs to transform, adopt a highly effective strategy planning, offer high value-added through innovation and stay competitive.

6.7 Research Limitations

The limitation of this online survey is that data was collected through questionnaires. The questionnaires are more suitable for those holding positions as program coordinators and not very practical for those not dealing with course planning. Moreover, the disadvantage of a cross-sectional study is that it cannot analyse behaviour throughout time. The timing of the survey is not guaranteed to be representative. The challenges of building a sample pool depend on the variables of the population being investigated. No further information has been obtained from the survey because of the time constraints to collect all necessary data during the COVID-19 lockdown in Singapore since April 2020. The study is limited to two SPHEIs from the twenty-eleven institutes, deemed insufficient for generalisation.

In future research, the study will need to be expanded significantly to include more SPEHIs for administrative and academic processes to provide a comprehensive picture of Lean Thinking practice in SPHEIs. Last but not least, the researcher has limited financial and resources support due to self-funded research. Although this study has some limitations, these have not negatively affected the study results.

6.8 Future Work

Future research is required to overcome the study's limitations and generalise the results. It will extend the scope to include more SPHEIs to comprehend Lean Thinking characteristics across themes such as administration and operation process; curriculum design and delivery process; teaching and learning process; leadership and sustainability; quality and performance. Moreover, similar research can be carried out in private HEIs or public universities in other countries by extending more variables in the CP&DP. Practitioners or researchers working as Lean consultants can use Lean Thinking Kaizen Academic Process Canvas as a stepping-stone in Lean Management in Higher Education Industries in other countries and Singapore. It provides a more profound scope of Lean Thinking in Higher Education knowledge applied in this study.

6.9 Closing Remarks

During the past five years, conducting the research has allowed the researcher to understand how SPHEIs has indirectly implemented Lean Thinking practices in CP&DP. This research has made a significant contribution to Lean Thinking in Higher Education by identifying 12 steps with 15 components Lean Thinking Kaizen Academic Process Canvas in education. This study has addressed the better implementation of Lean Thinking in Higher Education, such as “do the things right” and “do the right things” can significantly widen the business profit gap. The study observed that SPHEIs know to reduce 33% internal wastage from three activities and add 67% value if the activities are done right the first time and all the time. Implementing Lean Thinking requires changes in mindsets, processes and culture, and management must be dedicated to the transformation and willing to train all employees to fit the Lean Thinking culture. The future of Lean Thinking in Higher Education is bright, but the journey to adoption in the education industry remains a long way.

6.10 Summary

Firstly, the use of bibliometric analysis was appropriate for the scope of this study, and the literature identified several key trends of published documents. Two articles on Six Sigma and Lean management connect to Singapore. Thus, there appears to be a gap in the recent literature concerning Lean Thinking practice in SPHEIs (Chapter 2). Next, the researcher found that most completed studies are based in universities in the United States, the United Kingdom, and India to benefit Lean Higher Education significantly. The literature review revealed five different themes of critical Lean Thinking in Higher Education. The researcher has developed and discussed the theoretical framework of literature review, knowledge gap analysis, and conceptual framework of the research study (Chapter 3).

Thirdly, the researcher provided a detailed discussion of the need for research, from selecting the research philosophy paradigm and strategy to the method chosen for data collection and analysis (Chapter 4). Fourthly, the researcher presented the quantitative results of the questionnaire survey, which indicated positive acceptance among the respondents regarding the evidence-based practices of the various attributes, a highly positive significant test results within and between groups. Also, qualitative data on how SPHEIs used the Lean Thinking practice in the CP&DP were analysed and addressed to understand the quantitative findings better as evidence-based strategies (Chapter 5). Hence, it rejected three null hypotheses and answered the research questions (RQs), achieving the research objectives (ROs) and research aim (Chapter 1).

Finally, the researcher discussed the realisation of research aim and objectives, quality of research, the contribution to theory, knowledge, and professional practice. Theoretical implications impact the researcher's value in the study, and it could come from the additional variables the researcher added to the original view. The researcher contributed to the knowledge that 33% of internal wastage comes from three activities or processes. However, if the activities are done right the first time and all the time, they add a 67% value to increase the revenue stream. The professional practice has 12 steps with 15 components of Lean Thinking Kaizen Academic Process Canvas form a complete "big picture" of "T" shape or foundation and "U" shape or methodology components from problem to solution. The self-explanation canvas helps SPHEIs restructure, adopts highly effective strategic planning, gives high value-added through innovation, and stays competitive by improving educational processes. Last but not least, the limitation of this study and future work that help other researchers in this field were also presented (Chapter 6).

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A mixed-methods investigation of evidence-based Lean Thinking practice to Kaizen academic processes for Private Higher Education Institutes in Singapore

Appendices

Appendix 1 - Committee Private Education Support Documents

10/4/2019

Employment Indicators For Private Education Institution (PEI) Graduates Remain Constant

1 in 2 PEI graduates in full-time permanent employment 6 months after graduation

The Committee for Private Education has released the results of the Private Education Institution (PEI) Graduate Employment Survey (GES) 2017/18. Employment outcomes[1] of the 2017/18 cohort are similar to those of the 2016/17 cohort.

Key Findings of PEI GES 2017/18

About 10,200 individuals completed full-time bachelor's level external degree programmes (EDPs) at PEIs between May 2017 and April 2018, and 39.5% responded to the PEI GES survey. In comparison, about 10,200 individuals completed full-time bachelor's level EDPs and 37% responded to the survey last year.

Of this group, this press release focuses on the employment outcomes of about 2,800 respondents who are economically active[2] fresh graduates and excludes working adults undergoing part-time degree programmes, and fresh graduates who are not economically active. A total of 40 PEIs were surveyed, of which 27 had graduated from full-time bachelor's level EDPs.

Similar to the Polytechnic and Joint Autonomous Universities' Graduate Employment Surveys, the PEI GES 2017/18 now provides information on a wider range of employment indicators, including part-time/temporary employment and unemployment rates, to give a fuller picture of the employment status of PEI graduates.

PEI fresh graduates from the 2017/18 cohort had marginally higher employment rates and the same median gross monthly salary as compared to the 2016/2017 cohort. The overall employment rate and the full-time employment rate for PEI fresh graduates were 80.7% and 48.2% respectively. In comparison, the corresponding figures for Autonomous University (AU) fresh graduates were 90.2% and 81.2%.

The proportion who were unemployed and still looking for a job, or who were in involuntary part-time/temporary employment, was 27.2% for PEI fresh graduates - higher than the 9.3% for AU fresh graduates and 8.9% for post-National Service polytechnic graduates. The survey also showed that the median gross monthly salary of PEI fresh graduates was $2,650, compared to $3,500 for AU fresh graduates and $2,501 for post-National Service polytechnic graduates.

Detailed results of the survey can be found in Annexes B, C & D, and on the SSG website at www.ssg.gov.sg/cpe/ges.html

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[1] *Definition of the employment indicators is in Annex A.*

[2] *Economically active graduates are those who are working, or not working but actively looking and available for a job.*

Annex A

Definition of Employment Indicators

Overall Employment Rate refers to the number of graduates working on a full-time permanent, part-time, temporary or freelance basis, as a proportion of graduates in the labour force (i.e. those who were working or not working but actively looking and available for work).

Full-time Permanent Employment refers to employment of at least 35 hours a week and where the employment is not temporary. It includes those on contracts of one year or more.

Part-time Employment refers to employment of less than 35 hours a week.

Temporary Employment refers to casual, interim or seasonal employment, including those on contracts of less than one year.

Freelancers refer to those who operate their own business without employing any paid worker in the conduct of their business or trade.

Gross Monthly Salary comprises basic salary, fixed allowances, over-time pay, commissions and other regular cash payments, before deduction of the employee's CPF contributions and personal income tax. Employer's CPF contributions, bonuses, stock options, other lump sum payments and payments-in-kind are excluded.

Involuntary part-time/temporary employment refers to those who indicated that they were in part-time/temporary employment as they tried but were unable to obtain a full-time permanent job offer so far.

Voluntary part-time/temporary employment refers to those who indicated that they were in part-time/temporary employment as they were pursuing/ preparing to commence further studies, taking active steps to start a business venture, due to personal choice and other reasons.

Unemployed but starting work soon refers to those who indicated that they were not working as they had accepted job offer and will start later, or were taking steps to start business venture.

Unemployed and still looking for a job refers to those who indicated that they were not working but actively looking and available for work.

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Annex B

Employment outcomes across PEI graduates from the 2016/17 and 2017/18 cohorts and AU graduates from the 2018 cohort

Employment Indicators	PEIs (Full-time EDPs)		AUs[1] (NUS, NTU, SMU, SUSS)
	2016/17	2017/18	2018
Overall Employment Rate	79.0%	80.7%	90.2%
Full-Time Permanent Employment Rate	47.4%	48.2%	81.2%
Proportion who are Freelancing	3.7%	5.7%	1.8%
Part-time/Temporary Employment Rate*	27.9%	26.8%	7.2%
Voluntary	*Not available**	16.1%	4.9%
Involuntary		10.7%	2.3%
Unemployment Rate	21.0%	19.3%	9.8%
Unemployed but starting work soon	2.9%	2.8%	2.9%
Unemployed and still looking for a job	18.0%	16.5%	7.0%
Median Gross Monthly Salary (Full-Time Permanent Employment)	$2,650	$2,650	$3,500

** Voluntary and involuntary part-time/temporary employment rates were tracked from the 2017/18 run onwards.*

[1] This referenced the 2018 Joint AU Graduate Employment Survey (JAUGES) results that were published on 26 Feb 2019.

1

Annex C

Employment Outcomes of Fresh Full-Time EDPs by Institution (for institutions with 10 or more respondents)

		2017/18 GES Employment Rate and Salaries of Fresh PEI Graduates from Full-Time EDPs			Response Rate[1]	No. of Economically Active Fresh Graduate Respondents[2]
		Overall Employment Rate	Full-Time Permanent Employment Rate	Median Gross Monthly Salary		
1	CURTIN EDUCATION CENTRE	78.0%	60.0%	$3,000	34%	50
2	NGEE ANN ACADEMY	85.4%	53.7%	$2,500	66%	41
3	SINGAPORE INSTITUTE OF MANAGEMENT	84.7%	50.0%	$2,700	45%	1,799
4	KAPLAN HIGHER EDUCATION ACADEMY	78.3%	47.3%	$2,500	44%	452
5	PARKWAY COLLEGE OF NURSING AND ALLIED HEALTH	90.9%	45.5%	$3,200	81%	11
6	PSB ACADEMY	65.1%	44.5%	$2,600	39%	146
7	ERC INSTITUTE	65.9%	40.9%	$2,840	27%	44
8	JAMES COOK UNIVERSITY	75.3%	40.7%	$2,600	27%	81
9	MANAGEMENT DEVELOPMENT INSTITUTE OF SINGAPORE	64.7%	35.3%	$2,300	23%	68
10	RAFFLES COLLEGE OF HIGHER EDUCATION	42.1%	26.3%	$2,300	14%	19
11	AIR TRANSPORT TRAINING COLLEGE	65.2%	17.4%	$2,825	73%	23

[1] Response rate refers to the percentage of graduates from full-time degree programmes in PEIs who responded to the survey.
[2] Results of PEIs based on a small sample size of fewer than 30 full-time fresh PEI degree graduates may not be representative of the institution's graduate employment outcomes. Users should exercise caution in interpreting the data.

1

Annex D

List of Private Education Institutions with Graduates from Full-Time EDPs that Participated in PEI GES 2017/18

1	AIR TRANSPORT TRAINING COLLEGE
2	AMITY GLOBAL INSTITUTE
3	AUSTON INSTITUTE OF MANAGEMENT
4	CURTIN EDUCATION CENTRE
5	DIMENSIONS INTERNATIONAL COLLEGE
6	EAST ASIA INSTITUTE OF MANAGEMENT
7	ERC INSTITUTE
8	FIRST MEDIA DESIGN SCHOOL
9	FTMSGLOBAL ACADEMY[#]
10	INFORMATICS ACADEMY
11	ITC SCHOOL OF LAWS
12	JAMES COOK UNIVERSITY
13	KAPLAN HIGHER EDUCATION ACADEMY
14	MANAGEMENT DEVELOPMENT INSTITUTE OF SINGAPORE
15	NANYANG INSTITUTE OF MANAGEMENT
16	NGEE ANN ACADEMY
17	PARKWAY COLLEGE OF NURSING AND ALLIED HEALTH
18	PSB ACADEMY
19	RAFFLES COLLEGE OF HIGHER EDUCATION
20	S P JAIN SCHOOL OF GLOBAL MANAGEMENT
21	SAA GLOBAL EDUCATION CENTRE
22	SDH INSTITUTE

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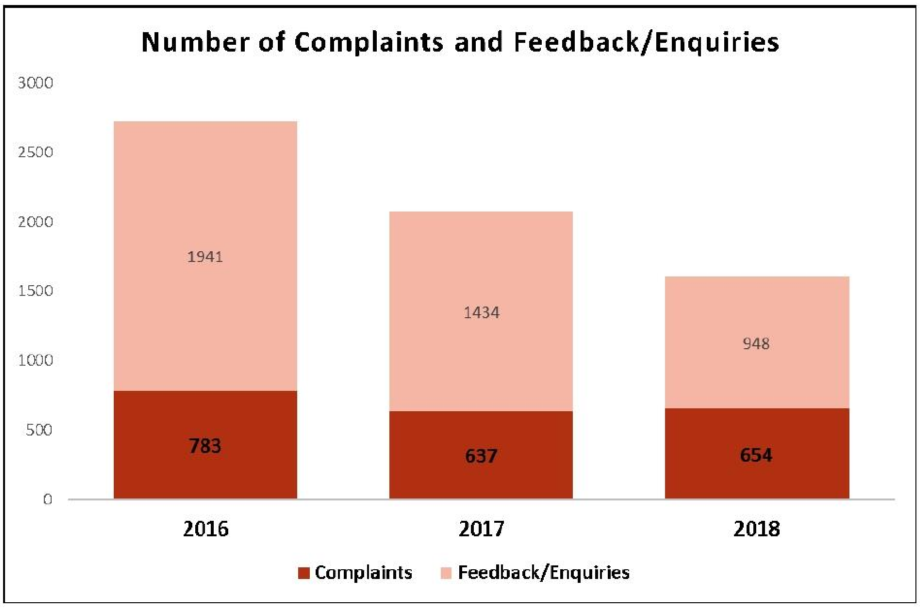
23	SINGAPORE COLLEGE OF TRADITIONAL CHINESE MEDICINE
24	SINGAPORE INSTITUTE OF MANAGEMENT
25	SINGAPORE RAFFLES MUSIC COLLEGE
26	TEG INTERNATIONAL COLLEGE#
27	TMC ACADEMY

The degree programmes offered in these PEIs will cease after existing students have graduated from the programme.

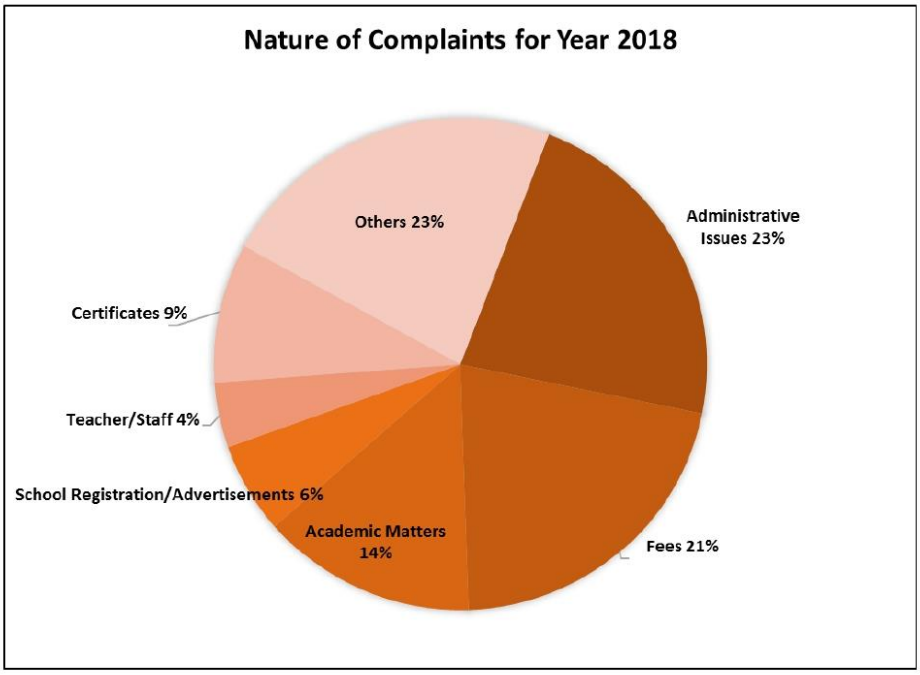
2

Complaint Statistics Related to Private Schools

The absolute number of complaints has remained steady, although there has been a significant decrease (41%) in the total volume of feedback or queries received over the last 3 years. In 2018, 4 in 10 cases received by CPE were complaints against private schools.

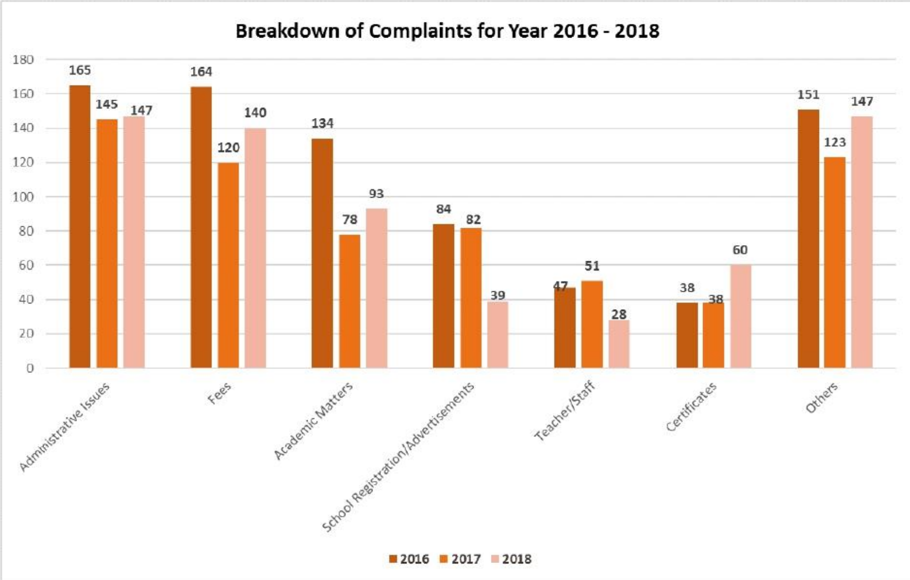


Administrative Issues (23%) and **Fees** (21%) were the top grievances for the year 2018.



Breakdown of complaints by categories

The bar chart below shows the breakdown of complaints CPE received from 2016 to 2018. **Administrative Issues** remains to be the top feedback category for private school students over three consecutive years. Between 2017 and 2018, the number of complaints increased for all feedback categories except **School Registrations/Advertisements** and **Teacher/Staff**. Notably, complaints about certificates increased by almost 60%.



Examples of complaints by categories

Administrative Issues: Relocation of school premises, school facilities, time-tabling, request to view examination papers, admission and withdrawal processes, deferment and disciplinary policies, issues related to the management of examinations e.g. sitting arrangement, venue, time

Fees: Fees increase, the refund due to course withdrawal, disputes on a payment schedule or outstanding fees

Academic Matters: Disputes on progression pathway, disputes on different exemptions given to students based on their qualifications, disputes on marks received for examinations and assignments, problems with industry attachment provided by the school

Teacher/Staff: Alleged favouritism and bias towards other students, teaching quality of teachers, service standards of school administrative staff

Certificates: Recognition of certificates/courses, delay in receiving certificates/transcripts.

School Registrations/Advertisements: Misleading advertisements by schools, complaints on unregistered institutions

Others: Issues with course fee insurance coverage, problems related to student visas, issues related to the closure of schools such as disruption of studies, difficulties in contacting the private school

Mediation and Settlement Rate

The CPE Mediation Arbitration Scheme aims to help students resolve disputes with their private school. In 2018, only about 1% of the total number of complaints were deemed suitable for resolution under the CPE mediation arbitration Scheme and successfully mediated.

Students are advised to find out more about the available options and limitations in resolving disputes with private schools before signing up for a course.

Should you have an issue with your school, highlight it to your school's management as the first step, especially for issues that do not contravene the Private Education (PE) Act and/or its Regulations (e.g. matters on school administration and service quality).

Contact us if you find that the school is still unable to address your concerns. We will investigate issues that may have contravened the Private Education (PE) Act and/or its Regulations and take action where appropriate.

Appendix 2 - List of Bibliometric Analysis of Documents

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Appendix 3 - Survey Invitation Email

Survey Invitation Email

Dear Sir/Madam

I am currently doing my doctoral studies at The University of Northampton, Faculty of Business & Law. I am conducting a mixed triangulation (staffs, lecturers and students) method study about Lean Thinking practices to Kaizen academic processes in private Higher Education institutes.

I wish to include your Private Higher Education Institute as the participant because I am interested in your experience in how Lean Thinking (Add Values and Reduce Wastes) practice can Kaizen academic processes would add significance to my research.

I am carrying out this study using Online Survey and the links are provided for you to open the survey form. You need to spend 10-15 minutes of your time to complete the survey and submit it online using your appropriate devices (e.g. laptop, desktop, mobile, tablet).

Your participation in this research is voluntary and your responses will be kept confidential. Once you log in to the link, you will read the research information and sign the consent form. Should you have any queries on the research study, please feel free to contact me.

Please copy the right links and mass email to your respective colleagues. Thanks.

For Administrators (for Higher Education)
https://northampton.onlinesurveys.ac.uk/... _admin
Password: XXXX

For Full-Time and Part-Time Lecturers
https://northampton.onlinesurveys.ac.uk/..._lecturer
Password: XXXX

For Full-Time and Part-Time Students (Undergrads and Postgrads)
https://northampton.onlinesurveys.ac.uk/..._student
Password: XXXX

I would be very grateful for your participation in this survey and for submitting it at the earliest. Please be assured that the information you give will be kept strictly confidential and used for academic research purpose only. Thank you for your participation!

Thank you
Yours Sincerely
Lim Chin Guan (DBA Candidate)
The University of Northampton
Faculty of Business & Law
Email: chin.lim@northampton.ac.uk
Mobile: XXX 2586

Appendix 4 - Participant Information Sheet

Participant Information Sheet

Study title
A mixed-methods investigation of evidence-based Lean Thinking practice to Kaizen academic processes for Private Higher Education Institutes within Singapore

About the Survey
Learning from Lean Thinking is a novel undertaking in the academic industry. Establishing a framework of the Lean Thinking model for Private Higher Education Institutes (PHEIs) is important as this management philosophy has the potential to Kaizen academic processes.

This survey aims to investigate the extent/importance which PHEIs have attributed to delivery values and eliminate wastes in the Course Planning and Delivery Process. These summarise into the

- Course Resources
- Course Contents
- Course Pedagogy
- Course Assessment
- Course Evaluation
- Course Refinement

Please be assured that the information you give will be kept strictly confidential and used for academic research purpose only. Thank you for your participation!

What is the purpose of the study?
This study aims to investigate evidence-based Lean Thinking practices can Kaizen academic processes and thus lead to the growth of the education industry. This survey is a case study and will add to the researcher understanding of how Lean Thinking practice can help the education industry in Singapore to improve.

Why have I been chosen?
You have been asked to take part in the study because the researcher is interested in your views on how evidence-based Lean Thinking practice can Kaizen academic processes. Your Higher Education institute has selected to take part in this case study. You are asked to complete the online survey questionnaire.

Do I have to take part?
Taking part is entirely voluntary. If you decide to take part, you will be asked to sign a consent form to confirm that you understand the study and are happy to participate. If you change your mind, you are free to withdraw from the study.

What will my participation involve?
It will take about 30 to 40 minutes to complete the online survey questionnaires. The questions will all refer to evidence-based Lean Thinking practice to Kaizen academic processes.

What are the possible benefits of taking part?
The information obtained from this study will be used for the researcher to comprehend how the evidence-based Lean Thinking practice can Kaizen academic processes. This research contributes to new knowledge which Lean Thinking practice will impact private Higher Education institutes' growth within Singapore in future.

What are the possible risks or disadvantages of taking part?
The disadvantage is using your time from your busy schedule to take part in this study. The advantage is you incur no cost involved in this study. There is no physical or emotional risk expected from participating in this research study and your answers to the questionnaire will remain anonymous.

Will my information be kept confidential?
All the information collected for this study will be anonymised and stored securely on a password-protected computer. Any information that you provide will be kept confidential and the researcher will keep this data safely locked up on university property. The university requires that it be kept for ten years to make sure the research is based on genuine evidence.

What will happen to the results of the study?
The results from this study will be used in the following ways: researcher's academic thesis; researcher's journal articles; researcher's conference and seminar; contribute to policy deployment for the Committee for Private Education (CPE) to use as a benchmark.

Who has reviewed the study?
This study has been reviewed and approved by the Faculty of Business & Law Research, Research Ethics Committee.

Contact for further information
If you have any questions about this study or your possible involvement then please contact me using the contact details below.

- Lim Chin Guan (Researcher), chin.lim@northampton.ac.uk
- Dr Amin Hosseinian-Far, amin.hosseinian-far@northampton.ac.uk
- Dr Dilshad Sarwar, dilshad.sarwar@northampton.ac.uk
- Dr Easwaramoorthy Rangaswamy, erangaswamy@singapore.amity.edu

Thank you for considering taking part in this study.

Appendix 5 - Participant Consent Form

Participant Consent Form

Please read each statement below and then confirm that you agree or disagree by placing your initials in the appropriate box.

	Tick
• I have read and understood the information provided to me in the information sheet.	☐
• I have had an opportunity to ask questions about this research.	☐
• I agree to take part means that I am willing to complete the online survey questionnaire at my private Higher Education Institute (HEI).	☐
• I understand that I can decline to answer any questions.	☐
• I understand that I can withdraw my answers in part or full, anytime up to any stage of the project without being penalised or disadvantage in any way.	☐
• I agree to anonymised quotations being used in any academic presentations or publications of this work.	☐
• I agree to my data being used in any subsequent work that builds on this current research and I understand that such information treats as confidential and handled by the Data Protection Act 1998.	☐

Type your initials or signature of giving consent

The date of giving contents

Date needs to be format “DD/MM/YYYY”, for example, 01/06/2020

Signature of the researcher obtaining consent,

Lim Chin Guan

Appendix 6 - Survey Questionnaires – Administrators

Survey Questionnaire (Administrators)

A mixed-methods investigation of evidence-based Lean Thinking practice to Kaizen academic processes for Private Higher Education Institutes in Singapore

About the Survey

Learning from Lean Thinking is a novel undertaking in the academic industry. Establishing a framework of the Lean Thinking model for Private Higher Education Institutes (PHEIs) is important as this management philosophy has the potential to Kaizen academic processes. This survey aims to investigate the extent/importance which PHEIs have attributed to deliver value and eliminate wastes in the Course Planning and Delivery Process. These summarise the course resources, course contents, course pedagogy, course assessment, course evaluation and course refinement. Please be assured that the information you give will be kept strictly confidential and used for academic research purpose only. Thank you for your participation!

Part 1: Introduction to Lean Thinking

Lean Thinking or philosophy means guaranteeing value creation while working on waste reduction.

The five lean principles are:

1. **Specify values** from the customer's (student) point of view, seeking to add more value by reducing waste.
2. **Value stream** mapping of materials and information, eliminating whenever possible those steps that do not create value.
3. Creating a continuous **flow**, standardised work by defining sequence, smoothly toward the customer (student).
4. Conceiving a broad direct communications system for pulling services, letting the customer (student) **pull** value from the next upstream activity.
5. As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, and repeating the process and until a state of **perfection** is reached in which perfect value is created with no waste.

The four types of waste for Higher Education:

1. **People waste** refers to the failure to capitalise on the knowledge skills and abilities of employers.
2. **Process waste** refers to shortcomings in academic processes.
3. **Information waste** refers to information that is being deficient in supporting academic processes.
4. **Asset waste** refers to not using resources most effectively.

Part 2: Demographics Information

Gender	: ☐ Male ☐ Female
Age	: ☐ 25 – 29 ☐ 30 – 39 ☐ 40 – 49 ☐ 50 – 59 ☐ 60 – 69
Position held	: ☐ Professional ☐ Manager ☐ Executive ☐ Technician
Working Faculty	: ☐ Engineering ☐ Business ☐ Life Science ☐ Postgraduate
Job role	: ☐ Administrative Staff ☐ Academic Staff
Supporting Level	: ☐ Diploma ☐ Degree ☐ Master ☐ Doctorate ☐ Other
Current year of working experience	: ☐ <5 ☐ 5 – 10 ☐ 11 – 20 ☐ 21 – 30 ☐ >31
Participant's Name (option)	:

Part 3: Lean Thinking Evidence Practices

3.1 Course Resources

Please rate the level of evidence practice in the course resources.

S/No	Course Resources [C1] **Question 1:** **How do you plan the course resources used?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C1.1	**Cohorts** The team optimises roll-in the new/previous cohort with an existing/current cohort that studies the same module.	☐	☐	☐	☐	☐
C1.2	**Lecturers** The team assigns the right lecturer to teach the module base on lecturer subject discipline and availability.	☐	☐	☐	☐	☐
C1.3	**Facilities** The team books the right facilities (e.g. classroom, laboratory) for the right activities (e.g. lecture, tutorial, practical) subjected to student class size.	☐	☐	☐	☐	☐
C1.4	**Timetable** The team optimises the timetable planning to make sure there is no crash with other teaching modules and exam days.	☐	☐	☐	☐	☐
C1.5	**Overall** The team works closely with the lecturers/students to support the teaching/service and provide necessary teaching/service assistance.	☐	☐	☐	☐	☐

3.2 Course Contents

Please rate the level of evidence practice in the course contents.

S/No	Course Contents [C2] **Question 2:** **How do you plan the course contents of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C2.1	**Syllabus** The syllabus of the module is clearly defined and approved by the faculty of the school.	☐	☐	☐	☐	☐
C2.2	**Objectives** The learning objectives of the module are clearly stated and approved by the faculty of the school.	☐	☐	☐	☐	☐
C2.3	**Materials** The learning material resources (E-textbook, slide, note) of the module is consistently uploaded to the online system.	☐	☐	☐	☐	☐
C2.4	**Outcomes** The learning outcome of the module stated clearly by completing the course work and passed the exam paper.	☐	☐	☐	☐	☐
C2.5	**Overall** The course contents have been distributed uniformly throughout the semester.	☐	☐	☐	☐	☐

3.3 Course Pedagogy

Please rate the level of evidence practice in the course pedagogy.

S/No	Course Pedagogy [C3] **Question 3:** **How do you plan the course pedagogy of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C3.1	**Lectures** The contact hours of lectures are clearly stated in the course outline and distributed uniformly throughout the semester.	☐	☐	☐	☐	☐
C3.2	**Tutorials** The contact hours of tutorials are clearly stated in the course outline and distributed uniformly throughout the semester.	☐	☐	☐	☐	☐
C3.3	**Practical** The contact hours of practice are clearly stated in the course outline and distributed uniformly throughout the semester.	☐	☐	☐	☐	☐
C3.4	**Consultation** Encourage lecturers to offer consultation for the student during and after the lesson.	☐	☐	☐	☐	☐
C3.5	**Overall** The course pedagogy has been well-defined throughout the semester and delivered the lesson effectively.	☐	☐	☐	☐	☐

3.4 Course Assessment

Please rate the level of evidence practice in the course assessment.

S/No	Course Assessment [C4] **Question 4: How do you plan the course assessment of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C4.1	**Attendance** E-attendance, compare to manual attendance, is effectively implemented.	☐	☐	☐	☐	☐
C4.2	**Tests/Quizzes** The number of tests/quizzes and the percentage breakdown for each class test stated clearly.	☐	☐	☐	☐	☐
C4.3	**Coursework** The number of coursework and percentage breakdown for each coursework stated clearly.	☐	☐	☐	☐	☐
C4.4	**Examination** The exam paper setting format and its percentage stated clearly.	☐	☐	☐	☐	☐
C4.5	**Overall** All the set papers (e.g. class test, coursework, exam) submit to the exam centre for moderation and proofreading before the course starts.	☐	☐	☐	☐	☐

3.5 Course Evaluation

Please rate the level of evidence practice in the course evaluation.

S/No	Course Evaluation [C5] **Question 5:** **How do you analyse the course evaluation of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C5.1	**<u>Reaction</u>** Evaluate how students react to the study module by asking questions that establish the students' thoughts.	□	□	□	□	□
C5.2	**<u>Learning</u>** Evaluate how students have developed in ability, knowledge, or mindset from informal to formal tests and assessments.	□	□	□	□	□
C5.3	**<u>Behaviour</u>** Analyses the differences and assess the possible change in the student's behaviour after completing the module.	□	□	□	□	□
C5.4	**<u>Results</u>** Survey the results of the study programme that links to better graduate employment for the student.	□	□	□	□	□
C5.5	**<u>Overall</u>** The aim of the evaluation should include course resources, course contents, course pedagogy and course assessment.	□	□	□	□	□

3.6 Course Refinement

Please rate the level of evidence practice in the course refinement.

S/No	Course Refinement [C6] **Question 6: How do you enhance the course refinement of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C6.1	**Engagement** Analysis of student engagement relates to skills, emotions, participation and performance.	☐	☐	☐	☐	☐
C6.2	**Experience** Analysis of student experience relates to the campus environment, learning, studying, and peer harmony.	☐	☐	☐	☐	☐
C6.3	**Satisfaction** Analysis of student satisfaction relates to course evaluation for each module.	☐	☐	☐	☐	☐
C6.4	**Achievement** Analysis student achievement relates to knowledge, self-motivation, behaviour, mindset and potential career path in the specific industry.	☐	☐	☐	☐	☐
C6.5	**Overall** The team continue to pursue perfection for every course refinement in the Higher Education programme.	☐	☐	☐	☐	☐

Part 4: Lean Tools Competency

Please rate the level of Lean Tools competency in the Course Planning and Delivery Process.

S/No	Lean Tools Competency [C7] **Question 7: What are the Lean Tools used in the Course Planning and Delivery Process?**	Lean Tools competency				
		Very Unlikely	Not Likely	Neutral	Likely	Very Likely
		1	2	3	4	5
C7.1	**Policy Deployment (Hoshin Kanri)** Do you align the goals of your institute (strategy), with the plans of middle management (tactics) and work performed on the institute floor (action)?	☐	☐	☐	☐	☐
C7.2	**5S** Do you practice 5S (Sort, Set-In-Order, Shine, Standardise and Sustain) to organise your work area?	☐	☐	☐	☐	☐
C7.3	**Plan – Do – Check – Act (PDCA)** Do you implement PDCA iterative method for your work improvement?	☐	☐	☐	☐	☐
C7.4	**Error Proofing (Poka-Yoke)** Do you achieve zero defects/errors in your work delivery process?	☐	☐	☐	☐	☐
C7.5	**Waste (Muda)** Do you practice removing no value-added in academic processes?	☐	☐	☐	☐	☐
C7.6	**Overburden (Muri)** Do you avoid pushing a process or person beyond natural limits?	☐	☐	☐	☐	☐
C7.7	**Unevenness (Mura)** Do you check irregular academic schedules caused by an internal problem?	☐	☐	☐	☐	☐
C7.8	**Value Stream Mapping (VSM)** Do you visually map the current and future state of academic processes in a way that highlight opportunities for improvement?	☐	☐	☐	☐	☐

Part 5: Lean Thinking relates to the Course Planning and Delivery Process

Tick more than one area if necessary:

S/No	Lean Thinking [C8] **Question 8: What are the possibilities to use Lean Thinking in the Course Planning and Delivery Process?**	Course Resources	Course Contents	Course Pedagogy	Course Assessment	Course Evaluation	Course Refinement
C8.1	**<u>Identify value</u>** From the student point of view, seeking to add more value by reducing waste.	☐	☐	☐	☐	☐	☐
C8.2	**<u>Value stream</u>** Mapping the course materials and information, remove waste and create value.	☐	☐	☐	☐	☐	☐
C8.3	**<u>Create continuous flow</u>** Standardised work by defining sequence, smoothly toward the student.	☐	☐	☐	☐	☐	☐
C8.4	**<u>Establish the "pull" system</u>** Let downstream (student) pull value from the next upstream (school) activity.	☐	☐	☐	☐	☐	☐
C8.5	**<u>Strive for perfection</u>** Begin the process again and continue it until a state of perfection is reached.	☐	☐	☐	☐	☐	☐
C8.6	**<u>Eliminate people waste</u>** Refer to the failure to capitalise on the knowledge skills and abilities of employers.	☐	☐	☐	☐	☐	☐
C8.7	**<u>Eliminate process waste</u>** Refers to shortcomings in the academic processes.	☐	☐	☐	☐	☐	☐
C8.8	**<u>Eliminate information waste</u>** Refers to information is being deficient for supporting academic processes.	☐	☐	☐	☐	☐	☐
C8.9	**<u>Eliminate assets waste</u>** Refers to not using resources most effectively.	☐	☐	☐	☐	☐	☐

Part 6: Key Performance Indicators

Please rate the level of performance in the Course Planning and Delivery Process.

S/No	Key Performance Indicators [C9] **Question 9:** **What is your current institute performance level?**	Performance level Very Poor 1	Poor 2	Average 3	Good 4	Excellent 5
C9.1	Higher Education Performance	□	□	□	□	□
C9.2	Higher Education Productivity	□	□	□	□	□
C9.3	Higher Education Quality	□	□	□	□	□
C9.4	Delivery Values	□	□	□	□	□
C9.5	Remove Wastes	□	□	□	□	□
C9.6	Student Satisfaction	□	□	□	□	□
C9.7	Student Development	□	□	□	□	□

Part 7: Self-Administrated Open-Structure Questions

C10.1 What are the main current problems in the Course Planning and Delivery Process?

C10.2 Is there any other element that is important in the Course Planning and Delivery Process?

C10.3 How much do you know about Lean Thinking (add values and reduce wastes) in Higher Education?

C10.4 Do you believe Lean Thinking practices can improve the Course Planning and Delivery Process in your institute?

C10.5 Do you see Lean Thinking practices link the strategic planning and transformation in your institute?

Thank you for taking the time to complete this questionnaire.
If you have any questions about the survey, please feel free to contact Mr Lim Chin Guan, the University of Northampton, at (65) XXXX 2586 or email **chin.lim@northampton.ac.uk.**

Appendix 7 - Survey Questionnaires – Lecturers

Survey Questionnaire (Lecturers)

A mixed-methods investigation of evidence-based Lean Thinking practice to Kaizen academic processes for Private Higher Education Institutes in Singapore

About the Survey

Learning from Lean Thinking is a novel undertaking in the academic industry. Establishing a framework of the Lean Thinking model for Private Higher Education Institutes (PHEIs) is important as this management philosophy has the potential to Kaizen academic processes. This survey aims to investigate the extent/importance which PHEIs have attributed to deliver value and eliminate wastes in the Course Planning and Delivery Process. These summarise the course resources, course contents, course pedagogy, course assessment, course evaluation and course refinement. Please be assured that the information you give will be kept strictly confidential and used for academic research purpose only. Thank you for your participation!

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Lean Thinking or philosophy means guaranteeing value creation while working on waste reduction.

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1. **Specify values** from the customer's (student) point of view, seeking to add more value by reducing waste.
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The four types of waste for Higher Education:

1. **People waste** refers to the failure to capitalise on the knowledge skills and abilities of employers.
2. **Process waste** refers to shortcomings in academic processes.
3. **Information waste** refers to information that is being deficient in supporting academic processes.
4. **Asset waste** refers to not using resources most effectively.

Part 2: Demographics Information

Gender	: ☐ Male ☐ Female
Age	: ☐ 25 – 29 ☐ 30 – 39 ☐ 40 – 49 ☐ 50 – 59 ☐ 60 – 69
Position held	: ☐ Professional ☐ Manager ☐ Executive ☐ Technician
Teaching Faculty	: ☐ Engineering ☐ Business ☐ Life Science ☐ Postgraduate
Job role	: ☐ Administrative Staff ☐ Academic Staff
Teaching Level	: ☐ Diploma ☐ Degree ☐ Master ☐ Doctorate ☐ Other
Current year of working experience	: ☐ <5 ☐ 5 – 10 ☐ 11 – 20 ☐ 21 – 30 ☐ >31
Participant's Name (option)	:

Part 3: Lean Thinking Evidence Practices

3.1 Course Resources

Please rate the level of evidence practice in the course resources.

S/No	Course Resources [C1] **Question 1:** **How do you know the course resources used?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C1.1	**Cohorts** I know the total number of cohorts that I will teach for that module.	☐	☐	☐	☐	☐
C1.2	**Lecturers** I know the teaching module and make my availability to match the timetable planning.	☐	☐	☐	☐	☐
C1.3	**Facilities** I know the lesson's venue (e.g. lecture, tutorial, practical) through visual display on campus or web-based system via mobile.	☐	☐	☐	☐	☐
C1.4	**Timetable** I take part and discuss the timetable planning activities with the team to accommodate my availability.	☐	☐	☐	☐	☐
C1.5	**Overall** I receive the necessary support from the team for my teaching during the semester.	☐	☐	☐	☐	☐

3.2 Course Contents

Please rate the level of evidence practice in the course contents.

S/No	Course Contents [C2] **Question 2:** **How do you know the course contents of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C2.1	**Syllabus** I understand the syllabus of the module and presented it to the student on the first day of the lesson.	☐	☐	☐	☐	☐
C2.2	**Objectives** I understand the learning objectives of the module and the delivery of my teaching.	☐	☐	☐	☐	☐
C2.3	**Materials** I can reach the learning material resources (e.g. E-textbook, slide, note) and other supplement material of the module from the online and offline system.	☐	☐	☐	☐	☐
C2.4	**Outcomes** I set the coursework and exam paper to meet the learning outcome of the module.	☐	☐	☐	☐	☐
C2.5	**Overall** I deliver the course content, which distributed uniformly throughout the semester, based on the schedule planned.	☐	☐	☐	☐	☐

3.3 Course Pedagogy

Please rate the level of evidence practice in the course pedagogy.

S/No	Course Pedagogy [C3] **Question 3: How do you know the course pedagogy of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C3.1	**<u>Lectures</u>** I am aware of the contact hours of the lecture. Ability to make the classroom interactive and deliver an interesting lecture.	□	□	□	□	□
C3.2	**<u>Tutorials</u>** I am aware of the contact hours of the tutorial. Ability to solve the tutorial problems and explain the query clearly.	□	□	□	□	□
C3.3	**<u>Practical</u>** I am aware of the contact hours of practical. Ability to illustrate the experiment and guide the student.	□	□	□	□	□
C3.4	**<u>Consultation</u>** I glad to give consultation for the student during and after the lesson.	□	□	□	□	□
C3.5	**<u>Overall</u>** I follow the course pedagogy throughout the semester, encourage the student to take part, reinforcement learning.	□	□	□	□	□

3.4 Course Assessment

Please rate the level of evidence practice in the course assessment.

S/No	Course Assessment [C4] **Question 4:** **How do you know the course assessment of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C4.1	**Attendance** I don't need to check student attendance manually since it is captured by an E-attendance device.	☐	☐	☐	☐	☐
C4.2	**Tests/Quizzes** I understand how many tests/quizzes need to set and the percentage breakdown for each class test.	☐	☐	☐	☐	☐
C4.3	**Coursework** I understand how much coursework need to set and the percentage breakdown for each coursework.	☐	☐	☐	☐	☐
C4.4	**Examination** I understand how to set the exam paper format and its percentage contribution.	☐	☐	☐	☐	☐
C4.5	**Overall** I aware all set papers (e.g. class test, coursework, exam) must submit to an exam centre for moderation and proofreading before the course starts.	☐	☐	☐	☐	☐

3.5 Course Evaluation

Please rate the level of evidence practice in the course evaluation.

S/No	Course Evaluation [C5] **Question 5:** **How do you analyse the course evaluation of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C5.1	**Reaction** I check how the students react to the study module during the course.	☐	☐	☐	☐	☐
C5.2	**Learning** I analyse the students whether they truly understood the concept well in learning,	☐	☐	☐	☐	☐
C5.3	**Behaviour** I see students behaviour whether they use in the application on what they learned.	☐	☐	☐	☐	☐
C5.4	**Results** I appreciate the study programme has a positive impact on a student looking job in a specific industry.	☐	☐	☐	☐	☐
C5.5	**Overall** I glad to receive feedback from the current teaching course to improve my teaching and learning skills.	☐	☐	☐	☐	☐

3.6 Course Refinement

Please rate the level of evidence practice in the course refinement.

S/No	Course Refinement [C6] **Question 6:** **How do you enhance the course refinement of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C6.1	**Engagement** I see student engagement relate to skills, emotions, participation and performance.	☐	☐	☐	☐	☐
C6.2	**Experience** I see student experience relate to the campus environment, learning, studying, and peer harmony.	☐	☐	☐	☐	☐
C6.3	**Satisfaction** I see student satisfaction relate to the course evaluation for each module.	☐	☐	☐	☐	☐
C6.4	**Achievement** I see student achievement relate to the knowledge, self-motivation, behaviour, mindset and potential career path in the specific industry.	☐	☐	☐	☐	☐
C6.5	**Overall** I continue to pursue perfection for every course refinement in the Higher Education programme.	☐	☐	☐	☐	☐

Part 4: Lean Tools Competency

Please rate the level of Lean Tools competency in the Course Planning and Delivery Process.

S/No	Lean Tools Competency [C7] **Question 7:** **What are the Lean Tools used in the Course Planning and Delivery Process?**	Lean Tools competency Very Unlikely 1	 Not Likely 2	 Neutral 3	 Likely 4	 Very Likely 5
C7.1	**Policy Deployment (Hoshin Kanri)** Do you align the goals of your institute (strategy), with the plans of middle management (tactics) and work performed on the institute floor (action)?	☐	☐	☐	☐	☐
C7.2	**5S** Do you practice 5S (Sort, Set-In-Order, Shine, Standardise and Sustain) to organise your work area?	☐	☐	☐	☐	☐
C7.3	**Plan – Do – Check – Act (PDCA)** Do you implement PDCA iterative method for your work improvement?	☐	☐	☐	☐	☐
C7.4	**Error Proofing (Poka-Yoke)** Do you achieve zero defects/errors in your work delivery process?	☐	☐	☐	☐	☐
C7.5	**Waste (Muda)** Do you practice removing no value-added in academic processes?	☐	☐	☐	☐	☐
C7.6	**Overburden (Muri)** Do you avoid pushing a process or person beyond natural limits?	☐	☐	☐	☐	☐
C7.7	**Unevenness (Mura)** Do you check irregular academic schedules caused by an internal problem?	☐	☐	☐	☐	☐
C7.8	**Value Stream Mapping (VSM)** Do you visually map the current and future state of academic processes in a way that highlight opportunities for improvement?	☐	☐	☐	☐	☐

Part 5: Lean Thinking relates to the Course Planning and Delivery Process

Tick more than one area if necessary:

S/No	Lean Thinking [C8] **Question 8: What are the possibilities to use Lean Thinking in the Course Planning and Delivery Process?**	Course Resources	Course Contents	Course Pedagogy	Course Pedagogy	Course Evaluation	Course Refinement
C8.1	**Identify value** From the student point of view, seeking to add more value by reducing waste.	☐	☐	☐	☐	☐	☐
C8.2	**Value stream** Mapping the course materials and information, remove waste and create value.	☐	☐	☐	☐	☐	☐
C8.3	**Create continuous flow** Standardised work by defining sequence, smoothly toward the student.	☐	☐	☐	☐	☐	☐
C8.4	**Establish the "pull" system** Let downstream (student) pull value from the next upstream (school) activity.	☐	☐	☐	☐	☐	☐
C8.5	**Strive for perfection** Begin the process again and continue it until a state of perfection is reached.	☐	☐	☐	☐	☐	☐
C8.6	**Eliminate people waste** Refer to the failure to capitalise on the knowledge skills and abilities of employers.	☐	☐	☐	☐	☐	☐
C8.7	**Eliminate process waste** Refers to shortcomings in the academic processes.	☐	☐	☐	☐	☐	☐
C8.8	**Eliminate information waste** Refers to information is being deficient for supporting academic processes.	☐	☐	☐	☐	☐	☐
C8.9	**Eliminate assets waste** Refers to not using resources most effectively.	☐	☐	☐	☐	☐	☐

Part 6: Key Performance Indicators

Please rate the level of performance in the Course Planning and Delivery Process.

S/No	Key Performance Indicators [C9] **Question 9:** **What is your current institute performance level?**	Performance level				
		Very Poor	Poor	Average	Good	Excellent
		1	2	3	4	5
C9.1	Higher Education Performance	☐	☐	☐	☐	☐
C9.2	Higher Education Productivity	☐	☐	☐	☐	☐
C9.3	Higher Education Quality	☐	☐	☐	☐	☐
C9.4	Delivery Values	☐	☐	☐	☐	☐
C9.5	Remove Wastes	☐	☐	☐	☐	☐
C9.6	Student Satisfaction	☐	☐	☐	☐	☐
C9.7	Student Development	☐	☐	☐	☐	☐

Part 7: Self-Administrated Open-Structure Questions

C10.1 What are the main current problems in the Course Planning and Delivery Process?

C10.2 Is there any other element that is important in the Course Planning and Delivery Process?

C10.3 How much do you know about Lean Thinking (add values and reduce wastes) in Higher Education?

C10.4 Do you believe Lean Thinking practices can improve the Course Planning and Delivery Process in your institute?

C10.5 Do you see Lean Thinking practices link the strategic planning and transformation in your institute?

Thank you for taking the time to complete this questionnaire.
If you have any questions about the survey, please feel free to contact Mr Lim Chin Guan, the University of Northampton, at (65) XXXX 2586 or email **chin.lim@northampton.ac.uk.**

Appendix 8 - Survey Questionnaires – Students

Survey Questionnaire (Students)

A mixed-methods investigation of evidence-based Lean Thinking practice to Kaizen academic processes for Private Higher Education Institutes in Singapore

About the Survey

Learning from Lean Thinking is a novel undertaking in the academic industry. Establishing a framework of the Lean Thinking model for Private Higher Education Institutes (PHEIs) is important as this management philosophy has the potential to Kaizen academic processes. This survey aims to investigate the extent/importance which PHEIs have attributed to deliver value and eliminate wastes in the Course Planning and Delivery Process. These summarise the course resources, course contents, course pedagogy, course assessment, course evaluation and course refinement. Please be assured that the information you give will be kept strictly confidential and used for academic research purpose only. Thank you for your participation!

Part 1: Introduction to Lean Thinking

Lean Thinking or philosophy means guaranteeing value creation while working on waste reduction.

The five lean principles are:

1. **Specify values** from the customer's (student) point of view, seeking to add more value by reducing waste.
2. **Value stream** mapping of materials and information, eliminating whenever possible those steps that do not create value.
3. Creating a continuous **flow**, standardised work by defining sequence, smoothly toward the customer (student).
4. Conceiving a broad direct communications system for pulling services, letting the customer (student) **pull** value from the next upstream activity.
5. As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, and repeating the process and until a state of **perfection** is reached in which perfect value is created with no waste.

The four types of waste for Higher Education:

1. **People waste** refers to the failure to capitalise on the knowledge skills and abilities of employers.
2. **Process waste** refers to shortcomings in academic processes.
3. **Information waste** refers to information that is being deficient in supporting academic processes.
4. **Asset waste** refers to not using resources most effectively.

Part 2: Demographics Information

Gender	: ☐ Male ☐ Female
Age	: ☐ 25 – 29 ☐ 30 – 39 ☐ 40 – 49 ☐ 50 – 59 ☐ 60 – 69
Nationality	: ☐ Singapore ☐ Others: _________
Study Faculty	: ☐ Engineering ☐ Business ☐ Life Science ☐ Postgraduate
Study Level	: ☐ Bachelor ☐ Master ☐ Doctorate
Duration of Study	: ☐ <=2 years ☐ 2 years ☐ 3 years ☐ 4 Years ☐ >=5 years
Current year of Study	: ☐ 1st year ☐ 2nd year ☐ 3rd year ☐ 4th year ☐ 5th year and above
Current Semester	: ☐ 1st ☐ 2nd ☐ 3rd ☐ 4th
Participant's Name (option)	:

Part 3: Lean Thinking Evidence Practices

3.1 Course Resources

Please rate the level of evidence practice in the course resources.

S/No	Course Resources [C1] **Question 1:** **How do you know the course resources used?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C1.1	**Cohorts** I know different cohorts study the same module together.	☐	☐	☐	☐	☐
C1.2	**Lecturers** I know the lecturer teaching the module when I receive the timetable before the semester begins.	☐	☐	☐	☐	☐
C1.3	**Facilities** I know the lesson's venue (e.g. lecture, tutorial, practical) through visual display on campus or web-based system via mobile.	☐	☐	☐	☐	☐
C1.4	**Timetable** I know my timetable via email or from the school website before the semester begins.	☐	☐	☐	☐	☐
C1.5	**Overall** I receive the necessary support from the team for my study during the semester.	☐	☐	☐	☐	☐

3.2 Course Contents

Please rate the level of evidence practice in the course contents.

S/No	Course Contents [C2] **Question 2:** **How do you know the course contents of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C2.1	**Syllabus** The syllabus of the module has informed on the first day of the lesson.	□	□	□	□	□
C2.2	**Objectives** The learning objectives of the module have described and demonstrated in the delivery plan.	□	□	□	□	□
C2.3	**Materials** The learning material resources (e.g. E-textbook, slide, note) have downloaded from the online system before the lesson starts.	□	□	□	□	□
C2.4	**Outcomes** The dateline of coursework and exam format has informed on day one of the lessons.	□	□	□	□	□
C2.5	**Overall** Pre-reading the course content, which distributed uniformly throughout the semester, before the lesson start.	□	□	□	□	□

3.3 Course Pedagogy

Please rate the level of evidence practice in the course pedagogy.

S/No	Course Pedagogy [C3] **Question 3: How do you know the course pedagogy of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C3.1	**Lectures** I attend the lectures punctually, take notes and ask questions during the lesson.	☐	☐	☐	☐	☐
C3.2	**Tutorials** I attempt the tutorial questions first and check the solution during the lesson to reinforce my learning.	☐	☐	☐	☐	☐
C3.3	**Practical** I attend the practical lesson, follow the instruction, set up the experiment safely, collect the data, analyse the finding and writing a report.	☐	☐	☐	☐	☐
C3.4	**Consultation** I consult the lecturer during and after the lesson planned if I need help with my study.	☐	☐	☐	☐	☐
C3.5	**Overall** The course pedagogy has been well-defined throughout the semester and I take part in-class activities to reinforce my learning during the lesson.	☐	☐	☐	☐	☐

3.4 Course Assessment

Please rate the level of evidence practice in the course assessment.

S/No	Course Assessment [C4] **Question 4:** **How do you know the course assessment of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C4.1	**Attendance** I must tap my student card before and after the lesson to capture my E-attendance.	☐	☐	☐	☐	☐
C4.2	**Tests/Quizzes** I am aware of the number of tests/quizzes and the percentage breakdown for each class test of the module.	☐	☐	☐	☐	☐
C4.3	**Coursework** I am aware of the number of coursework and percentage breakdown for each coursework of the module.	☐	☐	☐	☐	☐
C4.4	**Examination** I am aware of the exam paper format and its percentage contribution to the module.	☐	☐	☐	☐	☐
C4.5	**Overall** I experience all the set papers (e.g. test/quiz, coursework, exam) are presented with error-free.	☐	☐	☐	☐	☐

3.5 Course Evaluation

Please rate the level of evidence practice in the course evaluation.

S/No	Course Evaluation [C5] **Question 5:** **How do you feedback to the course evaluation of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C5.1	**Reaction** I satisfy the pedagogy teaching approach by various lecturers in this study programme.	☐	☐	☐	☐	☐
C5.2	**Learning** I acquire new knowledge, skill and experience after completing the study programme.	☐	☐	☐	☐	☐
C5.3	**Behaviour** I change my behaviour and know how to tackle the problem differently after completing the study programme.	☐	☐	☐	☐	☐
C5.4	**Results** I believe there is an impact on my career after completing the study programme.	☐	☐	☐	☐	☐
C5.5	**Overall** I glad to give feedback for the study programme by sharing my experience in learning and studying.	☐	☐	☐	☐	☐

3.6 Course Refinement

Please rate the level of evidence practice in the course refinement.

S/No	Course Refinement [C6] **Question 6:** **How do you improve the course refinement of each module?**	Level of evidence-practice				
		Not at all	Very little	Somewhat	Moderately	Large extent
		1	2	3	4	5
C6.1	**Engagement** I engage the skills, emotions, participation and performance of my study.	☐	☐	☐	☐	☐
C6.2	**Experience** I experience the campus environment, learning, studying and peer harmony of my study.	☐	☐	☐	☐	☐
C6.3	**Satisfaction** I give feedback on the course evaluation to express my satisfaction.	☐	☐	☐	☐	☐
C6.4	**Achievement** I receive knowledge, self-motivation, good behaviour, mindset change and has a potential career path in the specific industry.	☐	☐	☐	☐	☐
C6.5	**Overall** I believe the school continue to pursue perfection for every course refinement in the Higher Education programme.	☐	☐	☐	☐	☐

Part 4: Self-Administrated Open-Structure Questions

C10.1 What are the main current problems in the Course Planning and Delivery Process?

C10.2 Is there any other element that is important in the Course Planning and Delivery Process?

Thank you for taking the time to complete this questionnaire.
If you have any questions about the survey, please feel free to contact Mr Lim Chin Guan, the University of Northampton, at (65) XXXX 2586 or email chin.lim@northampton.ac.uk.

Appendix 9 - Online Surveys Dashboard