Universidade do Minho
Escola de Engenharia

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Lean Dissertation Writing Process (LDWP)

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Dissertaion of Master In Industrial Engineering

Supervised By
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ABSTRACT

Lean Dissertation Writing Process (LDWP)

This dissertation delves into applying Lean management principles to the dissertation writing process (DWP), considering that research can be seen as a business, incurring costs, and generating waste. Lean management, a philosophy originating from the manufacturing sector, is explored to enhance research efficiency and productivity. The scientific objective is to create a framework for integrating lean principles into the dissertation writing process (DWP), tailored to researchers' needs. Three research questions are formulated to address common challenges in DWP, the potential of lean management to overcome these challenges, and the stages required for successful lean implementation.

The study uses a qualitative research methodology to gather and analyze data on applying lean principles in DWP, resulting in a conceptual framework. The findings suggest that lean concepts, such as waste reduction, value stream mapping, and continuous improvement, can significantly improve the efficiency of DWP. Lean methodologies promote disciplined project management, aiding researchers in setting goals, tracking progress, and addressing bottlenecks. It is emphasized that lean approaches should be adapted to specific research environments and personal preferences.

The research questions show that researchers often struggle with difficulties related to time allocation, work arrangement, and personal impediments. While Lean management can reduce some of these issues, it may not comprehensively address factors such as psychological barriers. This dissertation offers a Lean framework that guides researchers throughout the DWP, from goal setting to a comprehensive roadmap, enabling more effective process navigation.

In conclusion, integrating lean principles into DWP can enhance efficiency, effectiveness, and the overall quality of dissertation writing. While not a one-size-fits-all solution, lean methodologies provide a valuable foundation for improvement, benefiting both individual researchers and the academic community.

Keywords: Lean management, Dissertation Writing Process, Lean Writing, Lean Research, Lean Framework.

RESUMO

Lean Dissertation Writing Process (LDWP)

Esta dissertação explora a aplicação de princípios Lean Management no processo de escrita de uma dissertação (DWP), considerando que a fase da pesquisa pode ser vista como um negócio, visto que pode incurrer em custos e gerar desperdício. Lean Management, é uma filosofia que surgiu do setor industrial e é explorada para aprimorar a eficiência e produtividade da pesquisa. O objetivo científico é a criação de um framework para a integração de princípios Lean no processo de escrita de dissertação (DWP), adaptado às necessidades específicas dos investigadores. Três questões de pesquisa são formuladas para abordar desafios comuns no DWP, o potencial de Lean Management para superar esses desafios e as etapas necessárias para uma implementação Lean bem-sucedida.

O estudo utiliza uma metodologia de pesquisa qualitativa para obter e analisar dados sobre a aplicação dos princípios Lean no DWP, resultando num framework conceptual. As descobertas sugerem que os conceitos Lean, como a redução de desperdício, o mapeamento do fluxo de valor e a melhoria contínua, podem melhorar significativamente a eficiência do DWP. Deste modo, as metodologias Lean promovem uma gestão de projetos disciplinada, que auxília os investigadores na definição de objetivos, no acompanhamento do progresso e identificação de bottlenecks. Além disso, é importante destacar que as abordagens Lean devem ser adaptadas a ambientes de pesquisa específicos e preferências pessoais.

As questões de pesquisa mostraram que os investigadores frequentemente enfrentam dificuldades relacionadas à alocação de tempo, organização do trabalho e questões pessoais. Embora a gestão Lean possa reduzir alguns destes problemas, pode não abordar barreiras psicológicas. Desse modo, esta dissertação oferece um framework Lean que pode orientar os investigadores ao longo do DWP, desde a definição de metas até um plano abrangente, possibilitando uma navegação mais eficaz no processo.

Em conclusão, a integração dos princípios Lean no DWP pode aprimorar a eficiência, eficácia e a qualidade geral da escrita de dissertações. Embora não seja uma solução única para todos, as metodologias Lean fornecem uma base valiosa para a melhoria, beneficiando tanto os investigadores individuais quanto a comunidade académica.

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LIST OF ABBREVIATIONS

APA - American Psychological Association

cf. - Latin: “confer,” compare

EX - Example

DWP - Dissertation Writing Processes

GDSCs - General Dissertation Structure Contents

JIT – Just In Time

LDWP - Lean Dissertation Writing process

LDWPF - Lean Dissertation writing process Framework

LHE - Lean Higher Education

MLA - Modern Language Association.

NNVA - Necessary but Non-value Adding

NVA – Non-Value Adding

PDCA - Plan-Do-Check-Act

TPS - Toyota Production System

VA – Value-Adding

VS - Value Stream

VSM - Value Stream Mapping

WIP - Work in Progress

CHAPTER 1: INTRODUCTION

In the first chapter, the underlying problem of the master's dissertation is discussed, followed by a statement of the study's scientific Objective. Three research questions linked to the scientific objective are formulated, and the research methodology is outlined. At the end the Structure of the Work is expalined.

1.1 Problem Area and Scientific Objective

Each year, the world generates millions of research papers, and billions of dollars are invested in these studies. With such a massive volume of research being conducted, it is not surprising to consider the entire process as a business. Countless researchers spend significant time and effort in their work. just like any business, these research processes incurs various expenses and generates different forms of waste.

If we see a dissertation as a final product, it must go through many phases. Various sorts of expenses are included throughout this procedure, and as a result, different forms of waste will be generated. Consequently, we may use lean management to reduce these wastes and enhance the process.

LEAN is a philosophy that Toyota Motor Company developed in the early 1950s due to common sense to enhance production performance by removing daily reported avoidable losses (T. Ohno, 1988). It is a set of ideas, processes, tools, and procedures to enhance safety, quality, cost, delivery, productivity, and improvement. We can say it is a movement for continuous improvement that seeks to implement business practices with less waste and shorter lead times.

This philosophy establishes operational excellence as a strategic pillar through guiding concepts and practices. Due to the "Toyota Way," the two primary principles of strategic business philosophy to increase product quality are continuous improvement and employee respect (Liker, 2004).

The Goal of applying lean principles to the research business is to enhance the flow of research operations and reduce waste, making research and educational work more efficient and successful. While Lean has been widely adopted in manufacturing industries, there has been less interest in transferring Lean thinking to the educational sector. However, like any other project, writing a research dissertation involves several stages requiring arrangement and management. By adopting lean thinking, researchers can improve their laboratory and research operations, making their work more effective and potentially leading to higher productivity and decreased costs.

As Lean principles have found value in various sectors, including the health, construction, and services industries, they can undoubtedly bring substantial benefits to the research sector as well.

This study uses a qualitative research methodology to gather and analyze data on applying lean principles in DWP, resulting in a conceptual framework. The scientific objective of this study is to create a framework (Research Methodology) that incorporates lean management into the dissertation writing process (DWP). This framework would be a starting point for customized implementation based on specific research requirements, establishing lean management methodologies in research projects.

The research survey shows that researchers often struggle with difficulties related to time allocation, work arrangement, and personal impediments. The findings suggest that lean concepts, such as waste reduction, value stream mapping, and continuous improvement, can significantly improve the efficiency of DWP. While Lean management can reduce some of these issues, it may not comprehensively address factors such as psychological barriers. This dissertation offers a Lean framework that guides researchers throughout the DWP, from goal setting to a comprehensive roadmap, enabling more effective process navigation.

In conclusion, the vast amount of research conducted annually and the significant investments made in these studies make the research process akin to a business. Implementing lean management principles in the research business offers the opportunity to reduce waste and enhance productivity. The scientific objective of integrating lean management into the dissertation writing process is to create a framework that can be customized to meet researchers' specific needs, ultimately leading to greater efficiency and success in their research endeavors.

1.2 Research Question and Research Scope

Theoretical concepts about DWP management and lean management in general serve as the basis for this study. Before delving into the broad topic of lean DWP, a solid theoretical foundation for both research areas is developed. Extensive literature research is conducted to assess the current status of lean research dissemination in higher education institutions to approach lean DWP.

Based on this, a conceptual framework for integrating lean management into the dissertation writing process (DWP) is developed. Three research questions were asked to organize the framework's development process, which may be used to achieve the specified objective. The research questions are then presented and briefly formulated:

1) *What are the common challenges (barriers) students face during the DWP?* This question focuses on the challenges and barriers in front of successful DWP. Regarding research quality and methodology, potential inconsistencies and errors are identified.

2) *How can implementing a lean management approach help overcome these barriers?* Based on the challenges identified in the first question, this question covers the fundamental solution to overcome the obstacles as the answer to question one.

3) *What stages and steps are required to implement Lean principles within DWP successfully?* Based on the findings from the previous two research questions, the answer to this question creates a framework that guides researchers to have a successful dissertation writing process. This helps overcome most of the researcher's obstacles during their DWP.

1.3 Research Methodology

A research methodology has to be established and implemented to conduct the study. Different scientific techniques must be examined and considered to choose which research methodology would best help the study achieve its objective, as is outlined in section 1.1.

The primary objective of this study is to establish a conceptual framework for applying lean approaches to the dissertation writing process (DWP). The framework aims to be highly adaptable to ensure its usability and relevance across various dissertations.

Numerous factors must be taken into account while developing a research methodology. According to Collis and Hussey (2009), research should be categorized based on its aim, procedure, rationale, and result. In this case, the objective of the dissertation can be classified as descriptive research. The research seeks to characterize the current state of lean management in the research sector, gathering information and insights about the application of lean management in DWP.

The study's research methodology can be described as qualitative. To address the research questions, qualitative data will be gathered and analyzed using interpretive techniques instead of quantitative methods. This choice is partly due to the limited data availability for quantitatively analyzing DWP's lean management implementation approaches.

In terms of outcomes, the study can be classified as fundamental research. The underlying research topic is broader, and the study is primarily conducted to enhance the overall understanding of adopting lean management methods in the dissertation writing process rather than focusing on immediate

framework implementation. The research aims to contribute to general knowledge and theoretical understanding of this topic rather than solve specific issues arising during the dissertation writing process.

The study's logical approach may be regarded as inductive. The theoretical framework is derived from observations made through empirical reports. The approach moves from specific to general, starting with dissertations that use lean management in concrete ways and ending with a more generalized model for using lean management.

1.4 Organization of the Dissertation

The dissertation is organized as follows:

1. Introduction: Chapter one introduces the research topic, outlines its significance, presents research objectives, and provides an overview of the dissertation's structure.

2. Theoretical Foundation of Lean Management and Dissertation: Chapter two is divided into two sections. The first section establishes the theoretical background of lean management, offering a comprehensive understanding of its principles. The second section explores the DWP, its challenges, and its process management.

3. Data Collection and Analysis: Chapter three focuses on gathering data from the survey related to the research, emphasizing typical issues in DWP. It then analyzes and discusses this data to deepen our understanding of the research area.

4. Conceptual Application and Challenges: Chapter four defines the foundation for applying research findings, bridging theory with practical data and analysis. It also discusses when the framework is useful, potential challenges, and alternatives.

5. Conclusion and Future Research: Chapter five provides research conclusions, summarizes key findings, discusses implications, and suggests future research directions.

This organizational structure facilitates a logical progression from theory to practical challenges, data acquisition, and analysis, concluding with a reflection on research significance and prospects for future inquiries.

CHAPTER 2: THEORETICAL FOUNDATION OF LEAN MANAGEMENT AND ACADEMIC DISSERTATION – A SYSTEMATIC APPROACH

This chapter includes two sections. The first section of the chapter embarks upon a critical investigation of key concepts that will serve as the building blocks for establishing a comprehensive scientific foundation and ultimately accomplishing the objectives outlined in this Dissertation. As the focal point of this chapter, the concept of "lean" will be extensively explored, shedding light on its origins, historical development, fundamental principles, and the essential tools associated with its implementation. Simultaneously, the second section of this chapter delves into the fundamental aspects of writing a dissertation, providing a comprehensive understanding of its distinctive characteristics, structure, writing process, and common challenges students face. The chapter aims to equip students with the necessary knowledge and tools to confidently embark on their dissertation writing journey by integrating these topics.

2.1 An Introduction To Lean Management

In this section of this dissertation, the concept of "lean" will be extensively explored, tracing its historical roots, elucidating the five foundational principles, exploring diverse tools, and extending its application from industry to office environments and higher education.

2.1.1 A Brief History of Lean Concept

The " lean " concept originated in the manufacturing industry, particularly in the Toyota Production System (TPS), developed by the Japanese automaker Toyota. The principles of lean thinking have since been applied to various industries and sectors beyond manufacturing. The history of the lean concept can be traced back to the mid-20th century, and it has passed through four phases since then, as shown in Figure 2.1 below:

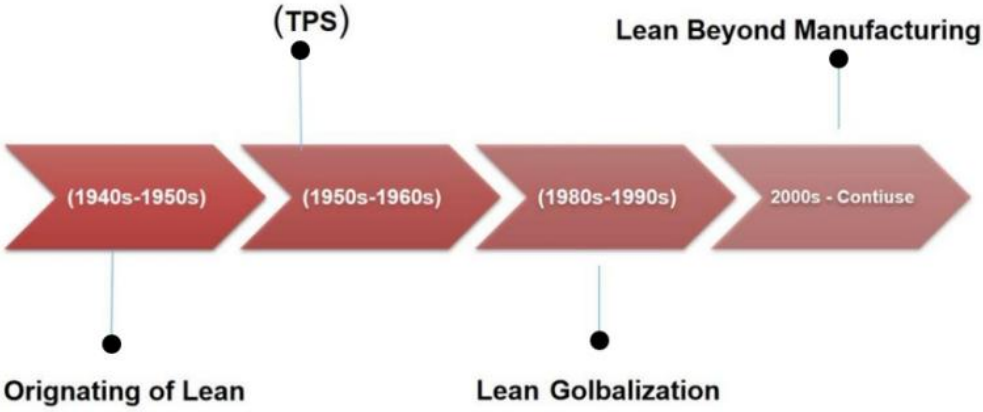


Figure 2. 1 The 4 Phases of Lean History

Kiichiro Toyoda and Taiichi Ohno, Toyota's leaders in Japan's initial post-World War II period (the 1940s and 1950s), faced the challenge of developing innovative strategies to compete with more significant, more established automakers. Taiichi Ohno is often hailed as the father of the Toyota Production System, and his team in the 1950s formulated the foundational principles of lean manufacturing. They aimed to enhance efficiency, minimize waste, and elevate overall productivity. (T.Ohno, 2013) (Bicheno & Holweg, 2016)

The second lean phase was the Toyota Production System (TPS), which was developed throughout the 1950s and 1960s and aimed to eradicate waste, enhance quality, and boost efficiency in manufacturing. Built on fundamental principles such as just-in-time (JIT) production, continuous improvement (Kaizen), and respect for people, TPS reshaped manufacturing practices. JIT involved producing what was necessary, precisely when needed, reducing excess inventory and associated costs. Kaizen fostered continuous improvement by engaging all employees in identifying and implementing small, incremental changes to enhance efficiency and quality. (S. Rogstad, 2010) (Saar, 2021)

The success of Japanese manufacturing, particularly Toyota, sparked the third phase of lean, which saw the dissemination of lean thinking on a global scale in the 1980s and 1990s. Inspired by this success, Western companies studied and adopted lean principles to enhance their operations. The seminal book "The Machine That Changed the World" by James P. Womack, Daniel T. Jones, and Daniel Roos, published in 1990, was pivotal in introducing the term "lean" to a broader audience (Damrath, 2012; Jasti et al., 2020).

During the fourth phase, which is from the 2000s and beyond, the principles of lean thinking transcended manufacturing and found application in diverse industries such as healthcare, services, and

software development. This evolution led to methodologies like Lean Six Sigma, a fusion of lean principles with statistical methods to improve quality and efficiency. (Damrath, 2012)

In summary, the lean concept, born out of the Toyota Production System, has not only witnessed widespread adoption but has also adapted across various industries, contributing significantly to efficiency, quality, and overall organizational performance.

2.1.2 Five principles of Lean

The five principles of lean are foundational concepts that guide organizations toward continuous improvement and value creation. In their book "The Machine That Changed the World," Womack and Jones outlined these five principles of lean manufacturing, which focus on lean organization rather than lean manufacturing. (WOMACK and Jones, 2003; John Bicheno, 2009). Figure 2.2 below represents the five lean principles cycle, and each of them is described below:

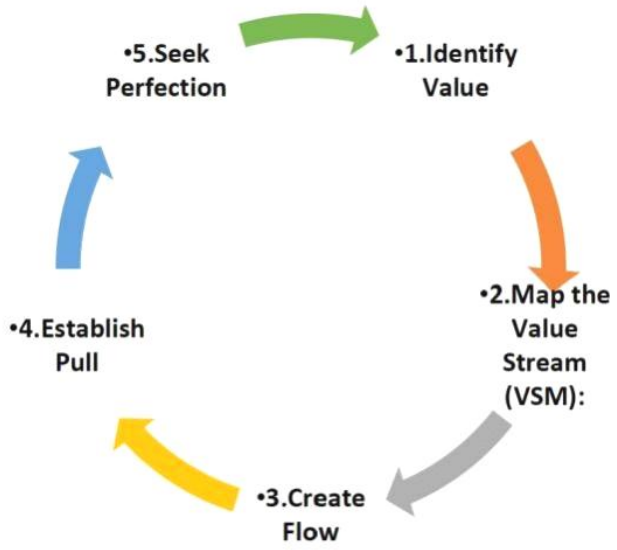


Figure 2. 2 The 5 Lean Principles Cycle (Adopted from (Lean Thinking and Practice, n.d.)*)*

1) Identify value.

Determine and specify value in terms of the customer. This principle strongly emphasizes understanding the consumer's values and concentrating on providing that value (Dayi et al., 2016). The company creates value in the form of a product or service that the consumer will purchase; thus, the customer determines the value of the product based on their requirements and preferences. From a

producer's perspective, this value is difficult to calculate and differentiate because the production process consists of numerous steps, some of which have no relation to the final product purchased. According to lean thinking, some of these steps do not add value to the customer and only represent waste (Kazi & Konstantinos, 2018). Value is a product or service sufficiently satisfying customers' expectations at a particular time and price. Alrashed & Kang (2017)

2) Map the Value Stream (VSM)

This principle relates to the Flow of processes from raw materials to the final consumer or from the creation of the product to its delivery into the market. The whole value chain must be identified for all goods and product families inside a company. The principle also addresses capturing and removing waste along the value stream. Which usually shows large quantities of waste in the form of unnecessary processes, backtracking, and junk (National Research Council Canada, 2004). We can identify VSM by eliminating or decreasing non-value-adding (NVA) operations in the value stream (Hajri, 2013).

3) Create Flow

According to Womack and Jones (2003), Flow is "the progressive achievement of tasks along the value stream so that a product proceeds from design to launch, order to delivery, and raw materials into the hands of the customer with no stoppages, scraps, or backflows."

One of the Flow's advantages is increasing process efficiency while increasing quality to satisfy customers' needs. The plan is to minimize work by area of specialty, which will decrease the long distances taken between departments to complete specific processes. Additionally, eliminating batch jobs and replacing them with one-piece flow cells would reduce lead time and enhance quality. Thus, the flow concept implements the lean program efficiently and straightforwardly. (J. Womack& Jones, 2015) (Dayi et al., 2016)

4) Establish Pull:

Pull is "a system of cascading production and delivery instructions from downstream to upstream activities in which the upstream supplier produces nothing until the downstream customer signals a need. The opposite of push." (James P. Womack, 2003).

Instead of putting a product on the market where there may be no demand, this principle lets the client choose the product from the organization's value stream. The concept suggests that the first action that initiates a product's manufacturing shouldn't be made without the client's consent (Mwacharo, 2013).

5) Seek Perfection:

According to Wommack and Jones (2010), seeking Perfection is "the complete elimination of waste so that all activities along a value stream create value." After working systematically through the four preceding principles, a company can now see that Perfection in its processes is attainable. There is no definitive conclusion to the waste removal process. Therefore, pursuing excellence requires continual waste removal action enhancement (Widnall, 2016; Mwacharo, 2013).

In conclusion, the five Lean principles defined by Womack and Jones provide firms with a complete framework for improving operations, reducing waste, and delivering value to customers. Organizations can change their operations and achieve long-term success by concentrating on finding customer value, mapping the value stream, creating Flow, implementing pull-based processes, and aiming for Perfection.

2.1.3 Lean Tools and Techniques

Lean Tools and Techniques are a collection of methodologies, processes, and tools derived from the Toyota Production System (TPS)-based Lean manufacturing philosophy. Their primary goals are waste reduction, process optimization, and heightened customer value. These principles have transcended manufacturing and found extensive application across diverse sectors like services, healthcare, and software development. Implementing these principles converts a business into a lean operation and is the basis for lean thinking. While they offer guidance on creating and utilizing management tools and procedures effectively, they also cover using prominent Lean management techniques, even those not originally part of Lean, to supplement a larger Lean strategy. Essentially, any approach centered on customer value, particularly techniques related to production capacity, quality, system responsiveness, demand variability, production resource availability, and production control methodologies, aligns with lean management (Hines et al., 2004).

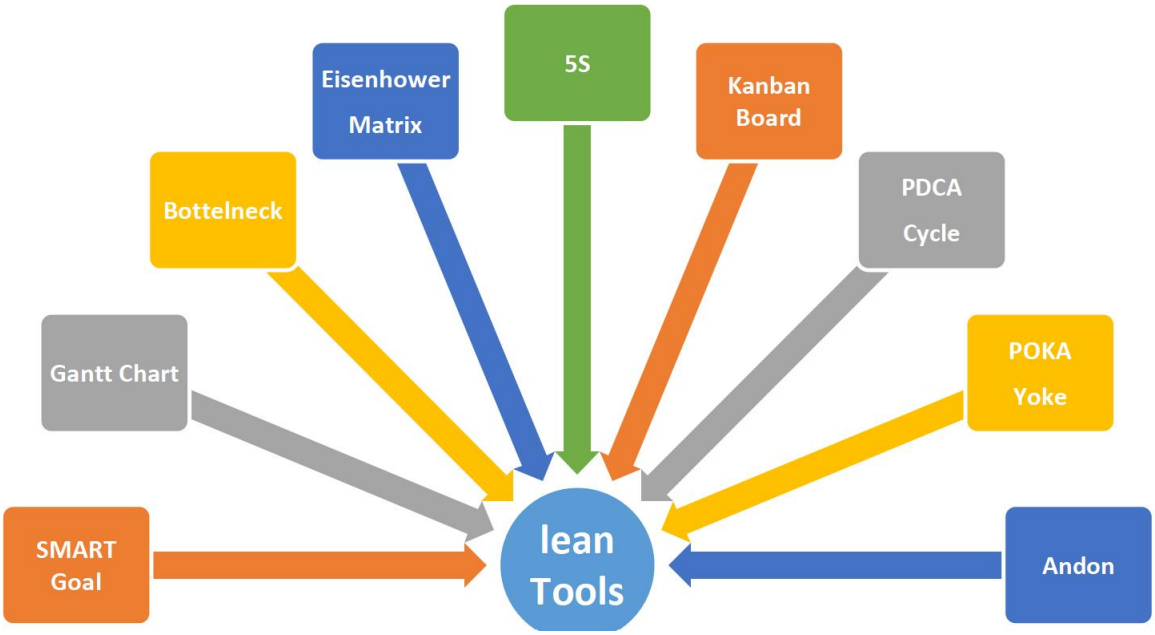


Figure 2. 3 Lean Tools and Techniques (Adapted from:(Damrath, 2012)*)*

The image above shows some of the most important lean management tools and techniques (Figure 2.3). We will introduce and explain each tool. In this section, we will introduce some tools that we believe can help with DWP. The chart in Figure 2.4 below briefly introduces each tool, and we will define them in detail later.

Figure 2. 4 A brief definition of the lean tools and techniques

Smart Goal:

SMART is an acronym for Specific, Measurable, Achievable, Relevant, and Time-Bound (John Lawler, 2010). It provides guidelines for goal setting for improved outcomes in areas like project management, employee performance management, and personal development. George T. Doran used the term for the first time in Management Review's November 1981 edition (Doran, 1981); cf. Figure 2.5 below.

Let's say you wish to increase your productivity considerably. In such a situation, you should make systematic, precise goals based on a resource you regularly return to to stay on track and avoid losing sight of your goals.

The SMART Goals framework assists you in achieving your goals and transforming into a high achiever. It helps you develop well-defined goals and leaves minimal room for assumption or confusion.

In this section, we will explain each criterion to establish a SMART goal, compare them with non-SMART goals, and choose the scenario of a SMART goal (someone who wants to be more educated).

Figure 2. 5 Smart Goal(Nutritioneering, n.d.)

- **S= Specific**

  A general goal like "our firm wishes to increase its revenue" suggests that the existing state is unsatisfactory. Turnover has to be increased. But there isn't a solid strategy in place to accomplish this goal. As a result, none of the people concerned are sure what to do. Therefore, the goals should be more clearly and adequately stated so everyone knows what is expected. A measurable action, behavior, or outcome must be described by the specific goal, for the association between a

quantitative value and a number, quantity, or percentage is beneficial (Graham Yemm, 2012). Table 2.1 below shows the difference between non-specific and specific goals.

Your goal has to be very clear and defined. If not, you won't be able to focus your efforts or feel inspired to accomplish them. The "five Ws questions" need to be addressed to create a specific goal. Cf. Figure 2.6 below.

Figure 2. 6 The Five "W" questions which address a specific goal.

Non Specific Goal	Specific Goal
I will read more.	I want to increase my knowledge, so I decided to read 300 pages per month so that I would read ten pages per day.

Table 2. 1 The difference between Non and Specific Goal.

- **M = Measurable**

While being specific is a good first step, quantifying your goals (i.e., ensuring they are measurable) will simplify monitoring your progress and recognizing your successes. To correctly measure the level of achievement, goals should be quantified. The critical concept of responsibility is also included in the measuring criteria; avoiding responsibility is far more difficult when measuring standards are precise and clear (Siegert & Taylor, 2004).

You may track missed objectives and adjust as conditions change by setting quantifiable goals. It helps in identifying prospective performance failures before it's too late.

C.f table 2.2 below shows the difference between non-measurable and measurable goals.

Non-Measurable Goal	Measurable Goal
I read more this year.	I aim to read 3650 pages this year, so I need to read 300 pages per month and ten pages daily.

Table 2. 2 The difference between Non and Measurable Goals.

- **A = Achievable**

  Disappointment will undoubtedly come if the goals are not reasonably attainable given the time, skill, and resources at hand. It must be practical and fair for both you and the people working with you and are involved in this project. If not, it discourages motivation, which may push everyone to their breaking point.

  In daily life, it is also essential to have an achievable goal, so you do not get disappointed when you reach it. Table 2.3 below shows the difference between non-achievable and achievable goals.

non- Achievable Goal	Achievable Goal
I will read all the historical books	I will read ten pages about history to increase my knowledge.

Table 2. 3 The difference between Non and Achievable Goals.

- **R = Relevant**

  Now is the time to consider the larger picture. Why are you establishing this particular goal? Are you motivated by your goal? How does this goal benefit you? Goals vital to you are often easier to accomplish since you will be more motivated.

  Make sure your goals are relevant before establishing them. Your goals should be in line with your beliefs and long-term goals. You may reconsider a goal if it doesn't support your more significant goals. When setting a goal, consider why it is important, how accomplishing it will benefit you, and how it will advance your long-term objectives.

  It is essential to think about the following evaluation criteria for a goal when determining whether it is relevant:

  - Is it necessary? What comes first?
  - Is this the right moment?

- What are the immediate and long-term effects of pursuing this goal?
- What are the potential risks, and how will things change over time?

Table 2.4 below shows the difference between Non-Relevant and Relevant goals.

Non – Relevant Goal	Relevant Goal
I will play football in order to increase my knowledge.	To make myself more educated, I will read more. Considering my daily schedule, I will read ten pages daily to do it every day.

Table 2. 4 The difference between Non and Relevant Goal

- **T = Time – bonded.**

It should be clear when you want to reach your goal. Anyone may have goals, but if they don't have realistic deadlines, it's unlikely that they will be achieved. To help you stay responsible and on course, establish reasonable deadlines. C.f Table 2.5

Ask precise questions regarding the goal deadline and what can be completed within that time frame. If you do not achieve your goal by the end of the day, think about it. It's possible that your goal was unfeasible, your schedule was too tight, or you faced unforeseen obstacles.

It is agood idea to divide your overall goal into more achievable sub-goals or time frames. It will help you specify what should be accomplished halfway through the goal.

Non Time – bonded Goal	Time – bonded Goal
I read more	I will be reading ten pages per day consistently during 2023

Table 2. 5 The difference between Non and Time- bonded Goal

It is important to mention that goals are relatively broad ends that more detailed sub-goals or objectives aim to achieve. Most of the time, misunderstandings arise at this point. Subgoals and objectives are essentially the same, although goals and objectives are very different. Table 2.6 the difference between Goal and Objectives.

The phrase "SMART goals," which has gained popularity, really relates more to sub-goals and objectives than it does to the far more general phrase "goals"(MacLeod, 2012).

Goals	Objectives (sub -Goal)
Broad in Scope	Narrower in Scope
General	Specific
Intangible	Tangible
Qualitative	Quantitative
Abstract	Concrete
End Result	Required Steps
Hard to validate	Easy to validate
Longer-term	Shorter-term

Table 2. 6 The difference between Goal and Objective

In conclusion, the SMART Goal, introduced by John Lawler and George T. Doran, provides a structured approach to goal setting for improved outcomes in various areas. By ensuring that goals are Specific, Measurable, Achievable, Relevant, and Time-Bound, individuals and organizations can enhance their clarity, accountability, and overall success. SMART goals help avoid ambiguity and foster motivation, making them a valuable tool for achieving personal and professional aspirations.

Gantt Chart

A Gantt chart is a widely used project management tool that provides a graphical way to plan, track, and manage tasks and activities over time. It is named after its inventor, Henry L. Gantt, an American engineer and management consultant who developed this tool in the 1910s and has since become a fundamental tool for project managers, team leaders, and individuals involved in project planning and scheduling (A. Bednjanec and M. F. Tretinjak, 2013).

The essential components of the Gantt chart, as it appears in the figure 2.7, are:

Task List Or activities: This is a list of all the tasks or activities that need to be completed for the project. Each task is represented as a separate line or bar on the chart.

Timeline: The timeline is represented horizontally, typically along the chart's top. It shows the project's duration, which can be in days, weeks, months, or even years.

Bars or Blocks: Each task is represented by a horizontal bar or block on the chart. The length of the bar corresponds to the duration of the task. The bars are positioned along the timeline to show when each task is scheduled to start and finish.

Dependencies: Gantt charts often include arrows or lines connecting tasks to show task dependencies. These dependencies illustrate the order in which tasks need to be completed. For example, Task B may depend on the completion of Task A, so there would be an arrow connecting the two.

Also, in some Gantt charts, you can find some other components like:

Milestones: Milestones are significant points or events in the project that are usually represented by diamond-shaped symbols. They help to mark critical points in the project's timeline, such as project kickoff, key deliverables, or project completion.

Resource Assignments: they can be information about the resources assigned to each task, including individuals, teams, or equipment. This helps in resource allocation and management.

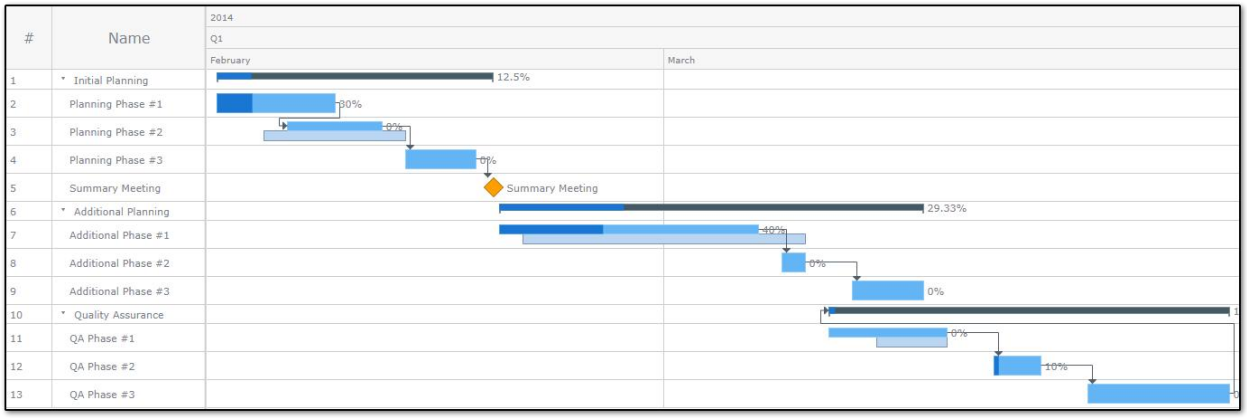


Figure 2. 7 The Basic Components of Gantt chart (Edureka, n.d.)

In a Gantt chart, the tasks are organized in individual rows, while the timeline runs along the top, divided into increments of days, weeks, or months, tailored to the project's duration. Each task's expected timeframe is depicted by a horizontal bar, with its left end signifying the task's start and the right end indicating its completion(Pankaja Pradeep Kumar., 2005).

To create a Gantt chart, you initiate by listing tasks and estimating their durations, arranging them on the timeline using bar lengths. Dependencies are illustrated with connecting lines for clear task sequencing. Resource allocation can be seamlessly integrated for efficient management. As the project progresses, the Gantt chart monitors and adjust for any delays, ensuring the project stays on course.

Bottleneck

Bottlenecks are operations or processes with limited capacities that lower the capacity of the entire production chain. If they aren't fixed, they could cost your business time and money and cause production delays. The bottleneck in the process is the work stage, which receives more work requests than it can handle at its full throughput capacity. Workflow is disrupted as a result, and the entire production process experiences delays.

In other words, even though this work stage is operating at full speed, it does not have the capacity to complete all the tasks quickly enough to move them on to the following stages without creating a delay. Cf Figures 2.10 and 2.11

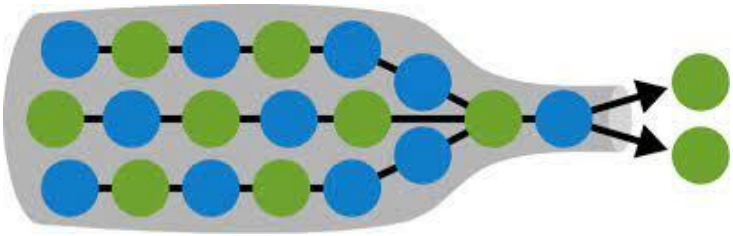


Figure 2. 8 Bottleneck (SOPHIE'S WORLD, n.d.)

Almost every system has one, even if it's a small bottleneck (Şimşit et al., 2014). Finding bottlenecks involves identifying where accumulation occurs, assessing throughput, determining whether each machine is being used to its fullest potential, and locating the machine with the most extended wait times.

Figure 2. 9 An example of a material flow (AllAboutLean, n.d.)

In conclusion, addressing bottlenecks is essential to avoid costly delays and optimize production efficiency. Identifying and resolving these capacity limitations is pivotal for sustaining a smooth workflow and ensuring business success.

Important Urgent (Eisenhower)Matrix

Important Urgent Matrix is also known as the Eisenhower matrix since the Idea of the matrix comes from Dwight D. Eisenhower (1890 – 1969). It is a decision-making technique and helps prioritize activities according to their significance and urgency. By using this matrix, people can prioritize which Tasks and which to ignore and make time for important tasks by eliminating "busy" activities that don't add much to long-term objectives. In this way, you can concentrate on creating a productive workflow that produces significantly better outcomes.(Mfondoum et al., 2019)

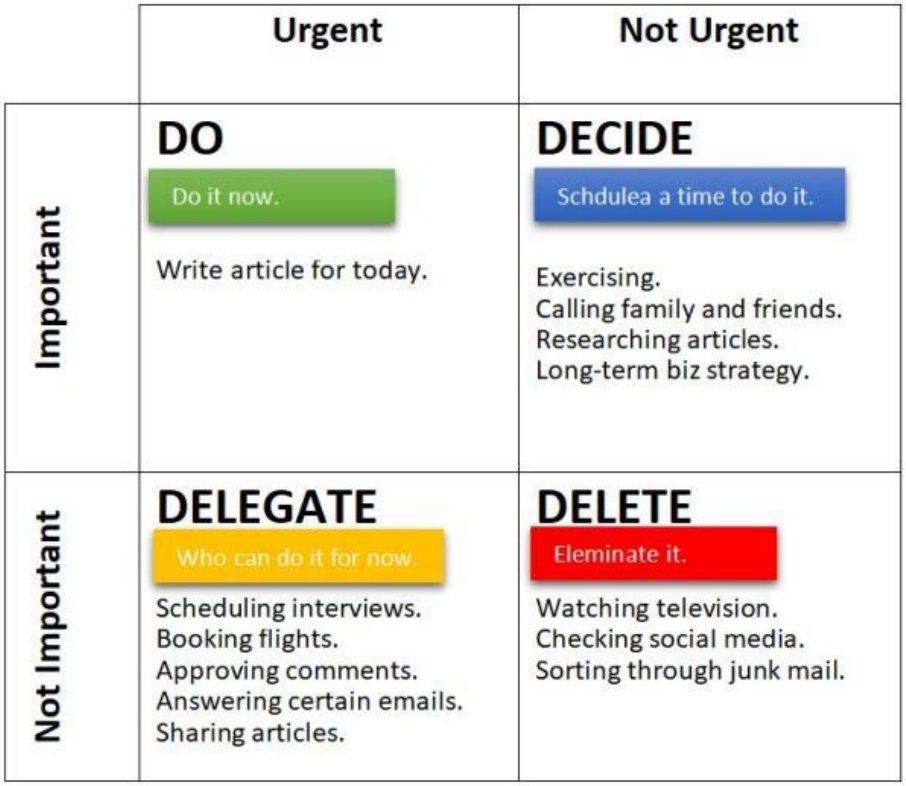


Figure 2. 10 The Eisenhower Box.Adapted from (Mfondoum et al., 2019)

The urgency and importance of each activity should be classified before using the matrix to prioritize the activities. To make this classification, you should understand the distinction between the two dimensions of essential and urgent:

Important activities: they are those Tasks that support long-term goals and fundamental values. Planning and thoughtful action are necessary for these Tasks. Determining what is important to you depends on your values and personal objectives. The things that are important to you can only be described by you. One technique to distinguish whether an activity is Important or unimportant is Asking, "Will the project suffer if this work isn't done?".

Urgency Activities: They are activities that demand quick attention. These are the problems that are immediately apparent and call for your attention. Various factors will determine if something is urgent or not, depending on what the project entails.

After determining the difference between importance and urgency, the next step is to divide your activities into four groups based on the Eisenhower decision-making Matrix for the four categories of Do, Decide, Delegate and Delete. Cf 2.10

- **Important Urgent Activity**

  The first quadrant, known as the **"Do" quadrant,** is where you should set those tasks that are both urgent and important. Putting an activity in this quadrant when it has to be done now has obvious repercussions and impacts your long-term objectives.

  In order to limit the number of 1st quadrant tasks you have, invest time preparing to predict and avoid problems. To rearrange your workflow, you can engage with customers, coworkers, or the coordinator. To see what changes may be made to prevent unexpected problems from happening.

- **Important, Not Urgent Activity**

  The second quadrant, known as the **"schedule" quadrant**, is where you should put any tasks that are important but not urgent. You may schedule these jobs for later completion since they impact your long-term objectives but don't need immediate attention. These activities will be taken up immediately, following those in quadrant one.

- **Not Important, Urgent Activity**

  The third quadrant, known as the **"delegate" quadrant**, is where you should put any Tasks that are urgent but not important. Usually, these activities have little impact on your long-term objectives.

  Create a plan to delegate, remove, or minimize the time you spend on this quadrant activity to reduce the workload. For instance, combine specific jobs to do them all at once, or let your coordinator know how much time you spend on busy work.

- **Not Important, Not Urgent Activity**

  This quadrant is known as the **"delete" quadrant**. There will be a few activities left over after you've gone through your to-do list and added activities to the first three quadrants. The things that were left undone weren't essential or urgent. These tasks prevent you from achieving your goals.

If you spend most of your time in quadrant 4, you probably feel pressured and unfulfilled. Keep tracking your time to see which activities occupy the most of it. Then, create a plan to eliminate or minimize them.

Intent and important activities are done first, whereas neither urgent nor important activities are finished last. Activity in one matrix box might need to be shifted to another as a deadline draws near(Murray et al., 2022)(Murray et al., 2022)(Murray et al., 2022)(Murray et al., 2022). For example, If you have a drawer full of clean underwear, washing underwear might not be urgent or important. However, this task becomes urgent and important once you run out of clean underwear. The urgency and importance of each activity should be classified before using the matrix to prioritize the activities. (Murray et al., 2022)

5S

The 5S methodology is a system for organizing and managing a workspace or environment. It originated in Japan and is widely used in Lean manufacturing and other process improvement methodologies.

Promoting orderliness, cleanliness, and discipline enhances effectiveness, efficiency, and employee morale, ultimately driving quality and productivity gains. It offers a uniform working environment, enabling employees to observe how processes function (Catterall, 2008). It influences employees' mindsets in a way they start to think positively about working in a well-organized environment where anything out of place is promptly seen and remedied rather than adversely (Mwacharo, 2013).

However, 5Ss is an effective technique that shouldn't be confused with cleaning or organizing. The three main goals of a 5S program should be to minimize waste, increase variance, and boost production(Bicheno, J. & Holweg, 2016)(Gapp et al., 2008).

Additionally, 5Ss The general advantages of implementing 5Ss in industries may be briefly summed up as follows:

- **Orderliness (Seiri and Seiton):** to increase effectiveness and efficiency by streamlining procedures, reducing burden and human error.
- **Cleanliness (Seiso and Seiketsu):** may lead to the maximizing of effectiveness by ensuring ongoing transparency, safety, well-being, and a contribution to a healthy existence.

- **Discipline (Shitsuke):** pushes the envelope for personal and professional standards. In addition to improving productivity over the long run and health and safety, shitsuke also aids in staff morale maintenance.

The original 5Ss are written in Japanese(Seiri, Seiton, Seiso, Seiketsu, and Shitsuke) and are typically interpreted as (Sort, Set in Order, Shine, Standardise, and Sustain)(Bicheno, J. & Holweg, 2016). The 5Ss are explained in the table 2.7 below (Yanagawa & Sun, 2006)

Japanese Term	English translation	Equivalent term starts with the letter S In English	Its Description
Seiri	Organization	Sort	Get rid of everything unnecessary immediately and dispose of any unneeded goods.
Saiton	Tidiness	set in order	organize everything, create a place for everything, and maintain their places.
Seiso	Purity	Shine	clean to original condition; Maintain everything in excellent shape.
Seiketsu	Cleanliness	Standardize	Establish a regular schedule to maintain and enhance the first three S's in your workspace, which is clean and free of destructive behaviors.
Shitsuke	Discipline	Sustain	All employees should seek to consistently use and improve the first four Ss as they should make them a habit.

Table 2. 7 5S terminology (Yanagawa & Sun, 2006).

In conclusion, the 5S method offers a systematic approach to workplace transformation, enabling businesses to handle issues related to messy settings. It produces an atmosphere of effectiveness, efficiency, cleanliness, uniformity, and discipline by encouraging organization, tidiness, and discipline. Along with increasing quality and efficiency, 5S also promotes a positive mentality among workers, making it second nature to have a tidy environment. Industries may benefit from using the 5S model in many ways, including improved processes, transparency, safety, and long-term productivity increases.

Kanban Board

Kanban is a Japanese term meaning "visual signal" or "card," invented by Taiichi Ohno, the Toyota industrial engineer, to increase production effectiveness and manage workflow. Over time, its applications

have extended beyond manufacturing to various industries, including software development, healthcare, and project management. (Taiichi Ohno, 1988)

A Kanban board is a powerful tool that visually represents work in progress (WIP) and the flow of tasks within a process. It typically consists of a board divided into columns, each representing a different workflow stage. Within these columns are cards or sticky notes, each representing a specific task or work item. (Lage Junior & Godinho Filho, 2010)

You may begin constructing your Kanban system by creating a Kanban board with three basic columns: "Requested (To Do)," "In Progress (Doing)," and "Completed (Done)." When designed, maintained, and operated properly, it acts as a real-time data repository, identifying system bottlenecks and anything else that might impede efficient operations. The board is the center of activity for all Kanban teams. Even though some teams prefer physical boards, virtual boards are an important component of any agile software development tool because of their traceability, ease of participation, and accessibility from many locations.

As shown in figure 2.11 below, a simple Kanban Board consists of four components: Visual signals, columns, work-in-progress limitations, and a delivery point.

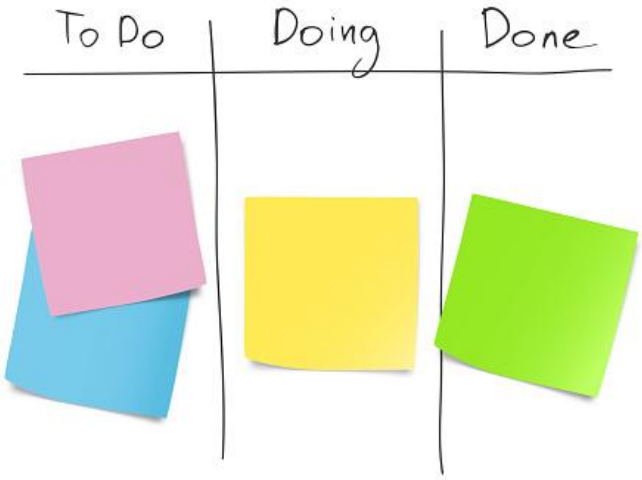


Figure 2. 11 Simple example of Kanban Board (IStoke n.d.)

- **A Visual Signal**

  The visual cards (tickets or stickies) on a kanban board are one of the first things you'll notice. Kanban teams typically write one project or work item per card on the cards, including all of their projects and work items.

- **Columns**

  The columns are another distinguishing feature of a kanban board. Each column represents a specific task that together makes up a "workflow." Cards go through the process until they are finished. Workflows might be quite simple, such as "To Do," "In Progress," or "Complete," or they can be very complicated.

- **work-in-progress limitations**

  WIP limitations define the most cards that may be placed in a single column. More than three cards cannot be placed in a column with a WIP limit of three. Before a new card may enter that process stage, when the column is "fully rolled," the team must focus on those cards and progress them. These WIP restrictions are important for identifying process bottlenecks, enhancing flow, and serving as a warning before you take on too much.

- **Delivery point**

  A kanban team's process ends at the delivery point. The point of delivery for most teams is when the client receives the item or service. The Goal is To move cards as quickly as possible from the request (to do) point to the delivery point. The time the team needs to move the card between these two points, called "Lead Time," refers to the interval between the two. The teams are always working to reduce their lead time as much as possible.

Businesses often use Kanban, which may also benefit individuals who need to plan their daily work to establish effective routines. Personal Kanban is a technique that encourages balance by reducing (WIP). Kanban is helpful for everyone with a lot on their plate, regardless of age or profession.

PDCA Cycle

The PDCA cycle refers to plan, do, check, and act. It is also known as the Shewhart cycle and the Deming cycle, taken by its founder's name(Shewhart, W. A. and Deming, 1986). Plan-Do-Check-Act, or PDCA, is a four-step project management technique used to accomplish continuous improvement involving planning, testing, evaluating, and implementing effective solutions. (Johnson, 2002).

It includes systematically testing potential solutions, evaluating the outcomes, and implementing those proven effective. It encourages small-scale testing of improvements before implementing systemic changes to company-wide procedures and work methods.

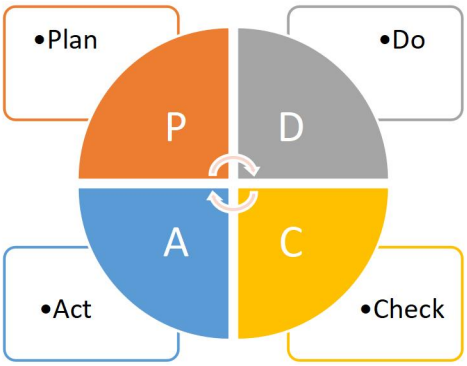


Figure 2. 12 PDCA Cycle. Adapted from(Moen & Norman, 2009)

As seen in Figure 2.12, there are four phases in it. The first phase is to plan, which is centered on identifying opportunities and organizing improvements. The intended alterations are tested in the second stage. The third stage, or "check," examines the outcomes of the previous step and finds the key takeaway. Finally, in the final step (act), appropriate action for a larger change should be made if the checked outcomes from the previous stage are successful. If not, it had to redo the process by going back through the cycle(Johnson, 2002).

The PDCA methodology is frequently used by companies trying to improve their internal and external processes to simplify their operations, reduce errors, cut costs, make a profit, enhance customer satisfaction, and increase results. Once established, businesses can repeat the PDCA Cycle and turn it into a standard operating procedure. The methodology's last stage, "Act," implements corrective measures and makes it perfect for continuous improvement projects.

Poka-Yoke (Mistake-Proofing)

Poka-yoke, which translates as "mistake-proofing" in Japanese (avoid [yoke] errors brought on by inattention [poka]), refers to any technique or system that prevents someone from making an action incorrectly. Shigeo Shingo, a Toyota Motor Corporation engineer, developed the method In 1961. (Dudek-Burlikowska & Szewieczek, 2009)(Shigeo Shingo, 1986).

Poka-yoke prevents waste by limiting or reducing quality errors that result in rework and scrap and eliminating potential safety risks. A typical Poka-Yoke duty is directing an operator to avoid making mistakes while the machine is being loaded.

There are two possible states in which a defect can exist: either it has already happened, in which case defect detection is required, or it is about to happen, in which case defect prediction is required(Dudek-Burlikowska & Szewieczek, 2009).

A good example of poka-yoke can be electrical sockets that accept a specific type of head (cf Figure 2.13 below) or washing machines that won't start if the door isn't shut to prevent flooding. Since complete error elimination is not always attainable, Poka-Yoke methods must be used to detect errors as quickly as possible in these conditions(Dvorak, 1998).

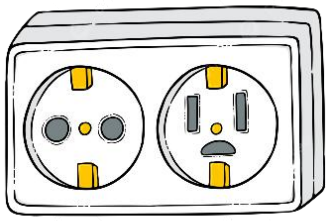


Figure 2. 13 electrical sockets example(Pngtree, n.d.)

Andon

Andon is a system designed for Lean manufacturing that notifies operators when there is a problem on the assembly line. Like a car's "check engine" light (cf Figure 2.14 below), the Andon system is intended to notify operators and management of issues in real-time so that quick corrective action may be performed.

Figure 2. 14 Car's "check engine" light example(I stoke, n.d.)

The system developed as part of the Toyota Production System (TPS) and it is used to "stop the line" when a product problem is found. The Jidoka principle of Lean, which enables individuals to stop the manufacturing process independently whenever a product problem occurs, is where the idea of Andon evolved. The term "Andon" means a "lantern" or "light" when translated from Japanese. This describes an alarm system notifying operators of a product fault in a production process.

The Andon cords stand in for the different lights that may be seen on an Andon board. Their function is to display the condition of a machine at a specific station or the kind of issue that has been discovered. The color-coded cables shown in the table 2.8 below are what most Andon boards use.

Color-Code	Condition	Action
	Production is normal	move on to the next level
	A problem occurred	the problem cannot be identified and needs more investigation
	Production is stopped	an operator needs to have a supervisor to check the facility

Table 2. 8 Andon Lean Manufacturing. (Lean Six Sigma Canada, n.d.)

Andon's main objective is to increase information flow and communication between factory operators, team leaders, and outside technicians if a production issue occurs.

Additionally, the idea behind Andon is to "stop the line" as soon as a product defect is discovered in order to decrease the possibility that it would be transferred farther along the process. The goal is to identify issues early since fixing them later in the production cycle may be expensive, particularly in manufacturing.

In conclusion, Lean Tools and Techniques have evolved from the Lean manufacturing concept and seek to reduce waste, simplify operations, and increase customer value. They have been effectively used in many different industries. These principles serve as a framework for developing and using management tools, but any strategy that emphasizes customer value aligns with the Lean philosophy. The selection and implementation of specific tools depend on organizational goals and context. These are just a few examples of Lean Tools and Techniques. There are many more, including Heijunka (production leveling), Jidoka (autonomation), and Value Stream Analysis.

2.1.4 Wastes in Lean Production

According to Womack and Jones, tasks can be categorized into three types: value-adding (VA), necessary but non-value adding (NNVA), and non-value adding (NVA). These classifications are summarized in the table 2.9 below(James P. Womack, 2003).

Types of Tasks	Definitions
Value Adding (VA)	Tasks that transform the item directly to the required form by the final customer.
Necessary but Non-Value Adding (NNVA).	Tasks that do not add value but are necessary within the existing production process.
Non-Value Adding (NVA)	Unnecessary tasks that do not add any value.

Table 2. 9 The difference between VA, NVA, and NNVA Tasks

In lean production, waste refers to any activity or resource that does not add value to the end product from the customer's perspective (Wahab et al., 2013). While studying the operations at Toyota Motor Company, Ohno identified three primary categories of waste that required elimination, which are Muda 無駄(waste), Mura 斑, (unevenness), or Muri 無理(overburden). as it appears in the figure 2.15 below. Later, we will explain each type of them.

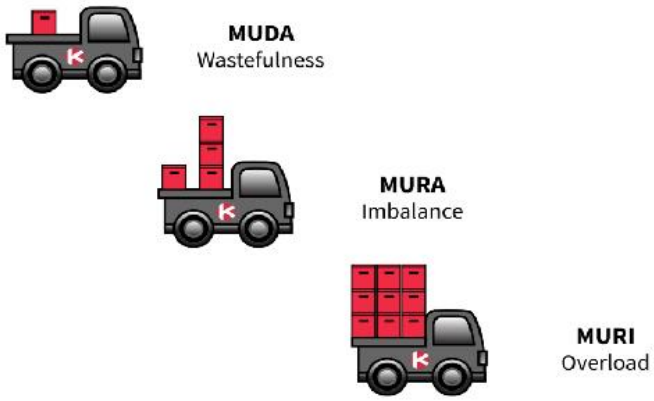


Figure 2. 15 Categories of waste in Lean context. (Firex, n.d.)

The 7 Muda (無駄, waste)

"Muda" is a Japanese term that translates to "waste" in English. In the context of business and manufacturing, particularly in the Lean management philosophy, "Muda" refers to any activity that consumes resources (time, money, effort) but does not add value from the customer's perspective.

There are two different types of Muda: Type one and Type two.

- ❖ The first type of Muda consists of customer-required procedures that include non-value-added tasks. For example, Inspection and safety testing, for instance, do not directly add value to the final product, but they are required to verify that the product is safe for the customer.
- ❖ The second type of Muda includes non-value-added tasks in its processes, which are useless for the customer, and these types of muda should be removed(Natalie J. Sayer, 2007).

Jones and Womack improved them and attempted to create seven clear forms of waste: (overproduction, waiting, unnecessary transportation, unnecessary motion, overprocessing, excess inventory, and defects). Each of these seven types of muda waste represents an opportunity for improvement and cost reduction(Womack, J.P. and Jones, 1996).

Additionally, the eighth type of waste, known as talents, emphasizes the loss of employee skills, knowledge, and creativity due to underutilization or lack of engagement, highlighting the significance of empowering and leveraging talent in Lean Production.

Mura (斑, Unevenness).

Mura, or unevenness, is a central concept in lean manufacturing. It refers to irregularities within production processes, such as demand fluctuations, workload variations, inventory imbalances, and machine downtime. These inconsistencies hinder efficiency, increase costs, affect product quality, and can lead to employee stress. Addressing Mura is important for lean objectives, involving strategies like leveling production, standardizing work, flexible staffing, implementing pull systems, and fostering continuous improvement. By tackling Mura systematically, organizations can enhance efficiency, cut costs, improve quality, and create customer-centric, sustainable operations aligned with lean principles.

Muri (無理, Overburden)

"Muri" in lean manufacturing and the Toyota Production System means overburden or excessive strain on systems, processes, or individuals. It manifests through excessive workloads, machinery strain, tight deadlines, and resource misallocation, leading to reduced efficiency, lower quality, increased costs, and employee burnout.

Muri indicates that your employees and procedures are overworked. One of the reasons they are overwhelmed is that they are not functioning to their full capacity. This might be the outcome of production fluctuations, poor job design or ergonomics, bad component fit, insufficient tools or equipment, and imprecise requirements (Damrath, 2012).

Strategies to overcome Muri include load balancing, standardized work, capacity analysis, continuous improvement (Kaizen), and optimized resource allocation. Addressing Muri enhances efficiency, quality, and employee well-being by creating a more balanced and sustainable workflow.

The eight types of Muda waste.

There are several descriptions of waste, but TPS and Taiichi Ohno's categorization of the seven types of waste, also known as (The seven Muda waste), is the most well-known. Later, James Womack and Daniel Jones in the late 90´s added the eighth waste, also known as the waste of unused human skill and creativity.Even though it was not one of the TPS wastes, it is well known cf 2.16. Liker (2004).

Figure 2. 16 The eight types of wastes(Six sigma daily, n.d.)

Here's a brief explanation of each type of waste:

1. **Overproduction**: According to Ohno, manufacturing products or production at an earlier stage than the client requires is the worst type of waste since it is the source of many other types of waste. This produces lengthy lead times and a great deal of effort. When an employee handles an order and delivers it to the incorrect client or forgets to send it, this form of waste is produced in the workplace. (Taiichi Ohno, 1988)

To decrease this sort of waste, it is important to communicate effectively with consumers to determine their use of the offered product or service. Knowing the customer's needs and desires simplifies eliminating NVA work waste.

2. **Over-Processing**: When a product or service is over-processed, more effort, more components, or more stages are included than what the consumer has requested. For example, in Figure 2.17 below, you can see some scenarios.

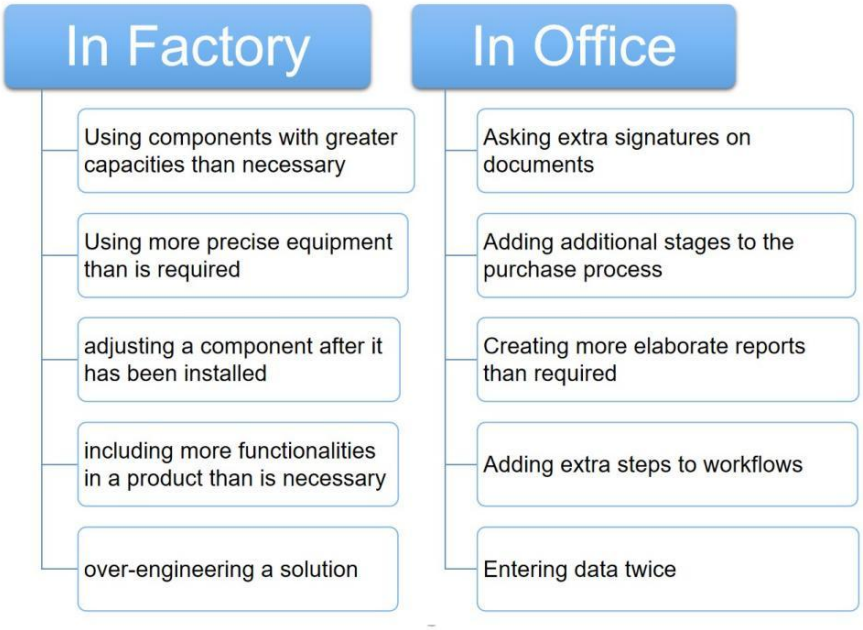


Figure 2. 17 Some examples of over-processing waste in Factory & Office

3. **Waiting**: Waiting for waste is probably the most apparent type of waste everyone may relate to. Waiting for data, deliveries, machinery, people, communications, or materials may be associated with various wasteful situations. When a production worker must wait for another production stage to conclude, this is often called waiting waste. In an office setting, we see that slow equipment and printers cause waiting or that an executive team (B) must wait for another functional team (A) to complete their work before continuing their own.
4. **Motion**: The term "motion waste" refers to any wasteful movement of people, machinery, or equipment. This involves walking, lifting, reaching, bending, and stretching, among other activities. Tasks requiring excessive mobility should be changed to improve workers' work and raise health and safety standards. Figure 2.18 below shows some examples:

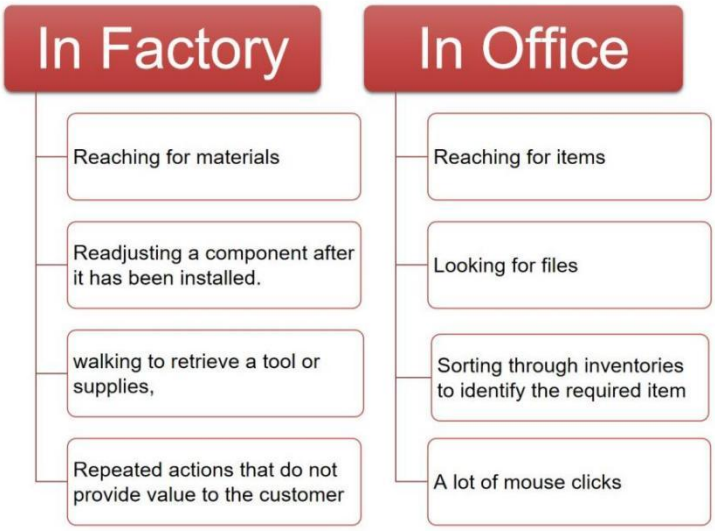


Figure 2. 18 Some examples of motion waste in Factory & Office

Solutions for motion can include ensuring that the workplace is well organized, positioning equipment close to the working area, and appropriately positioning items to avoid bending and straining.

5. **Defect:** Defects happen when a product is unsuitable for its planned use. This often leads to the product being reworked or destroyed. Both outcomes are unproductive because they increase operational expenses without producing consumer benefits**.**

   There are four solutions for defects:

   - ❖ Concentrate your focus on the most prevalent defect.
   - ❖ Create a procedure to identify irregularities and prevent the creation of defective products.
   - ❖ Redesign the procedure in a way that it does not produce defects.
   - ❖ Standardize work to achieve a uniform, defect-free production process.

6. **Transportation:** Transportation waste can be the unnecessary movement of employees, tools, inventories, equipment, or goods. Defects and product damage may result from excessive material movement. Furthermore, moving people and equipment around might cause additional effort, increased stress and damage, and tiredness.

   Employees who often cooperate with one another in the office should be near each other to decrease transportation waste.

7. **Inventory:** It might be challenging to see extra inventory as waste. Inventory is usually seen as an investment in accounting, and suppliers often provide savings for large orders. However, maintaining more inventory than required to support a regular flow of work may result in product flaws or damaged

materials, longer production lead times, inefficient use of capital, and difficulties concealed in the inventory. Figure 2.19 below shows some examples of inventory waste.

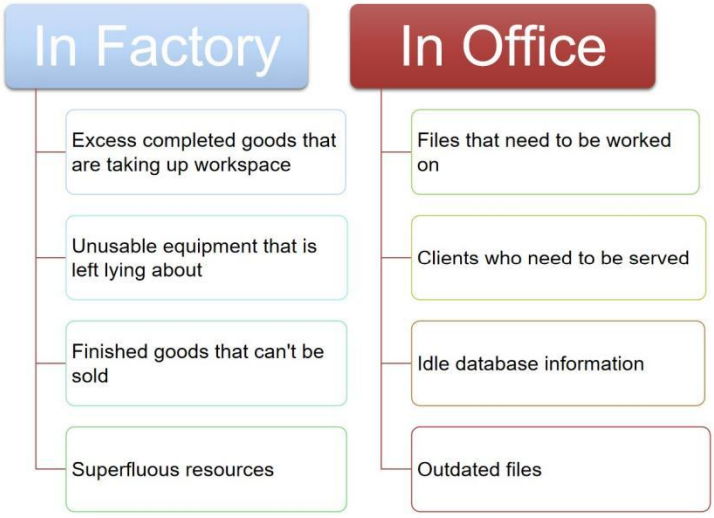


Figure 2. 19 Some examples of Inventory waste in Factory & Office

8. **Skills**: The eighth waste is applicable in both industry and office sectors. Talents, excellent ideas, time, and training experiences may be wasted if their coworkers do not interact with or listen to them. This factor might hinder the workers' use of their creativity and expertise. A common error associated with this is refusing to include workers in procedures that might enhance the operating procedures.

In conclusion, waste is an important topic addressed in lean production. Waste is divided into three categories: muda, mura, and muri. Muda represents a variety of wastes that reduce productivity, such as overproduction, waiting, unnecessary transportation, overprocessing, excess inventory, and defect waste. The eighth type of Muda waste, known as talent waste, highlights the loss of employee skills, knowledge, and creativity due to underutilization or lack of engagement. The main idea of lean manufacturing is eliminating waste since it increases productivity and lowers costs. Organizations may enhance their operations and provide more value to consumers by detecting and removing various sorts of waste.

2.1.5 Lean in the Service Industry

Lean concepts can be used in many different industries, not just manufacturing. They are instrumental in the service business. Even though the basic ideas are the same, each service has its own traits that require a different method. So, lean service focuses on improving operating quality, getting good financial results, and motivating employees to act in a good way. However, transferring industry tools to

services that can't be seen or touched doesn't always get the desired results. Less waste, empowering employees, and delivering on time are all important parts of Lean service. Excellence and constant growth are also based on putting the customer first and exceeding their expectations.

Lean service is a set of tools and methods that can raise operating standards, ensure good financial returns, and improve employee behavior. But, you should be careful because you might not get the results you want if you use tools made for manufacturing processes on services that are not physical. (Vignesh et al., 2016) (Andrés-López et al., 2015)

The five principles of Lean philosophy outlined by ART Byrne and Womack (2013) are equally applicable in the service sector. To meet customer needs, a service company must first and foremost offer essential value. Second, value stream mapping gives a complete picture of processes, steps, activities, and costs, which lets you set prices with more knowledge.

Flow optimization comes into play when a service company wants to cut down on waste. Leite and Vieira (2015) say that most service loss comes from employees being unable to make decisions independently, service mistakes, and transportation delays. In the manufacturing sector, goods are made and then kept. In the service sector, things happen in real-time, so there is no need to worry about overproduction or loss. As shown in Figure 2.20 below, the key pillars of the service industry are (Waste Reduction, Employee Empowerment, and Punctual Delivery).

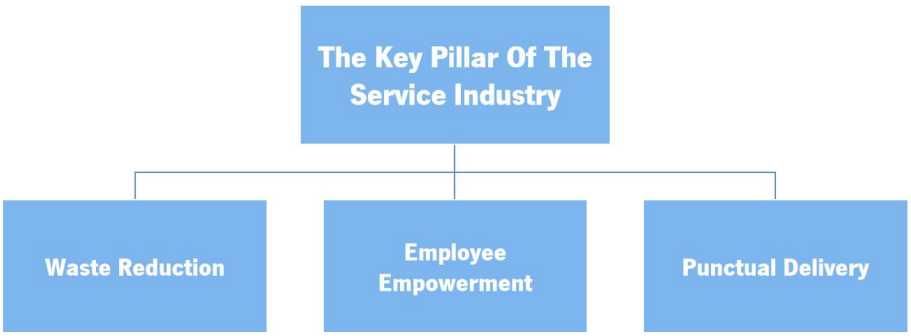


Figure 2. 20 The key pillar of the service industry.

In the service business, the employee is at the center of everything. They are the most important source of knowledge, the tool for delivering services, and the key to production and delivery.

The "To-Be-In-Time" idea is the most important in the service business. It ensures that services are provided quickly and in line with customers' wants. This stops waste and overproduction. Unlike manufacturing, services are provided upon request, mitigating the risk of excess production and associated waste.

The most important things in the service field are quality and constant growth. Organizations must continuously improve their services and how they offer them, and customer feedback is a key part of this process. To get accurate feedback, you need to build direct relationships with customers.

2.1.6 Lean Office

Lean Office applies lean principles to non-manufacturing and non-physical tasks, specifically within office settings or administrative departments of businesses. In this context, value is defined as the transfer of information and knowledge. It is a methodology grounded in Lean Thinking and an adaptation of Lean Production, aiming to deliver similar advantages to those the Toyota Production System offers. While Lean Production suits situations involving physical flow, Lean Office is particularly relevant in contexts characterized by the flow of information and knowledge (McManus et al., 2007).

The emergence of Lean Office can be attributed to businesses recognizing the necessity of applying these concepts to administrative environments and optimizing information flow within procedures. Before this, companies primarily focused on implementing Lean Production on the factory floor, aiming to identify and eliminate non-value-added tasks.

The significance of lean thinking in administrative areas becomes evident when it is determined that a substantial portion (60% to 80%) of expenditures related to customer requirements are administrative (Don Tapping, 2003).

Table 2.10 below illustrates the distinctions in the value stream between Lean Production concepts for production and administration (McManus et al., 2007):

Principal	Production	Administration
Value	Visible at each phase with a well-defined goal	Difficult to visualize with Emerging goals.
Value Stream	Materials, components	Information and knowledge
Continuous flow	Interactions are waste	Interactions must be effective when planned.
Pull Production	Based on Takt-Time	Based on business need
Seek perfection	Errorless process repetition	The method facilitates organizational enhancement.

Table 2. 10 Differences between office and production principles

Research conducted by the authors suggests that while certain industrial and service organizations have embraced integrated Lean practices, higher education institutions (HEIs) have been slow in adopting and advancing this process excellence technique (Antony et al., 2018).

In conclusion, lean office is the application of lean principles to non-manufacturing operations, focusing on optimizing the flow of information and knowledge. While lean production is suited for physical flow, lean office is highly relevant in contexts where information is the primary flow. Its adoption becomes crucial in administrative areas when a significant portion of expenses are administrative in nature. However, it is worth noting that HEIs have been slower in adopting lean practices than industrial and service organizations, despite their benefits.

2.1.7 Lean in Higher Education

Lean higher education has emerged as a transformative method for post-secondary schools looking to meet the changing demands of the higher education environment. In its application to higher education institutions (HEIs), LHE promotes "respect for people" and "continuous improvement," which is a management theory that the Toyota Motor Corporation pioneered. This method helps HEIs match their operations with the overall goals of beating client standards, controlling costs in an era of financial restraints, meeting public transparency requirements, and improving resource usage (Balzer et al., 2016).

Lean thought encourages HEIs to view their services through the lens of students, staff, managers, future companies, and government agencies, considering these groups as crucial to their success. While the idea of "customers" and "products" may not directly translate to the higher education setting, the principles of lean management can be changed to fit the unique nature of educational services (Haerizadeh & Sunder M, 2019).

This approach pulls from the same basic ideas and methods used in various fields, including industry, services, and government. It suits the unique control structures of HEIs and matches the interests of multiple parties, supporting cooperation rather than a zero-sum game (Salewski & Klein, 2009).

By implementing lean thinking, HEIs can enable student activity-based learning, boosting involvement and efficiency. This method understands that lean in higher education varies from its application in industry or standard services due to the specialized nature of educational services.

In conclusion, Lean Higher Education (LHE) offers post-secondary schools a realistic approach to meet the changing needs of the higher education field. This method helps HEIs to enhance output, lower

costs, meet accountability standards, and carefully deploy resources. In doing so, LHE helps students, teachers, and all partners, enabling higher education schools to thrive in an ever-changing educational environment.

2.2 Structure and Writing a Dissertation

This section delves into the fundamental aspects of writing a dissertation. This chapter aims to provide a comprehensive understanding of the distinctive characteristics of an academic dissertation, its structure, the process of writing, and the typical challenges that students may encounter during this endeavor. By exploring these topics, this chapter aims to equip students with the knowledge and tools to embark on their dissertation journey confidently.

2.2.1 An introduction to Dissertation

This section provides an overview of the dissertation's significance in academics. It explores a dissertation's purpose and objectives, highlighting its role in advancing knowledge. By understanding the nature and scope of a dissertation, students gain a comprehensive understanding of the expectations and standards required for successful completion.

A Dissertation is a comprehensive written investigation on a subject of the student's choosing. It takes a significant amount of time to complete and requires extensive writing and research under the supervision of a faculty supervisor. Dissertations tend to be longer in theoretical subjects and shorter in practical ones. The content and length vary based on your topic of study.

The term dissertation, according to the Concise Oxford Dictionary of Current English, is "a comprehensive discourse about a subject, especially one submitted in partial fulfillment of the requirements of a degree or diploma." The word originates from its Latin root, "disserto," which means to "talk, debate, dispute, or negotiate".(Thomas Hainey, 2022)

This dissertation is often the last assignment for a degree program or a final module for an academic study. Over the course of their school years, students have been given a lot of different kinds of knowledge to help them. However, a big part of what I've learned has come from doing research on my own for different projects. As a result, the dissertation can be seen as a way to practice learning on your own. Universities are using the terms "independent study" and "dissertation" more and more similarly, as they mean the same thing. No matter what the school calls it, the dissertation or independent study is a

test of the researchers' knowledge, their ability to collect and analyze data, and their ability to come to well-supported conclusions, as Buckler and Walliman (2008) said.

The main difference from previous works lies in the fact that students work on their dissertations independently. Most choices about the study technique and methods are made by the students themselves. They receive initial guidance on how to approach the work and have a supervisor to monitor their progress. This arrangement provides students with a considerable amount of freedom to pursue their interests and leverage their skills. Consequently, the project necessitates reflection and an analysis of the areas with the most promise. According to Buckler and Walliman (2008), the researchers are the only ones who can decide how to show themselves in the best way possible.

It is noteworthy, however, that the dissertation doesn't reach completion in a single, seamless step where students write parts consecutively. According to Buckler and Walliman (2008), the key to a successful dissertation lies in ensuring that the final product develops logically without abrupt changes. Consequently, there needs to be a reasonable sense of progression and order, with different parts receiving varying degrees of attention.

In conclusion, the dissertation represents a significant milestone in academic work, allowing students to showcase their expertise and enhance their knowledge and research abilities. While it offers freedom, a supervisor's guidance enables students to maximize their unique talents. A well-written dissertation demands extensive research, creative thinking, and logical progression, underscoring the importance of independence and the ability to deliver a persuasive presentation.

2.2.2 The Structure of Academic Dissertation

In this section, the structural elements of an academic dissertation are explored. A well-structured dissertation adheres to a specific format that includes various chapters and sections. The organization and sequencing of these components, such as the introduction, literature review, methodology, findings, and conclusion, are examined. By understanding the purpose and content of each section, students can effectively present their research logically and coherently.

The format of the dissertation will depend on the subject matter or discipline for which the student is writing. For instance, a dissertation prepared for a topic in the humanities differs in structure from one written for a subject in science. Nonetheless, it will typically include at least four or five chapters, encompassing an introduction and conclusion chapter.

In most cases, instructions and recommendations will specify the structure and manner in which the dissertation should be written. To create an outline for the dissertation, students should thoroughly read and comprehend the provided instructions. If there are no specific directions for the structure, then adhering to a general plan is recommended.

A dissertation that follows the "simple" conventional format reports on a single research project and contains the standard organizational components of an "introduction," "review of the literature," "materials and methods," "results," "discussion," and "conclusion."(Starfield & Paltridge, 2019)

Generally, a dissertation structure will consist of several contents (GDSCs) (cf Figure 2.21). It is important for students to confirm with their studies department the type of structure required, as different academic areas call for different dissertation formats.

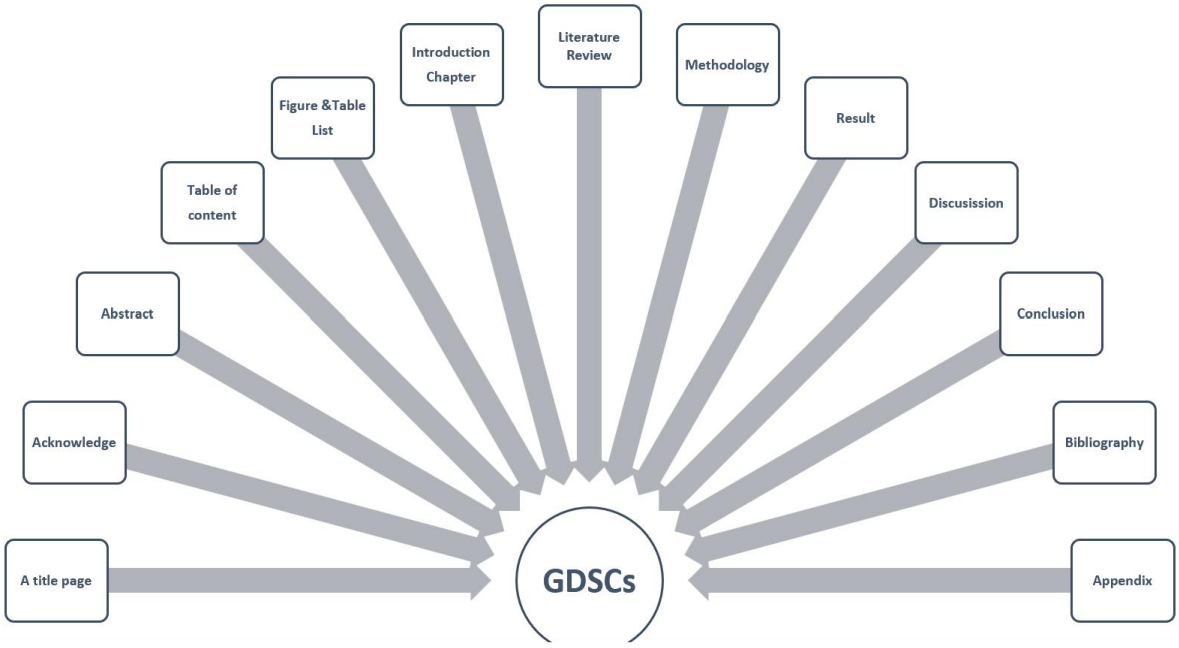


Figure 2. 21 General Dissertation Structure Contents (GDSCs)

A Title Page:

The first page of a dissertation includes information about the dissertation title, the author, date of submission, etc. (cf Figure 2.22).

It is important to note that a title page should be organized according to the format specified for your dissertation. Students should ensure to inquire with their faculty about the specific requirements.

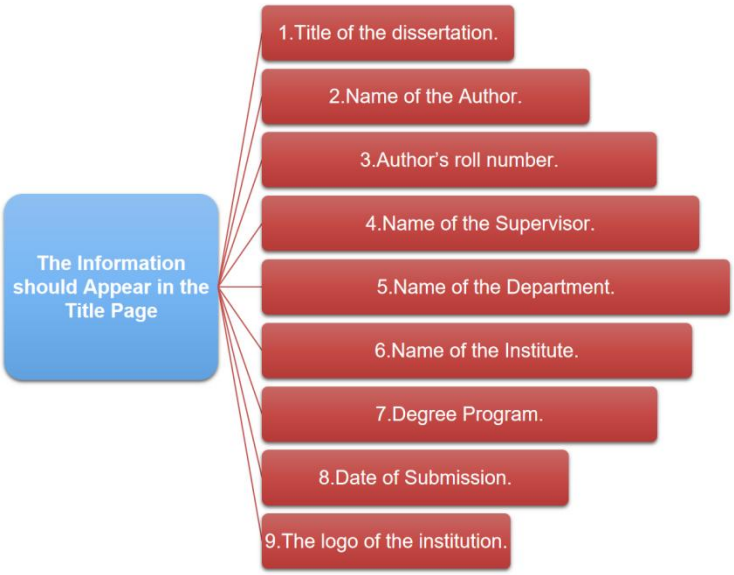


Figure 2. 22 The information should be written in the Title Page

Acknowledgement:

In this section, the student has the opportunity to express gratitude to the individuals who supported them throughout their study. In most cases, this section is optional and does not impact the grade; however, it is considered good academic practice to include it.

Abstract:

An abstract serves as a concise overview or digest of an article or dissertation. Writing a proficient abstract requires skill, and the most effective way to enhance summarizing and highlighting abilities is by reading multiple abstracts. The purpose of an abstract is to assist a potential reader in academia or research in determining whether the content aligns with their interests based on the topic or title.

Table of Contents

The table of contents for the dissertation comprises a listing of chapters and headings. All headings and sub-headings in the dissertation are presented in tables along with their respective page numbers.

List of Figures and Tables

This section provides a list of captions for figures and tables along with the corresponding page numbers, facilitating easier navigation for readers.

List of Abbreviation

The collection of abbreviations includes highly technical words and concepts. This section is designed to simplify the understanding of complex or unfamiliar terminology for readers.

An Introduction Chapter:

The introduction chapter, being the first chapter of the dissertation, allows the student to introduce their research project to the readers. This chapter provides a more detailed explanation of the abstract, expanding on its contents. The introduction goes beyond the brevity of the abstract, guiding the reader to understand the how, what, and why of the study. Adhering to these guidelines establishes a robust foundation for the remainder of the dissertation (Queen & Squires, 2011).

Literature Review:

A A literature review constitutes a significant component of a dissertation. In this section, the student evaluates compelling academic works on the topic, typically sourced from academic journal articles and high-quality industry publications. The purpose is to ensure that readers gain a comprehensive understanding of the topic through previously published academic papers.

Conducting a literature review demonstrates the student's comprehension of the subject's terminology, theories, significant variables, phenomena, methodologies, and history. It also enlightens the student about key scholars and study groups in the area. As stated by Randolph (2009), with minor modifications, the literature review is considered a "legitimate and publishable scholarly document."

Writing a literature review provides the framework for connecting recent results to earlier findings in the discussion part of a dissertation. Understanding the current condition of prior research is essential to assessing how the new study advances the existing body of knowledge (Randolph, 2009).

Methodology:

This section outlines the procedure for conducting the study, presenting details such as the type of research, data collection process, study topic, data analysis process, tools used, limitations, and rationale for data collection decisions.

The approach must be convincing to achieve the study's goals. In section 1.3 of this dissertation, the research methodology has been explained thoroughly (Queen & Squires, 2011).

The methodology section naturally follows the literature review, as the researcher outlines their research issue and reviews existing literature before detailing their approach

Results:

This section presents the investigation results, focusing on hypotheses, sub-questions, or subjects relevant to and supporting the study's goals. Depending on the dissertation style, the result section and discussion chapter may be separate, or the discussion may include the results.

Discussion:

The discussion section is prepared once the researcher has the results of their study. It assesses whether the results support the initial premise, highlights objectives and tasks outlined in the introduction, and addresses whether the results address the research questions. The validity and reliability of the findings are demonstrated, including a summary of key findings, a thorough analysis of data not supporting the hypothesis, and an exploration of restrictions affecting result reliability.

Conclusion:

This concise section outlines the student's accomplishments, summarizes study results, and suggests potential directions for future research. The conclusion is a critical component as committee members assess it after the introduction to determine if the goals outlined at the start of the dissertation have been achieved. It emphasizes key results, offers fresh perspectives, and identifies any gaps and restrictions in the research.

Bibliography:

The bibliography should enumerate all the sources utilized during the student's study. The author's last name must be provided alphabetically after each reference.

Appendices:

Some students include appendices in their dissertation plans, presenting additional data related to their research in the form of diagrams, tables, charts, maps, interviews, or questions. Appendices should strictly contain information relevant to the thesis's main body.

In conclusion, the structural elements of an academic dissertation play a vital role in presenting research logically and coherently. The format of a dissertation varies based on the subject or discipline, typically comprising chapters such as an introduction, literature review, methodology, results, discussion, and conclusion. Each component contributes to the overall success of the dissertation. The title page, acknowledgment, abstract, table of contents, list of figures and tables, and list of abbreviations provide essential information and aid in navigation. The introduction chapter introduces the research project, while the literature review demonstrates an understanding of previous academic works. The methodology section explains the research process, and the results and discussion sections present and analyze the findings. The conclusion summarizes accomplishments and highlights future research directions. Finally, the bibliography and appendices provide additional supporting material. Students can effectively communicate their findings by understanding and adhering to the appropriate structure.

2.2.3 How to Write an Academic Dissertation

This section focuses on essential components for a successful dissertation writing process (DWP). It covers defining a realistic goal, gathering necessary resources, organizing content effectively, initiating the writing process, ensuring coherence and flow, and incorporating suitable illustrations.

Writing up your dissertation is somewhat of a "rite of passage," but after years of research and study, it may be intimidating. Many students struggle to understand what is required of them during the last phase of their studies, which includes submitting their thesis for review. Figure 2.23 below shows the phases student needs to pass during DWP:

Figure 2. 23 Dissertation Writing Process Phases

Defining a realistic goal: Setting clear goals that include multiple sub-goals instead of just one main goal is an important aspect of writing a dissertation. Setting a broad goal, such as "The completion of the thesis in 5 months," may seem less productive. Although this may be the ultimate goal, it is crucial to break down this main goal into smaller, more achievable sub-goals. One challenge with a large goal is that a sense of accomplishment may not be felt until the entire paper is finished. Throughout the process, setting smaller targets or goals that contribute to the main goal is essential. This method is crucial for achieving success and maintaining sanity during the project.

Preparing all the needs: Prepare what is needed on the journey to the goal; it can include:

a) Drafts of the figures that may need to be used in each chapter.

b) Collecting and analyzing raw data and comprehensively explaining the statistical analysis used to present the results.

c) Referring to the sources of the tools and chemicals.

d) Collecting a bibliography to utilize for the dissertation

Organizing the content for the dissertation and how to begin writing it: As mentioned in the earlier section, the general introduction, methods, results (typically divided into numerous chapters, each with a very short introduction but with complete discussion), overall discussion, and bibliography constitute the usual dissertation content. Additionally, there will be acknowledgment, chapter and figure indexes, etc.

Connectivity: keeping in touch with the supervisor, seeking their feedback, following their comments, and redoing what they have asked to be changed. Until reaching the last version of the draft.

The dissertation's illustration: Considering the overall appearance of the dissertation is crucial. Although most institutions have their preferred writing formats, students should take this step to contemplate how they should illustrate their dissertations. Aspects like the type of photo used, its quality, font size, spacing between lines, etc., have an impact on how readers will relate to the dissertation.

In conclusion, this section underscores vital elements for a successful Dissertation Writing Process (DWP), emphasizing realistic goal-setting, comprehensive preparation, effective organization, continual connectivity with the supervisor, and thoughtful dissertation illustration.

2.2.4 The Typical Challenges of Writing a Dissertation

A A dissertation is not something a student can write easily. Everyone has a unique experience, but if students talk to their peers, they'll find that most of them struggle with the same issues. For a dissertation to be completed successfully, it is necessary to recognize and overcome these obstacles. This section provides helpful advice and methods for overcoming these obstacles. Let's look at the most typical difficulties students could encounter during their Dissertation Writing Process (DWP). Cf Figure 2.24.

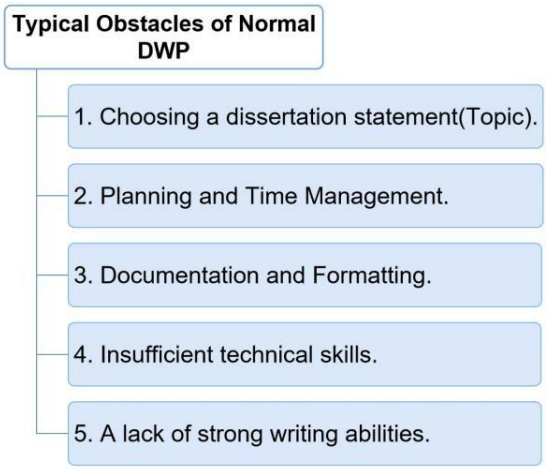


Figure 2. 24 Typical Obstacles of Normal DWP

1)Choosing a dissertation statement (Topic): Most students will have difficulty selecting the right topic; a topic with a wide scope may lead them in different directions, make it more difficult for them to obtain supporting data, and be more challenging to defend.

2) Planning and Time Management: Between choosing the dissertation statement and writing the dissertation, time management undoubtedly is one of the biggest obstacles students encounter. The interaction will go much smoother if the period is designated as the board plan and if a timetable is followed regularly and dependably.

3) Documentation and Formatting: The problem of formatting is a third challenge that students face while writing their dissertations. Each institution has its unique style manual and rules, but students often struggle to comprehend and apply them. Some rules, like specifying spaces after a period or deciding on page numbering in Arabic or Roman, prove particularly challenging.

4) Insufficient technical skills: Software issues might arise while writing a dissertation. Unexpectedly, many students graduate with Ph.D. degrees while unfamiliar with some obscure guidelines for using word-processing software like Microsoft Word. For instance, many students struggle to format a document such that page numbers vary from section to section under the demands of the school style guide or include a section break.

5) A lack of strong writing abilities: Obtaining excellent, relevant sources for a dissertation is a significant step in the proper direction. However, access to the most recent information does not guarantee success. The facts must be accurately and succinctly written out. This implies that, in order to

synthesize and tie the contents together while staying on topic, students must have strong writing abilities. For instance, the literature review considered the hardest section to write shouldn't just be a collection of citations and references. Students should employ perfect language and terminology to produce a concise and measured interpretation and writing of the literature review.

In the end, it can be said that writing a dissertation involves several challenges, such as choosing a thesis statement, managing time and plans, making sure the necessary paperwork and formatting are used, overcoming poor writing abilities, and dealing with technological issues. For completion to be effective, certain challenges must be overcome.

In conclusion, Chapter 2 of the dissertation consists of two main sections. The first section delves into the origins, principles, and tools of lean manufacturing, emphasizing its influence on waste reduction and continuous improvement across various sectors, including its application in the service industry, administrative functions (Lean Office), and higher education (Lean Higher Education). The subsequent section serves as a research guide, introducing dissertation requirements to support and elevate scholarly work.

CHAPTER 3: COLLECTING AND ANALYZING DATA IN TYPICAL WASTES DURING DWP IN THE FORM OF A SURVEY

As stated in the first chapter, to answer the first question of the research *What are the common challenges (barriers) students face during the DWP?* this survey aims to identify the problems and obstacles encountered during the writing phase of a Master's or Ph.D. dissertation that cause them waste time, which is considered as one of the primary resource that a student needs during their DWP.

In the context of dissertation writing, waste is defined as any activities, processes, or elements that do not contribute directly to the successful completion of the research and writing process. Waste can take various forms and deplete valuable time, energy, and resources without significantly enhancing the outcome. The identification and minimization of waste are crucial for enhancing productivity and ensuring the efficient completion of a dissertation.

Establishing clear goals, formulating an effective plan, prioritizing work, and maintaining a disciplined time management strategy all contribute to reducing waste throughout the dissertation writing process (DWP). Regularly evaluating the usefulness and importance of writing-related activities and tasks allows for the identification and removal of waste, thereby making the DWP more effective and successful.

Drawing from insights obtained through a literature review and interviews with some master students at the university, a questionnaire was developed to ascertain if other students had encountered similar issues. What major challenges are they facing? What significant waste streams are present, and how could lean methodologies be employed to address these issues?

3.1 Descriptive statistics (Demographic Data)

To enhance the authenticity of our data, we carefully put together a survey with a wide range of people. We strategically reached a global audience by sharing the survey on social media with foreign communication groups, like the Erasmus students group at UMinho. We also asked friends at different universities and countries for help and asked them to share the survey with their education groups. This method made sure that the participants were diverse, with people with different levels of schooling and academic positions, such as Master's and Ph.D. students and professors from different universities.

Figure 3.1 visually depicts the presence of participants at different education levels, featuring both Ph.D. and Master's students, along with their respective supervisors. This deliberate inclusion of supervisors, who serve as customers in this context, offers a comprehensive view of opinions within this academic dynamic.

One significant obstacle explored in our study is the impact of language skills on students. The challenge arises when students are compelled to write in a language other than their native or maternal language. This difficulty is amplified when students need to utilize a second or even a third language, commonly English. To address this, our participant pool consisted of individuals proficient in both native English and other maternal languages worldwide. Table 3.1 illustrates this commitment, showcasing participants proficient in 15 distinct mother languages.

Moreover, we recognized the potential divergence in experiences based on the differences in higher education systems across countries. Our study deliberately sought participants from a broad spectrum of countries to ensure comprehensive coverage of these disparities. Table 3.1 further highlights this global approach, indicating the inclusion of participants from 29 different countries spanning the EU, Africa, Asia, and the Americas continent.

In summary, this section delves into the demographics of the study population, providing insights into their age, nationality, first language, and education level distributions.

1. **Age Distribution:** The figures below show how the participants were distributed by gender and education level. The age ranges for 50% of the reported cases were 25 to 35, 25.6% were 18 to 25, and 22.1% were 35 to 50. The rest of the participants were over the age of 50.

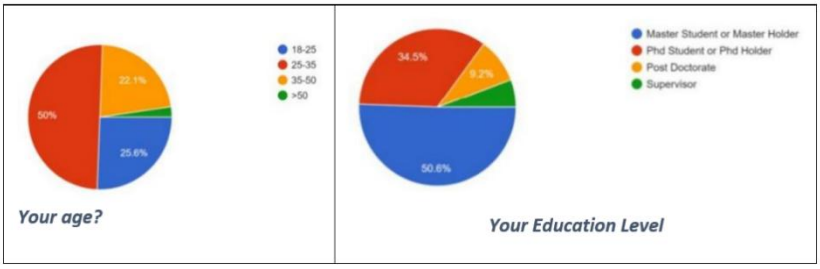


Figure 3. 1 Age & Education Level Distribution (N = 86)

2. **Education Level Distributions:** As shown in Figure 3.1, the majority of the cases presented, 50.6%, were master students or master holders, followed by 34.5% were Ph.D. students or Ph.D. holders, and 9.2% were post-doctorates. The rest were supervisors.
3. **Nationality:** In Table 3.1, the nationality of the participants is reflected.

4. **First Language Distributions:** Table 3.1 shows the diversity of the survey based on their first language.

Nationality	Numbers	Percentage
Angolan	2	0.024096386
Algerian	1	0.012048193
Belgian	1	0.012048193
Bolivian	1	0.012048193
Brazilain	3	0.036144578
British	2	0.024096386
Capoverdian	1	0.012048193
chinese	1	0.012048193
Colombian	1	0.012048193
Danish	1	0.012048193
Ecquadorian	1	0.012048193
Egyptian	3	0.036144578
France	4	0.048192771
Iraqi	6	0.072289157
Italian	2	0.024096386
Jordanian	7	0.084337349
Lebanese	4	0.048192771
Norwegian	1	0.012048193
Pelestinian	3	0.036144578
Portugese	18	0.21686747
Slovak	1	0.012048193
Spanish	2	0.024096386
syrian	8	0.096385542
Tunisia	3	0.036144578
Turkish	2	0.024096386
American	1	0.012048193
Ukranian	1	0.012048193
Yemeni	1	0.012048193
Saudi	1	0.012048193
Total	83	100

First Language	Number of participant	Percentage
Arabic	36	0.418604651
Mandarin	1	0.011627907
Crioulo	1	0.011627907
Danish	1	0.011627907
English	3	0.034883721
French	5	0.058139535
Italian	2	0.023255814
Kurdish	6	0.069767442
Norwegian`	1	0.011627907
Portugeses	22	0.255813953
Slovak	1	0.011627907
Spanish	4	0.046511628
Turkish	2	0.023255814
Ukranian	1	0.011627907
Total	86	100

Table 3. 1 Nationality & First Language of the Participant

3.2 Analyzing the Questions

After verbally polling some students, we identified the primary wastes that a researcher would encounter, and we built our questionnaire on those wastes to determine if it occurred with other researchers worldwide, even if they are not under the same education system, as it is shown in section 3.1. Cf Table 3.2.

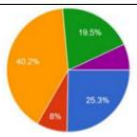
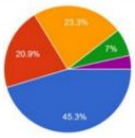
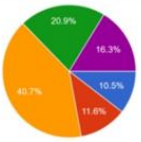
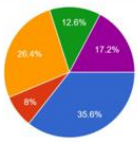
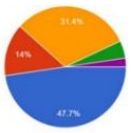
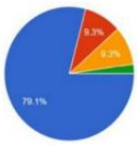
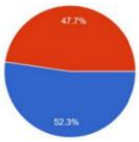
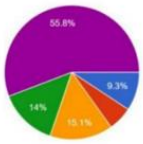
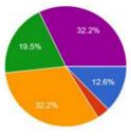
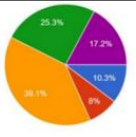
	A	B	C
1	 *If following a well-defined methodology would help in improving DWP?*	 *If you have lost time waiting for your supervisor to respond to them?*	 *If you have lost time waiting for data collection or Lab availability?*
2	 *If you had to repeat an experiment because of errors or mistakes in Data collection/ Lab work?*	 *Have you rewritten a text that you forgot to save or because of technical reasons?*	 *If you have lost time searching for uncited references that you had used?*
3	 *If you have removed a text since you lost their references?*	 *If you have rewritten a text because of bad quality?*	 *Have you purchased books/printed academic papers to use in your studies?*
4	 *have rescheduled a meeting with your supervisor since you did not prepare what they required?*	 *If you have forgotten a scheduled meeting with your supervisor?*	 ***If you were aware of the discounts & free services of your universities?***
5	 *How frequently have you met your supervisor?*	 *The Participants have met their supervisor in person?*	 *If you have removed some irrelevant or out-of-scope texts?*
6	 *If you have gotten distracted by social media during your work?*	 *If you could not concentrate on writing because of health or funding issues?*	 *If you could not concentrate on writing because of emotional, personal, or social-related issues?*

Table 3. 2 The Pie charts of the Survey answers.

In the first question, we asked the participants if they thought that using a clear approach would enhance the dissertation writing process. Nearly 82% of the participants, as indicated in (Table 3.2, cell 1A), believe that having a clear model would help enhance the dissertation process. Thus, it is likely that many students and researchers will benefit from our Lean research framework.

Waiting waste is one of the most noticeable wastes students face during their DWP, and most of the time, this kind of waste happens because of the second partner, which can be the supervisor, collected data, participants of a survey, or a lab.

2. That is why, in the second question, we asked our participants (If they had lost time waiting for their supervisor to respond to them?) As shown in (Table 3.2, cell 1B), over 70% of the participants said they wasted time waiting for their supervisor to meet them, reply to their emails, or provide feedback on their drafts at least a few times.

3. At least 75% of the participants, when asked whether they had ever wasted time waiting for data collection or lab availability, indicated that it had occurred to them more than once. Cf (Table 3.2, cell 1C),

Defect waste is another sort of waste that a student may encounter while working on their dissertation; therefore, we asked the participants about multiple situations in which astudents might face delays in finishing the process due to defect waste. As it is explained in points 4,5,6,7, and 8.

4. Repeating an experiment due to errors in data collection or lab work (during the writing of their dissertation) may prevent the student from completing the research. So, we asked our participants whether they had gone through such a situation or not. Approximately 80% of them confirmed that it occurred at least once. Cf (Table 3.2, cell 2A)

5. Students often experience losing texts and having to start again because they forgot to save their drafts or because of technical issues. So, we asked our participants if it had ever occurred to them, and nearly 65% of them said it had, at least once. Cf (Table 3.2, cell 2B).

6. Another frequent instance of squandering time while writing a dissertation is producing a draft without referencing it and then looking for the reference afterward. (Table 3.2, cell 2C) shows that about 70% of the participants had faced such a problem more than once, and (Table 3.2, cell 3A) shows that more than 50% of them had to delete a draft because they could not locate the references.

7. Rewriting a paragraph due to poor quality might be considered another defect or waste that can slow down the operation. As shown in (Table 3.2, cell 3B), approximately 90% of the participants had seen this waste at least once, with almost 80% having encountered it many times.

8. Removing a text since it was not related to the scope. We asked our participants to determine whether they had ever encountered this issue; the results show in (Table 3.2, cell 5C) that over 90% of them had to remove a written paragraph one or more times during their DWP.

Talent waste, which often happens due to the student's ignorance, is another kind of waste that may happen throughout the dissertation writing process. Any skill the students or their supervisors have but do not use falls under the category of talent waste. The services that their Universities or Institutions may also offer like discounts for specific software but they do not take advantage of them also fall under the category of talent waste. To ascertain if this was the case, we posed several questions to our participants, and they responded this way. C.f Point 9,10, and 11.

9. Missing or canceling a meeting with a supervisor can be considered a waste of talent since the students cannot benefit from their supervisor's expertise or ability, which wastes their time. We asked our participants if it had happened to them, and they answered as it appeared in (Table 3.2, cells 4A and 4B).

10. In return, any waiting that the students has, can be counted as talent waste since the student cannot use their talents. So, waiting for a supervisor, lab availability, or data collection can also be counted as talent waste. Cf (Table 3.2, cells 1B and 1C).

11. Also, as we mentioned above, not taking advantage of the offers and discounts of the student's institute can be counted as talent waste. So, we asked the participants if they knew about those benefits. As shown in the (Table 3.2, cell 4C), nearly 50% of the participants were unaware of their university offers and discounts.

Two other kinds of wastes that can be noticed in DWP are **Motion** and **Transportation** waste. Motion waste involves any needless motion that the researcher do going physically to meet supervisor or gathering data. Meanwhile, transportation waste involves any unnecessary movement of the student's tools or equipment that the student uses during DWP. Students could waste resources due to motion and transportation, as shown in the (Table 3.2, cells 5A and 5B). We can see in the figures that over 85% of the participants have seen their supervisor in person at least a few times during the process, and over 75% of participants have met with their supervisors at least once per month, which could cause both wastes. Therefore, any of these meetings that could be online can count as motion and transportation waste.

In addition to this conventional definition of waste, which is when a worker physically moves from one spot to another, we may state that throughout the DWP, any extra movements made by the students

when looking for a document, for example, searching for uncited references, as shown in (Table 3.2, cell 2C), online or on their own computer, counted as Motion waste.

Transportation waste, which follows motion waste on the list, is any unnecessary movement students make with their tools, such as personal computers, hard copies of books, lab work, data, etc. Moving a dissertation draft from one folder to another can cause transportation waste.

Overprocessing is another sort of waste that can happen During DWP. Writing more than required on a subject or a paragraph unrelated to the primary subject or research goal might be considered overprocessing.

However, since the full dissertation is the only product the students have, there won't be any overproduction if we treat the finished project as a solo product instead of the usual overproduction and inventory waste. Additionally, inventory will not be visible because only one piece of the product exists.

Since the research process depends entirely on the student, any circumstance that causes the students to stop or slow down in the process will impact the whole process. In addition to the previously mentioned factors, some additional personal factors, such as social and psychological factors, slow down and delay the process. According to our survey, most of our participants have stopped working on their processes due to psychological factors such as emotional, personal, or social-related issues. Cf (Table 3.2, Cell 6C).

Besides the psychological factors, another big obstacle students face today in terms of productivity is social media, as shown in (Table 3.2, cell 6A), where more than 85% of participants indicated that it distracted them during DWP.

In most cases, the students are not funded, the economy is another reason their DWP slows down since they have to work to live. Also, we should not forget health issues. Just like any other worker in other industries, students have health issues that can delay the DWP. According to our survey, more than 60% of the participants have stopped or are being sidetracked by health or financial concerns, as our participants have indicated in (Table 3.2, cell 6B)

Even so, the biggest resource a student will utilize to write their dissertation is their time, which directly impacts the process. Nevertheless, students can still waste resources like money and invest money in pointless instruments for their dissertations, for instance. For instance, purchasing resources or writing tools for their dissertation when they may borrow them from their institution might be considered a waste of money. It is when nearly 65% of our participants have bought a book or a source. Cf (Table 3.2Cell 3C).

CHAPTER 4: CONCEPTUAL MODEL FOR IMPLEMENTING LEAN IN DWP

Chapter four of this dissertation trys to answer the second and third question of the research dissertation. It guides students in preventing errors during the Dissertation Writing Process (DWP) and overcoming the challenges outlined in Chapter Three. The chapter explores the LDWP Framework, which focuses on the practical implementation of Lean tools to optimize the student's dissertation writing process (DWP). The chapter explains how Lean tools such as SMART Goals, Gantt Charts, the 5S methodology, the concept of bottlenecks, the Eisenhower Matrix, Kanban, the PDCA cycle, Poka Yoke, and Andon can be harnessed to enhance the DWP.

4.1 The Lean Dissertation Writing Process (LDWP) Framework

In this section, the aim is to present a streamlined dissertation model known as the Lean Dissertation Writing Process (LDWP) Framework. The framework serves as a well-defined structure to guide the dissertation writing process (DWP) while addressing common challenges encountered by students. The framework facilitates a more efficient and smoother DWP by comprising six sequential steps. By applying lean approaches, students may maximize their research efforts and reduce resource and time waste.

The journey begins with goal establishment and managing the tasks and activities needed to achieve the main goal. Students then organize and maintain the necessary materials for the journey and employ visual management techniques to monitor progress.

Figure 4.1 below shows the six steps of applying the LDWP, which guides the student through the step-by-step process to finish their DWP. Within each step of this process, the framework provides specialized tools to surmount obstacles students may encounter throughout the various phases of the DWP.

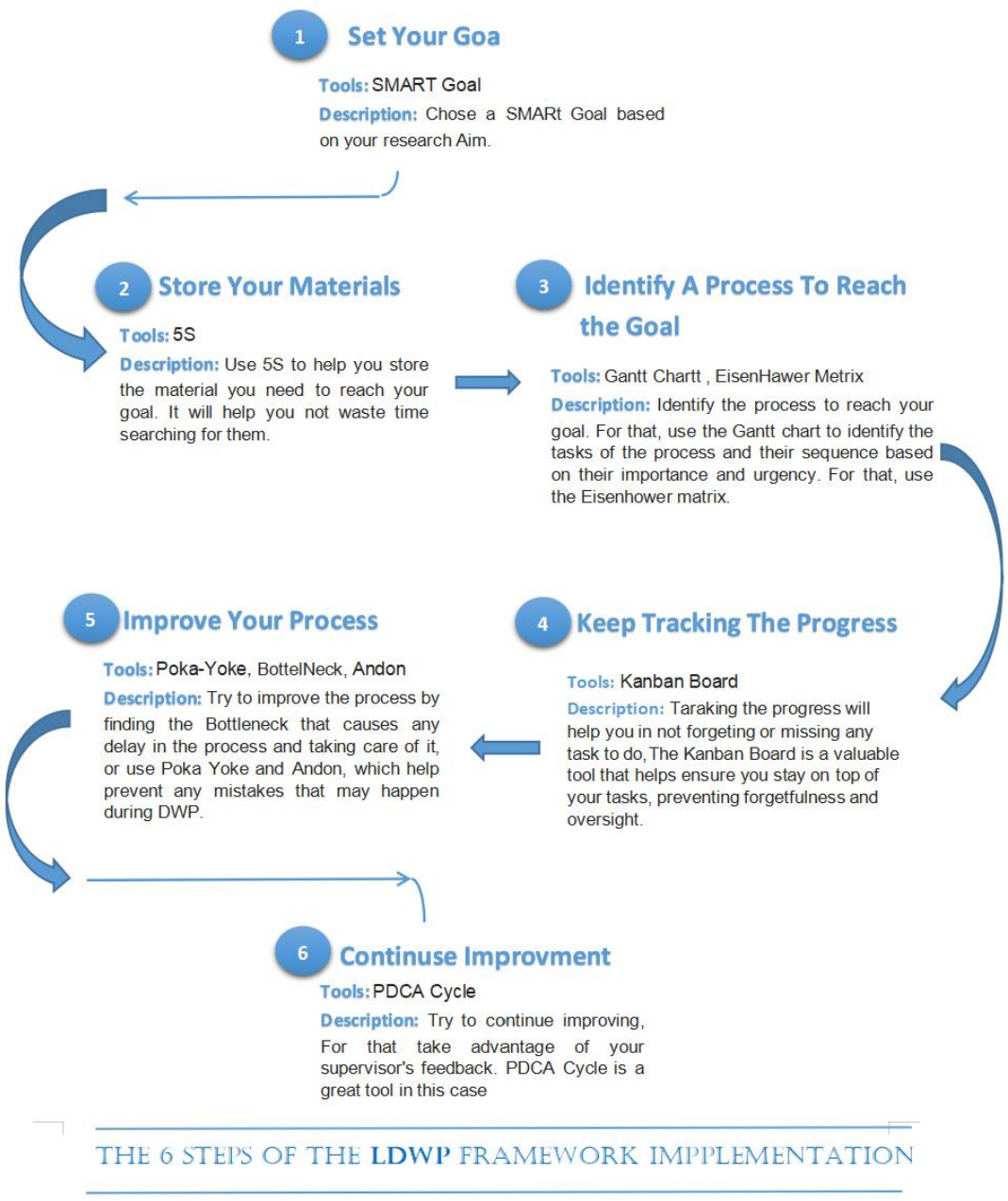


Figure 4. 1 The 6 Steps Of The Lean DWP Model

The framework starts with the early stages of the Dissertation Writing Process (DWP). When students have selected their topic or dissertation title, formulated their research questions, and defined their research aims, they often find themselves pondering, "What should be done next?" Setting a specific and well-defined goal based on their dissertation aim at this stage is important since it will have a substantial direct and indirect influence on the entire study process. Therefore, the first step starts by setting a goal, and the model is explained step by step.

Step 1: Set Your Goal.

Setting an established goal before starting any project is necessary since it lets the researcher carefully track the progress. This strategy reduces production delays and inefficiencies while preventing the unnecessary commitment of time and effort to pointless activities. As a researcher, after choosing the research aim, the researcher have a goal, but just having a general goal is not enough to increase the productivity and efficiency of the product. That is why this frame recommends a SMART (Specific, Measurable, Achievable, Relevant, Time-bound) goal.

A. SMART Goal:

Having a research aim such as "Writing a Lean research framework which helps students to write their dissertation" is still a goal, but too broad, and that does not help the student as a good goal should do in terms of directing and motivating them. That is why choosing a more specific goal will be more helpful. For that reason, using SMART Goal helps in selecting a more precise, measurable, achievable goal, in line with the importance of the project and constrained by a set time limit. Following this concept improves the student's capacity to successfully steer the project's course, encouraging good resource management and on-time job completion. Setting SMART goals acts as a light, pointing the project toward good results while reducing pointless diversions and delays (John Lawler, 2010).

So, the difference between the normal goal and the SMART goal will be:

Normal Goal: In dissertation writing, a typical goal is often a vague declaration of desire without specific guidelines or measures of accomplishment. It lacks the organization and precision required to successfully direct the research and writing process.

Example: "Finish the Dissertation."

SMART Goal: On the other hand, as appears in Figure 4.2, a SMART goal is a clearly stated goal that has been carefully constructed according to the SMART criteria. This type of goal provides a defined path, quantifiable results, and a deadline for completion, which aids in maintaining concentration and motivation throughout the dissertation process.

Example: An illustration of the SMART Goal, as shown in Figure 4.2 below, could be something like "Completing the literature review of my dissertation in 2 months, which will include evaluating and synthesizing at least 100 relevant articles of research on sustainable urban planning. This will provide a comprehensive foundation for the dissertation's theoretical framework and research methodology sections." The diagram

below illustrates the characteristics of a SMART goal and explains each of them in an example.

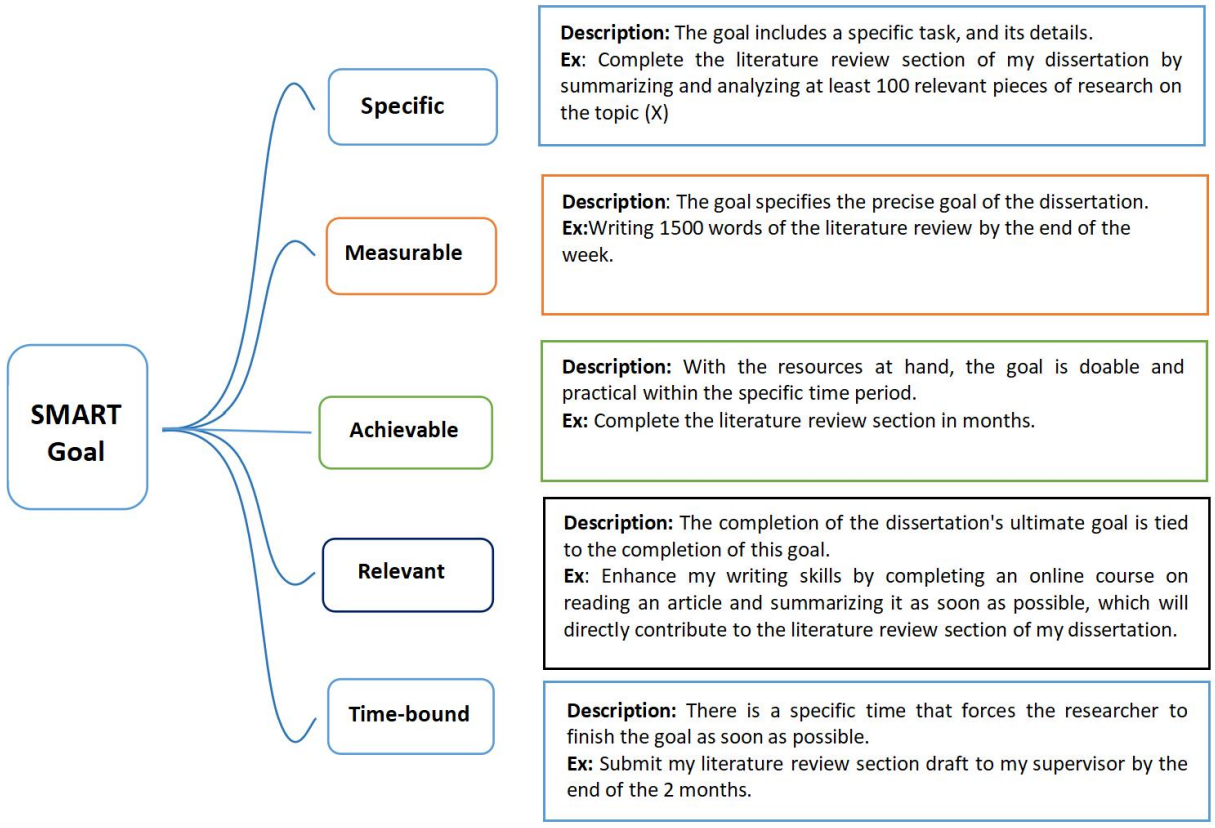


Figure 4. 2 The characteristics of SMART goals and an example for each

Student can have more than one goal or sub-goal by dividing the main SMART goal into smaller sub-goals for the tasks of the process. Creating a SMART goal for each dissertation task helps the student to be more specific, making the process more accurate.

Step 2: Store Your Materials

To ensure a successful Dissertation Writing Process (DWP), students must immerse themselves in relevant literature and gather necessary materials, such as references and laboratory resources. However, a common obstacle they face is storing and retrieving these materials, often leading to difficulties locating them when needed. The LDWP Framework recommends the 5S Lean tool to address this challenge, which helps efficiently organize, store, and manage data and resources.

5S

During Dissertation Writing Process (DWP), particularly in the literature review, according to (Table 3.2, cell 3A), over half of the students in our survey have encountered a situation where they read

numerous articles and come across numerous figures that they deem potentially valuable. However, considerable time may be wasted due to forgetting to save the information or failing to recall it when needed. In lean terminology, this scenario is called "Deffect waste," as it fosters unproductive activity.

The use of the 5S Lean technique is strongly advised to overcome these problems. This method provides a well-organized framework for organizing research materials, creating the ideal writing atmosphere, and developing reliable writing habits, as explained in the example below. The five guiding concepts of Sort, Set in Order, Shine, Standardize, and Sustain are the foundation of the 5S Lean tool. Following these guidelines, students may improve their organization, reduce interruptions, and increase productivity. The diagram below explains each S of the 5Ss application and gives an example to understand how to use it properly. Cf Figure 4.3

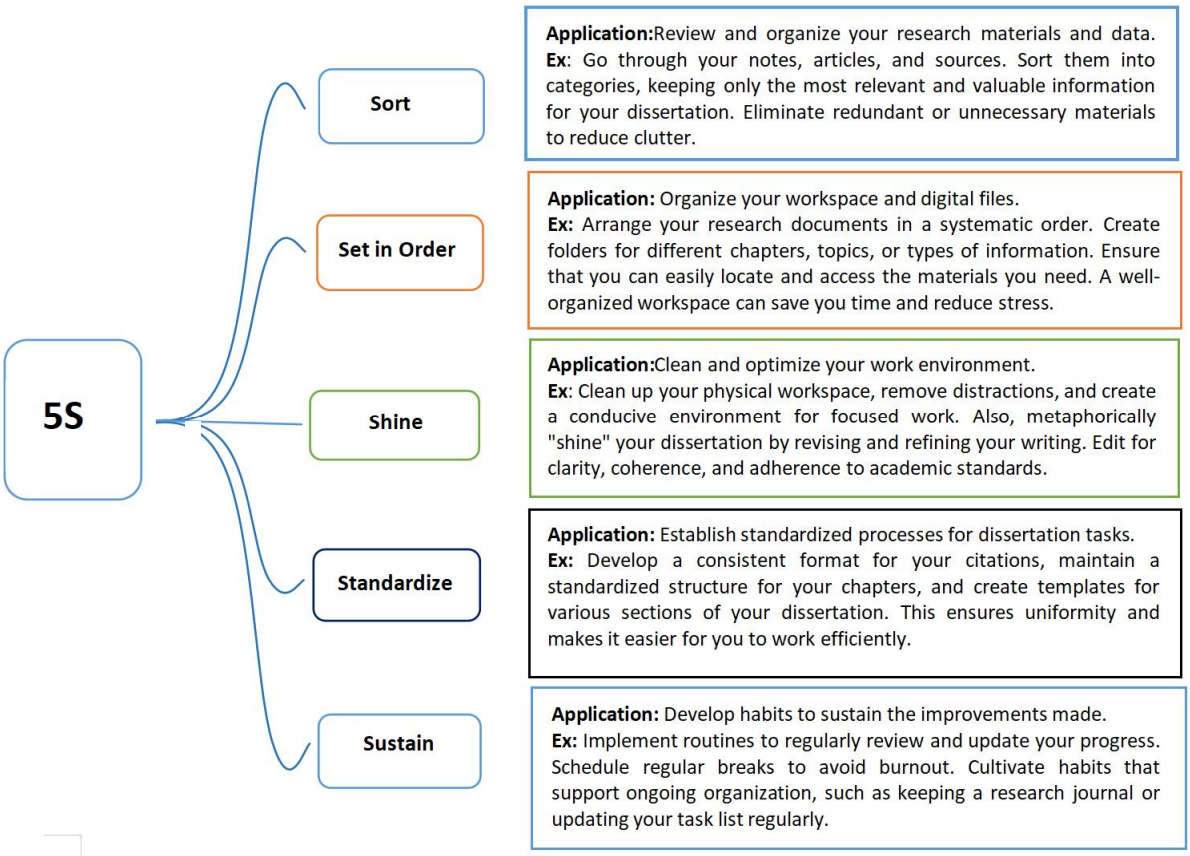


Figure 4. 3 A Graph shows how 5S should be applied in DWP

Applying the 5S principles to your DWP can enhance your organizational skills, streamline processes, and maintain a structured and efficient workflow. This approach can help students manage their time effectively, reduce stress, and produce a high-quality dissertation.

Step 3: Identify A Process to Reach Your Goal.

Now that the goal is described in a SMART way, it is time to begin the journey to achieve it. A well-defined process is important for a quick and secure progression. That is why the student should start to identify the tasks that should be done to reach the goal. To reach the goal, the student should calculate the time they have and estimate each task's duration so they can finish on time. The framework suggests the Gantt chart tool, which helps manage the process. It's important to remember that having a process isn't enough; the key is to find the quickest process with the fewest obstacles (Bottlenecks) to ensure a quick and easy journey. The sequence of the tasks may have a significant role in the processing speed, so it will be essential to make the sequence such that the tasks finish on time based on their importance and urgency. For that, the Framework offers the Eisenhower Matrix, which enables the student to prioritize and complete the tasks promptly, ensuring the most optimal and efficient route to the goal.

A. **Gantt Chart**

As a project management tool, the Gantt Chart is useful in identifying the sequence of activities that must be completed on time to reach the goal and ensure the overall project is completed on schedule. This chart is handy in research dissertations where multiple tasks need to be accomplished to achieve the ultimate goal of completing the dissertation. Figure 4.4 below shows the five steps of creating a Gantt Chart for the dissertation writing process (DWP).

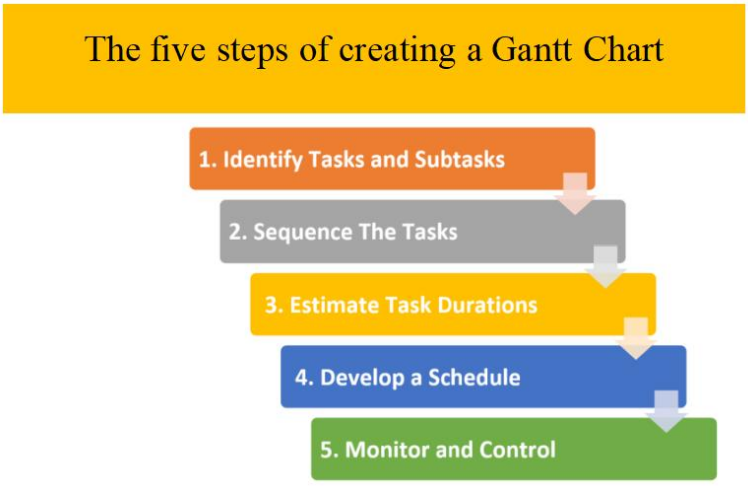


Figure 4. 4 The five steps of Creating a Gantt Chart for application in DWP.

Here's a step-by-step guide on how to create a Gantt Chart in a research dissertation, along with an example:

Step 1: Identify Tasks and Subtasks.

After clearly outlining the objectives and goals of the dissertation, the student should try to break the main goal down into tasks. Identify all the major tasks and subtasks required to complete the dissertation.

Example: If we consider this master dissertation as an example, it could include a literature review, research design, data collection, analysis, writing chapters, revisions, and final submission.

Step 2: Estimate Task Durations.

Provide time estimates for each task based on historical data, expert judgment, or the student's experience.

Example: Table 4.1 below shows each task and its duration.

The Time Is Need To Finish Each Task and its Sequence		
Number of the Task	Task	Duration(In Week)
1	Literature Review	7
2	Writing Methodology	2
3	Data Collection	6
4	Data Analysis	3
5	Writing Chapters	6
6	Revision and Editing	3
7	Final Submission	1

Table 4. 1 The sequence of the Tasks that need to be finished to reach the main goal and their duration.

Step 3: Sequence The Tasks.

Identifying the tasks' dependencies determines the logical order in which tasks must be performed. Certainly, some tasks may necessitate prior completion before subsequent tasks can be initiated. These task dependencies will aid in establishing a coherent order within the Gantt chart.

Example: In the tasks mentioned above, we can say:

- ❖ - A Literature Review must be completed before Research Design.
- ❖ - Data Collection depends on the completion of the Research Design.
- ❖ - Data Analysis can only start after Data Collection.

❖ - Writing Chapters follows the completion of Data Analysis.

At this point, the Eisenhower matrix can help make the sequence based on its importance and urgency. For example, finishing the literature review is as important as the introduction section, but since completing the introduction is based on the literature review, completing the literature review is more urgent, which means the literature review should come before the introduction section.

Step 4: Develop a Schedule.

1. **Create a Gantt Chart:** Use project management software or simple tools like Word or Excel in Microsoft Office to create a Gantt chart that illustrates the timeline for each task. Cf Figure 4.5

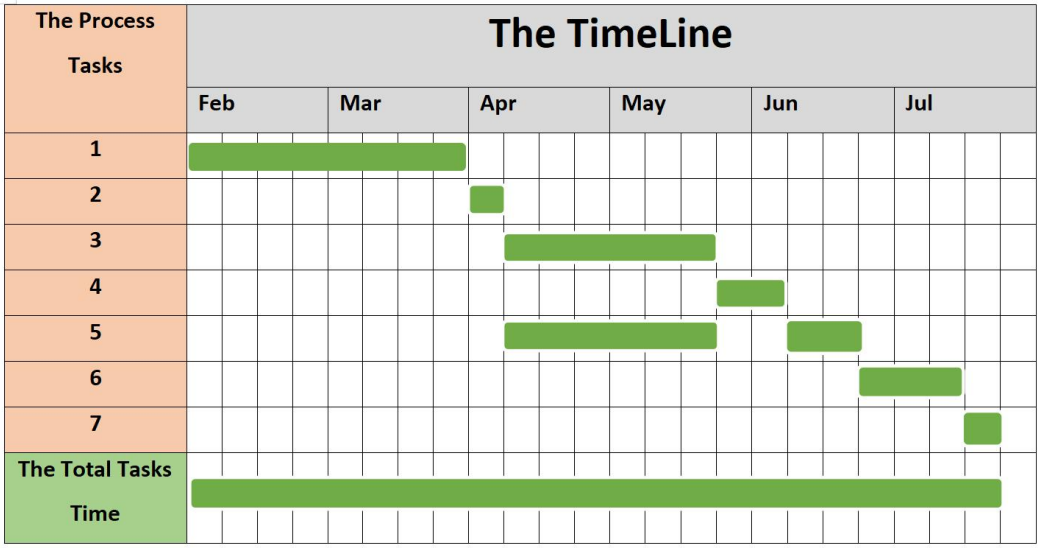


Figure 4. 5 Gantt Chart shows the tasks to finish the goal and their duration.

2. **Identify The Critical Route:** The critical route is the longest sequence of tasks that must be completed on time for the project to finish as scheduled. In the example, it will take 23 weeks. If you examine the sum of the duration of the tasks, you'll find that it is much longer than the duration of the critical route. However, for instance, if you can see that collecting the Data will take much time compared to the other tasks, it is better to consider at which point of the literature review (LR) you can start collecting your data concurrently with the literature review. Instead of waiting to finish the LR and then starting Data Collection, you should initiate it as soon as possible.

Example/ The critical route in this example is **Literature Review → Research Design → Data Collection → Data Analysis → Writing Chapters → Revision and Editing → Final Submission.**

Any delay in these tasks will directly impact the overall completion time of the dissertation. This means if any of these tasks on the critical path gets delayed, it will affect the overall completion date of your dissertation. The focus should be on managing and tracking these tasks closely to stay on schedule.

Step 5: Monitor and Control.

1. Regularly Update Progress: The student should keep track of the progress of each task and update the schedule accordingly.

2. Adjust as Necessary: If the student finds that a critical task is falling behind, allocate more time or resources to it to keep the dissertation on track. It is better for the student to be flexible and willing to adjust their plan if unexpected issues or opportunities arise during the writing process. Adaptation is a key principle in Lean thinking.

A Gantt chart is useful for project management since the dissertation project involves simultaneous tasks instead of following a strict order. In basic terms, a Gantt chart is a bar chart that shows the project's timeline. It breaks down the project into separate tasks or components, giving each a start and end date. Specific activities may run simultaneously or overlap, while others will start as soon as a previous activity is finished. A Gantt chart may be easily made using Word, Excel, or an online planner.

a) **Eisen Hower Matrix.**

RIn the process of Dissertation Writing Process (DWP), students may encounter mistakes that result in waste. Sometimes, students make suboptimal decisions when choosing between tasks, selecting less urgent ones over more important ones, leading to missed deadlines. In our survey, when respondents were asked about comparable incidents, half of them admitted to giving up on tasks they couldn't complete, a situation that could be mitigated by prioritizing tasks based on their importance.

The "Eisenhower Matrix" is an excellent lean tool technique recommended for overcoming these difficulties. This decision-making framework enables the student to prioritize tasks according to

their relevance and urgency. By focusing attention on tasks that will have the most significant impact, the technique helps maximize productivity and time management (Murray et al., 2022).

Let's now examine how the Eisenhower matrix applies to the process of writing a dissertation.

Imagine a student working on their dissertation. Here's how they could use the Eisenhower Matrix:

1. Urgent and Important (Do First): The student acknowledges the necessity of allocating six weeks for data collection. Based on the critical route outlined in the Gantt chart, time constraints are evident. This task falls within this quadrant, requiring prioritization to meet the established deadline.

2. Not Urgent but Important (Timeline): The success of the dissertation is contingent on the research phase, though its immediate urgency may not be apparent. It holds significance for the overall quality of the project. The student is advised to allocate specific hours in the calendar for thorough study sessions aimed at gathering necessary data and establishing a robust framework for the dissertation.

3. Urgent but Not Important (Delegate): An email from the department notifies the student of an urgent administrative form to be filled out. Despite its urgency in terms of scheduling, it lacks immediate relevance to the dissertation's subject matter. Delegating this task to another person or addressing it at designated times is recommended.

4. Not Urgent and Not Important (Eliminate): Tasks such as organizing bookmarks or tidying up the workstation may belong to this quadrant if excessively time-consuming. Even though these activities neither demand urgency nor directly relate to the dissertation, they can consume valuable time. The student is advised to minimize these distractions, particularly during extended work periods.

Utilizing the Eisenhower matrix facilitates the organization of activities, enabling the student to focus time and effort on crucial aspects for the successful completion of the dissertation. Making deliberate decisions on task prioritization and balancing short-term requirements with long-term objectives becomes achievable through this effective tool.

Step 4: Keep Tracking the Progress.

Another obstacle students face during Dissertation Writing Process (DWP), confirmed by more than 50 percent of our survey participants, is missing scheduled tasks such as meetings with the supervisor, as shown in (Table 3.2, cell 4A). Students frequently encounter the issue of missing or forgetting tasks, which can slow down progress. Visual management is a potent solution to prevent such obstacles, allowing

students to visualize and remember their tasks effectively. The Kanban Board is the Model's recommended solution, as it facilitates task tracking and workflow optimization through visualization.

Kanban Board:

Kanban is a helpful tool for task management and monitoring progress, providing a visual representation of the writing process, enabling the student to understand the workflow, efficiently manage resources, and maintain focus on the tasks at hand (Lage Junior & Godinho Filho, 2010).

Here is a discussion of how Kanban may be easily included in the student's daily routine during their DWP:

Setting Up a Kanban Board:

1. Create Columns: Look at the Kanban board as an assortment of columns representing different stages of the dissertation writing process. For example, the columns could be: "Ideation," "Research," "Outline," "Writing," "Editing," and "Final Review" in Table 4.2, or it can be a common Kanban table used in different areas, as it appears in Table 4.3, with columns like "To Do," "Doing," and "Done."

2. Tasks as Cards: Each task the student needs to complete for their dissertation is represented by a card. Write down the task briefly on each card. For instance, a card in the "Research" column could say, "Gather sources on topic X."

Example: Let's say the student is in their dissertation's "Research" phase. Their Kanban board can look like either Table 4.2 or 4.3.

Ideation	Research	Outline	Writing	Editing	Final Review
	Task 1 Task 2 Task 3				

Table 4. 2 an example of the Kanban Board for the Daily workflow of DWP.

To Do	Doing	Done
	Task 1 Task 2 Task 3	

Table 4. 3 an example of a Normal Kanban Board for Daily workflow. Adapted from (IStoke n.d.)

Daily Workflow:

1. Select Tasks: Look at the Kanban board at the beginning of the day. Choose which tasks need to be done today. The "Research" or "Doing" column should now include those tasks.
2. Work in Progress (WIP) Limit: To prevent overloading oneself, limit the number of assignments in the "Research" column worked on simultaneously. Consider setting a limit of three tasks to overcome bottlenecks instead of being busy with a lot of important or not urgent tasks.
3. Focus and Completion: Focus on these tasks throughout the day. Move the corresponding card to the "Done" column as each task is completed. Add a new card to the "Research" column whenever a new assignment arises.
4. At the end of the day, reflect on accomplishments. Any unfinished work is kept in the "Research (Doing)" column until the next day.

The student may improve their organization, time management, and general efficiency by utilizing a Kanban board to handle the dissertation writing process. This will make their everyday work more organized and manageable.

Step 5: Improve Your Process.

Wherever there is a process, there is waste that needs to be eliminated to improve the overall efficiency of the process. Errors and defect waste provide significant obstacles in the Dissertation Writing Process (DWP), significantly delaying progress. The main goal may be accomplished faster by preventing this kind of waste. To address this, the framework proposes the Bottleneck concept, which helps identify the spots that take so much time, and any delay in them will directly affect the dissertation delivery. Additionally, Poka-Yoke, a mechanism designed to proactively prevent errors and ensure the integrity of the research and writing process, is recommended. Simultaneously, the Andon system serves as an avenue for proactive problem-solving, fostering a culture of continuous improvement by facilitating the reporting and resolution of issues as they arise.

A. Bottleneck

First of all, it should be clear that Bottleneck is closer to a piece of advice or a concept that guides researcher to identify the spots that cause a delay in the process and later use the other tools to overcome these spots—more than a proper tool that has a solution for the obstacles.

A bottleneck in the writing of a dissertation is a step or assignment that slows down development and may prevent the project's completion. Maintaining an agile and effective writing process depends on recognizing and eliminating these barriers.

Our study, which included surveying 86 researchers from across the world, revealed that more than 70% of participants had difficulties working on certain parts of their research projects (waiting for supervisor clearance, gathering data, and availability, which lengthened procedures and pushed back final results.) which can be a bottleneck.

Identifying Bottlenecks in Dissertation Writing:

Example: Consider a student who is engaged in dissertation writing. The majority of the tasks have already been done, as have the research and data collection. However, it enables us to overcome the "data analysis" phase. There is a lot of data to go through and analyze, and it's taking considerably longer than planned. This causes a block in the flow of their dissertation writing.

Applying Lean Principles:

Even if the bottleneck idea itself isn't a typical Lean tool, students may apply Lean concepts to this context:

1. **Identify the bottleneck:** Admit that the data analysis stage is where work is stacking and holding back progress. For progress, it is important to have this awareness.

2. **Visualize Flow:** Create a a visual representation of the dissertation process. This could be a simple schedule or, like Figure 4.5, shows tasks, time duration, dependencies, and comparisons with other tasks.

3. **Limit Work in Progress (WIP):** In lean, limiting the work in progress helps to avoid overwhelming a particular stage. For the dissertation, this could mean setting a specific time each day for data analysis, focusing solely on that task during that time, or giving priority to this task. Students can use the Kanban table by limiting the WIP in the To Do list. In the later section, it will be explained better.

4**. Continuous Improvement:** Students can apply the concept of continuous improvement to enhance the effectiveness of the data analysis procedure. Are there methods or tools that might expedite the analysis? Can certain components of the analysis be delegated to others if necessary?

5. **Collaboration:** Lean encourages collaboration and cross-functional teams. In a dissertation, this could involve seeking assistance or input from the supervisor,peers, or experts in data analysis.

6. **Experiment and Adapt:** Just as Lean encourages experimentation, students can try different strategies to alleviate the bottleneck. For example, students can explore various data analysis tools or techniques to expedite the process.

By addressing the bottleneck in the dissertation work process, students can use the Eisenhower matrix to prioritize this task to prevent future issues.

B. Poka Yoke

The root cause of various obstacles, such as memory lapses, misinterpretations, work inaccuracies, and errors in tasks like data collection and citation creation, can be addressed by implementing poka-yoke. The methodology serves as an additional safeguard designed to preempt mistakes and guarantee the overall accuracy of research and the writing workflow.

The Poka-Yoke tool provides helpful tips for boosting productivity and reducing the incidence of common mistakes typically made by students when it comes to writing dissertations. Examples illustrate how Poka-Yoke can be employed:

1. The appropriate citation of sources and the creation of accurate references are the main areas where mistakes may occur during the dissertation writing process (DWP). Our survey concluded that errors in this area might result in plagiarism problems or inaccurate bibliographical information. To apply Poka-Yoke concepts to this procedure, students must create systems for error prevention and early mistake detection.

I. Standardized Citation Format: Implement a standardized citation format (such as APA, MLA, or Chicago style) that all students must follow, reducing the chances of errors related to inconsistent formatting.

II. Reference Management Software: Always use reference management software like (Mendeley, Zotero, or EndNote) that automatically generates citations and references in the correct format. This program guarantees correctness while preventing human formatting mistakes (cf Figure 4.6).

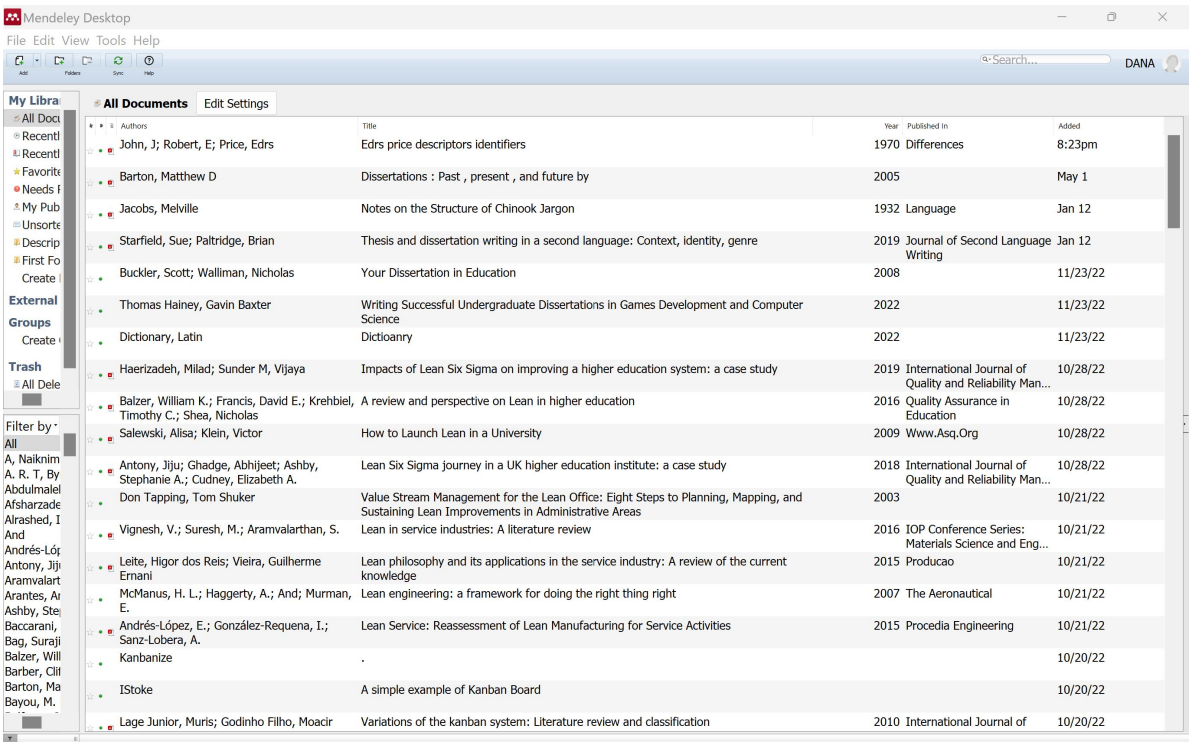


Figure 4. 6 An example of Mendeley Reference Management Software screen surface.

III. Peer Review: Before the final submission, include a peer review process where fellow students review each other's citations and references. This collaborative approach can catch errors that might have been missed during the writing process.

IV. As an additional safety measure, students are advised to include a validation step in their work routine to save their progress before concluding computer sessions. This precautionary measure is instrumental in preventing data loss resulting from unforeseen technology issues.

V. Plagiarism Check: Integrate a plagiarism detection tool such as (Scribbr, Grammarly, or DupliChecker) that scans the document and compares it to a vast database of existing literature. This helps catch unintentional instances of plagiarism and ensures the integrity of the work.

2. One obstacle faced by students, as confirmed by our survey, is the failure to save a working draft for various reasons, such as forgetfulness or technical issues. Microsoft Word offers a tool that automatically saves work every minute, presenting a helpful poka-yoke trick. Students should also store a copy of their work in their Google account. If these options are not feasible, a backup can be created by emailing a draft of the dissertation at the conclusion of the working day from one Gmail account to another. This ensures the availability of more than one draft copy.

3. Another obstacle confirmed by the survey is encountered by students in the form of writing issues, such as language barriers or a lack of focus, leading to challenges in the writing process. To address this, students can integrate a tool or system like Grammarly, which assists with grammar, spelling, punctuation, and clarity issues that may arise from a deficiency in language proficiency or a lack of focus. This serves as a beneficial poka-yoke trick in improving the writing quality.

Incorporating these Poka-Yoke principles into the dissertation writing process significantly reduces the probability of errors related to citations and references. This, in turn, enhances the quality of the research and prevents issues that could arise from improper sourcing.

In conclusion, the Poka-Yoke tool helps streamline the dissertation writing process by eliminating opportunities for errors, detecting them early, and creating a more robust and efficient workflow. It's about designing the process to minimize the chance of mistakes and promote higher quality in the final dissertation.

C. Andon

The Andon system represents the final element of the framework. It functions as a forward-thinking platform for problem-solving, promoting a culture of continuous improvement by empowering students to identify and address issues as they arise quickly.

An illustration of how the Andon Lean tool might enhance the dissertation writing process is as follows:

Setting up the Andon System: In the context of dissertation writing, the Andon system involves establishing mechanisms to identify and signal issues or challenges encountered during various research and writing stages. This could be done through color-coded flags, sticky notes, or digital tools indicating the nature of the issue.

For example, using text highlight colors can serve as the Andon system. During the literature review, red highlights may be used to mark texts that may not be needed, while yellow may indicate uncertainty, highlighting doubtful areas. And Green may be used for texts that are confidently deemed usable.

This color-coded system can also facilitate communication between the student and their supervisor. A color code, such as red for deletion, green for additions, or blue for doubtful content,

can replace written annotations. During meetings, this allows the supervisor to quickly identify and address specific points.

Once the issue is resolved, the student removes the sticky note, symbolizing the resolution of that particular challenge.

Metaphorically employing the Andon lean tool in the dissertation writing process enables students to proactively address obstacles, ensuring that their research and writing stay on track. This approach helps prevent prolonged delays, frustration, and subpar quality that might result from unresolved issues.

In conclusion, the incorporation of Lean tools, including SMART goals, Gantt Chart, Eisenhower Matrix, 5Ss, Kanban Board, PDCA Cycle, Poka Yoke, and the Andon system, empowers students in their Dissertation Writing Process by enhancing efficiency, minimizing waste, and fostering a culture of continuous improvement and collaboration for successful outcomes.

Step 6: Continuous Improvement

Collaboration and teamwork play integral roles in most Dissertation Writing Processes (DWPs), involving feedback and revisions, particularly between students and their supervisors. Disregarding these feedback loops can result in talent wastage. To mitigate this waste, the Model suggests employing the PDCA Cycle tool, a useful strategy for continuous improvement, systematic efficiency, and quality optimization.

PDCA Cycle

When working on the literature review section, students are advised to consider incorporating a section about X, such as the five lean principles, as suggested by their supervisor. To facilitate the addition of this section, the use of the PDCA cycle as a procedural framework is recommended. Figure 4.7 below illustrates the application of each phase in the process:

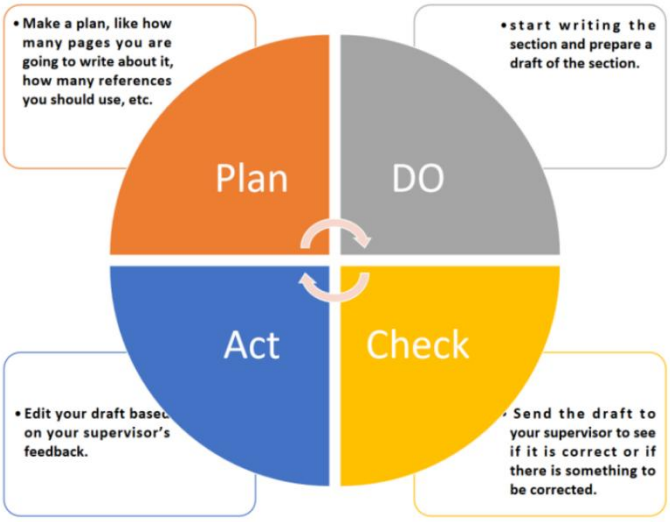


Figure 4. 7 shows how the PDCA Cycle should be applied in DWP.Adapted from(Moen & Norman, 2009)

Adhering to the PDCA cycle ensures that the dissertation becomes a continuous improvement process, allowing students to identify issues early, make necessary adjustments, and produce a higher-quality research document. It is essential to note that this procedure should be iteratively applied to a draft until it reaches a satisfactory level for submission.

4.2 Implementing lean management approaches to overcome the obstacles

In this section, we focus on addressing the second question of the dissertation, which was mentioned in section 1.2: ***How can implementing a lean management approach help overcome these barriers?*** Section 4.1 provides the necessary information to delve into this.

Upon reviewing Chapter 3, we observe the classification of obstacles based on the specific type of waste they generate. Here, we aim to identify each barrier and the type of waste they create and propose corresponding lean methodologies to overcome them. Cf Table 4.4.

The Obstacles	The Waste they may create	The lean tool can be used
Waiting for Data collection	Waiting waste	Gantt Chart
Waiting for Supervisors to respond	Waiting waste	Gantt Chart
Rewriting Unsaved manuscript	Defect waste	Poka-Yoke
Searching for Uncited reference	Defect waste	Poka-Yoke
Errors in data collection	Defect waste	PDCA Cycle, Poka-yoke
Editing bad-quality paragraph Writing out-of-scope texts	Defect waste Overprocessing	Andon, Poka-Yoke SMART Goal
Unnecessary meeting with supervisor in person	Motion and Transportation Waste	Andon
Missing scheduled meetings with supervisor	Talent waste	Kanban Board
Postponing the meeting due to the inability to complete the task on time.	Talent waste	Eisenhower matrix
Unaware of the university's available offers and discounts.	Talent waste	Poka-Yoke
Searching for saved material	Defect waste	5s

Table 4. 4 The obstacles during DWP, the waste they create, and the lean tools used in the framework.

Waiting Waste: Looking at (Table 3.2, cells 1A and 1B), it's clear that there are scenarios in which the student has to wait for a second person, like a supervisor, a questionnaire participant, or lab space, which causes delays in the dissertation writing process (DWP).

Solution: Using Gantt chart is deemed the optimal approach to address this issue. These charts facilitate the identification of tasks that can be concurrently executed while waiting for the second person or resources to become available. This method maximizes the efficient use of time, a critical resource in this process, aiming to minimize any unnecessary wastage.

Defect waste: as recognized, often arises from errors and mistakes during a process, resulting in redundant work. The implementation of strategies such as Poka-yoke, Andon, or the PDCA cycle is crucial for overcoming these challenges.

Here are five situations that lead to defect waste:

1. Errors in data collection (Table 3.2, cell 2A).

Solution/ To mitigate potential errors in the process, students are encouraged to implement the PDCA cycle. Initiate by planning the survey, defining its structure, determining the questions to be asked, specifying the number and type of questions, and estimating the time required for responses. Following the preparation of a manuscript of the plan (Do), submit it to the supervisor for evaluation (Check). Await feedback, and if adjustments are deemed necessary (Replan), make the required changes (Redo), resend the document for reassessment (Recheck), and iterate through this process until the supervisor approves the format. Once accepted, the survey can be shared with the relevant individuals (Act). This outlines the application of the PDCA cycle to develop a survey with reduced chances of errors.

2. Rewriting unsaved manuscripts. Cf (Table 3.2, cell 2B).

Solution/ To establish a poka-yoke routine, students can consider the following options:

A. Implement a poka-yoke system by configuring the dissertation software to automatically save modifications and linking it to a Google account for secure data storage on Google Drive. This safeguards against potential technical issues with the PC or software

B. In the absence of an official Microsoft Office account, students may institute a daily process by saving each daily progression in their Dissertation Writing Process (DWP) and transmitting the draft from one Gmail account to another. This method enables the maintenance of a comprehensive history of progress, facilitating the retrieval of older versions. Consequently, even after implementing changes that are later regretted, the student still retains access to the previous version. Refer to Figure 4.8 for further details.

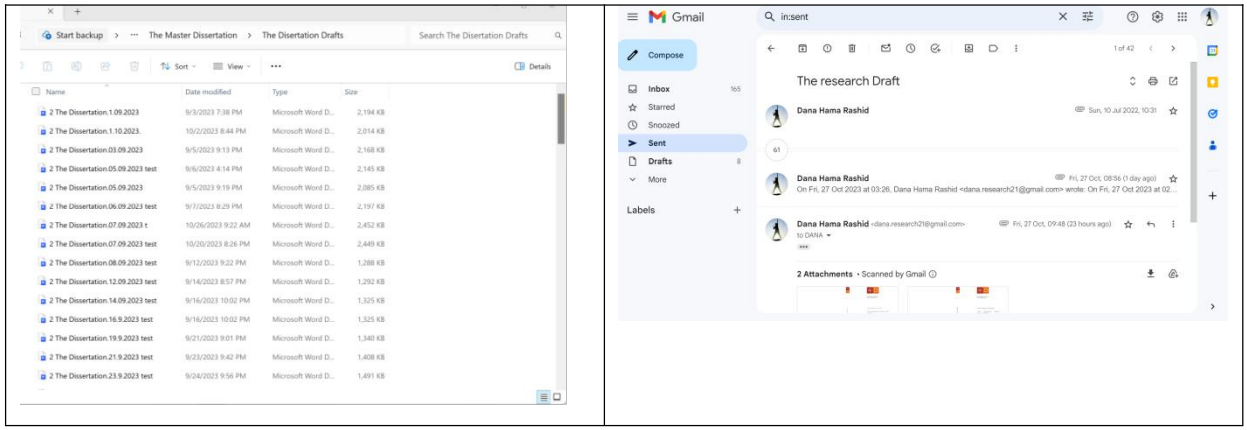


Figure 4. 8 Saving the history of my DWP.

3. Citations pose a challenge due to the risk of forgetting a reference, leading to wasted time either searching for the source or deleting the content.

Solution/ Implement a poka-yoke system by ensuring that no paragraph is left without its corresponding citation. Additionally, utilizing reference management software like Mendeley, which is free and highly beneficial in this context, can significantly streamline the process. C.f Figure 4.9

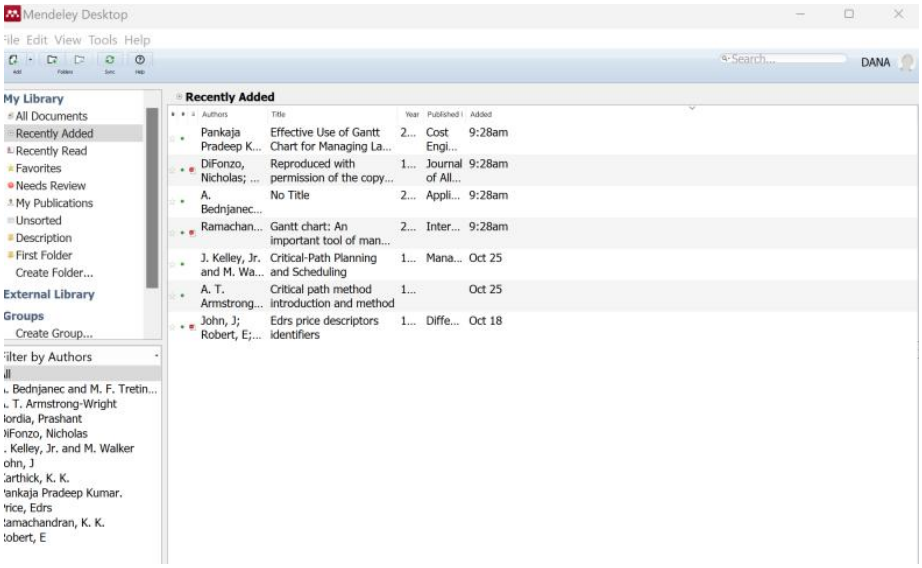


Figure 4. 9 Using Mendly to manage references of this Dissertation.

4. Spending unnecessary time reworking a paragraph due to its poor quality is another defect waste.

   A. The quality of the sources could cause this problem in the manuscript.

Solution/To guarantee that the search results align with the school's standards, students should utilize the websites recommended by their school or access them through the school's VPN. Refer to Figure 4.10 for reference.

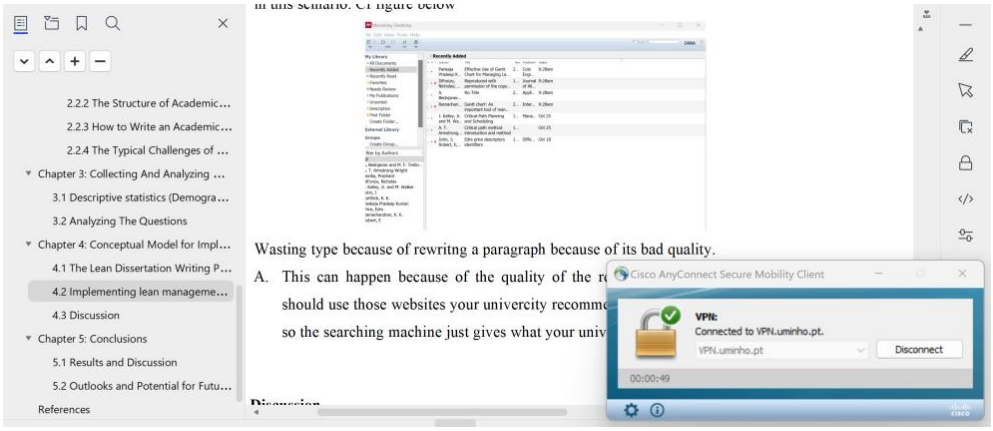


Figure 4. 10 Using the VPN of the University of Minho During this DWP.

   B. Or because of the way it was written, which could have spelling or grammar mistakes.

Solution/ Students are advised to utilize a spell-checker program such as Grammarly. Some of its features are available for free, while others may require the purchase of a license to access more advanced functionalities.

5. Removing a written text that was out of scope Cf (Table 3.2, Cell 5C).

Solution/ To avoid this mistake, Students are encouraged to clearly define their goals and maintain focus on their SMART goal as the guiding scope. Breaking down the main SMART goal into smaller SMART sub-goals can aid in staying focused on the overall objective.

6. In another scenario where students may encounter defect waste, particularly during information searching and exploration, they might come across interesting articles, images, or diagrams that they save for future use. However, difficulties may arise when attempting to locate these saved items later, even if the location is remembered.

7. **Solution/**To prevent this issue, students are recommended to employ the 5S lean tool when establishing their study space before commencing their exploration of the subject. This approach aids in organizing materials, ensuring they are easily accessible when required. Refer to Figure 4.11 for reference.

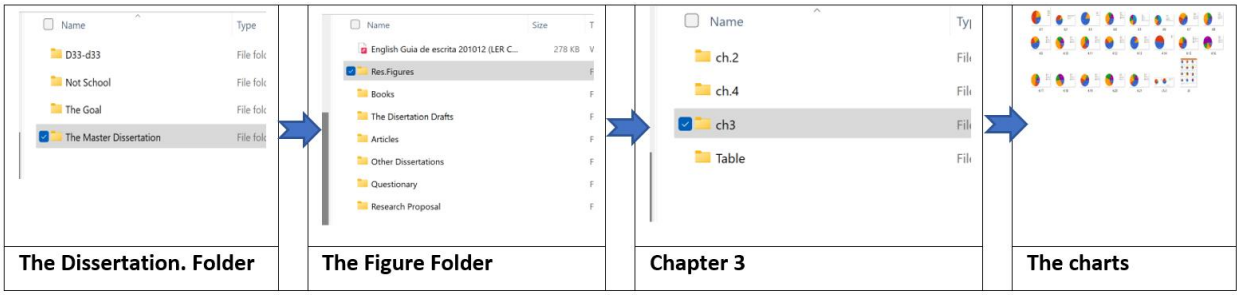


Figure 4. 11 Using 5S to store the materials I have used in this DWP.

Talent Waste Neglecting the university's services or not taking advantage of the time supervisors give are examples of wasted talent. According to the survey, this talent waste happened in three different situations.

A. As shown in Table 3.2, Cell 4A, participants acknowledged instances of missing meetings due to the inability to complete tasks on time. This issue may arise when students allocate excessive time to important yet less urgent tasks, resulting in the failure to meet objectives..

Solution/ A recommended solution involves students utilizing the Eisenhower Matrix to establish task priorities. This method facilitates the differentiation between important and urgent tasks, enabling more effective time management by appropriately scheduling less crucial tasks.

B. Forgetting a meeting with the supervisor leads to wasting talent.

Solution/ Implementing reminders and utilizing tools like a Kanban Board can effectively mitigate this problem. The Kanban Board visually shows tasks, helps manage ongoing work, and highlights pending tasks, thus reducing the likelihood of missing important meetings. Cf Figure 4.12

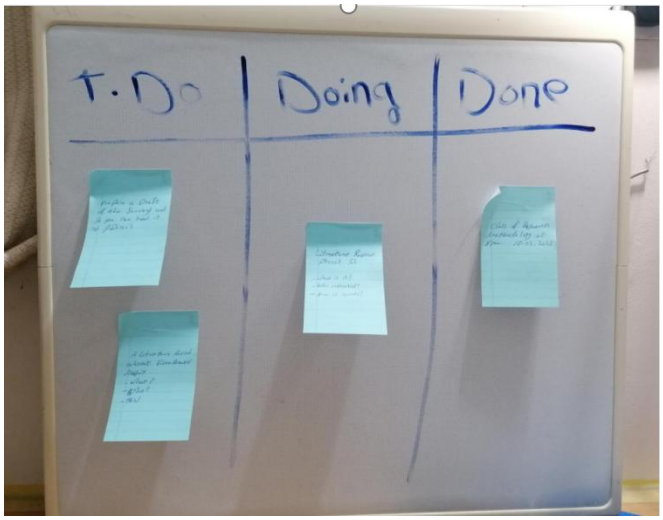


Figure 4. 12 Using Kanban Board to manage my daily tasks during this DWP.

or the student can set a reminder in their Google calendar, which serves as an effective measure to prevent the mistake.

C. Another thing that leads to wasted talent is when students are unaware of the services provided by their university. These services might include free access to journal articles, utilization of university labs or libraries, or access to software subscriptions like Microsoft Office or other relevant software.

Solution/ To mitigate this waste, the student should inquire with their university regarding available services and compile a list for reference whenever needed.

Motion and Transportation Waste according to the survey Cf (Table 3.2, Cell 5A and 5B), Some of the students have met their supervisor in person. Any meeting that could be done online can create motion waste and may have transportation waste if they have taken tools or materials with them, including their PC book or their car.

Solution/ After the pandemic, we realized we could do most of our meetings online instead of spending hours in transportation and moving to the meeting. That is why using nice software like Microsoft Team or Zoom helps us have good quality meetings and not have any of this waste. (Personally, for this study, thanks to my supervisor, we have done all our online meetings. Which could waste at least 3 hours for each meeting to go from my city to the city where my supervisor's office was).

Another Lean tool I used during my DWP was Andon, which saved me so much time that it might also benefit other students.

1. **Using Andon while reading articles:** Utilizing an Andon system, the student can consider highlighting texts with different colors. The identification of colors may vary; for instance, designating green for important information, yellow for useful content, and red for irrelevant details. Alternatively, the colors can be assigned based on the relevance to specific sections, such as using green for the literature review section and yellow for another section. This approach facilitates easy retrieval of information during article reviews. Refer to Figure 4.13 for visual guidance.

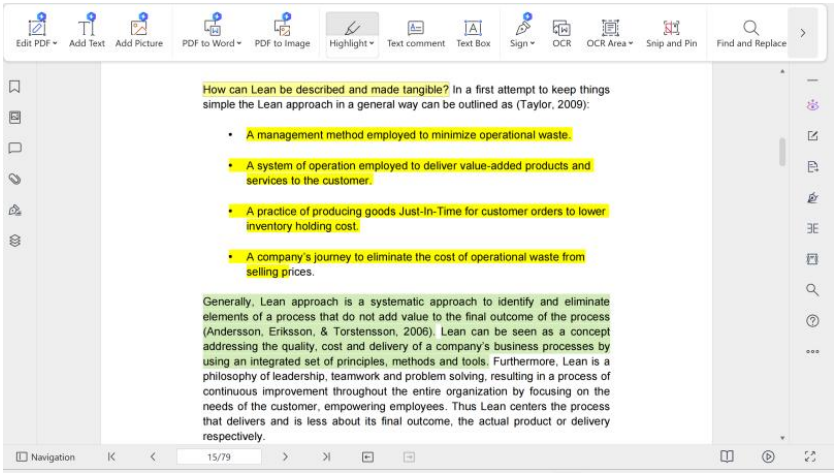


Figure 4. 13 Using Andon to decrease the wasting time in the revision of the articles in this DWP

2. **Employing Color in Feedback Communication between me and my supervisor:** When receiving feedback from my supervisor, errors are highlighted using distinct colors. This method significantly captures my attention directly, saving considerable time that would otherwise be spent searching for the errors. Cf Figure 4.14.

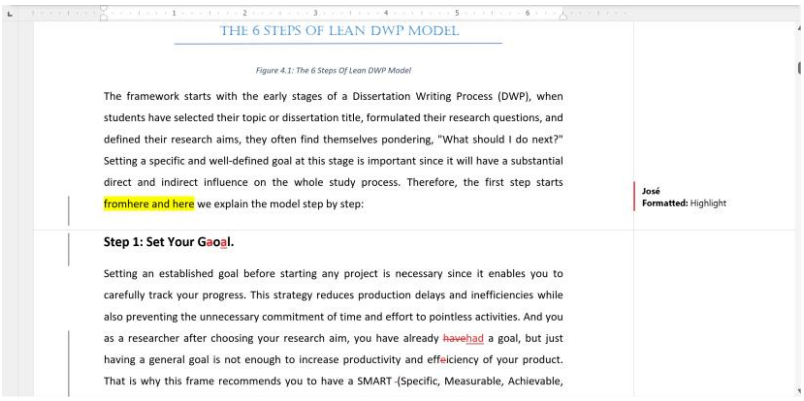

THE 6 STEPS OF LEAN DWP MODEL

Figure 4.1: The 6 Steps Of Lean DWP Model

The framework starts with the early stages of a Dissertation Writing Process (DWP), when students have selected their topic or dissertation title, formulated their research questions, and defined their research aims, they often find themselves pondering, "What should I do next?" Setting a specific and well-defined goal at this stage is important since it will have a substantial direct and indirect influence on the whole study process. Therefore, the first step starts fromhere and here we explain the model step by step:

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Step 1: Set Your Gaoal.

Setting an established goal before starting any project is necessary since it enables you to carefully track your progress. This strategy reduces production delays and inefficiencies while also preventing the unnecessary commitment of time and effort to pointless activities. And you as a researcher after choosing your research aim, you have already ~~have~~had a goal, but just having a general goal is not enough to increase productivity and effeiciency of your product. That is why this frame recommends you to have a SMART (Specific, Measurable, Achievable,

Figure 4. 14 Using Andon (Microsoft word Revision mode) with my supervisor

Overprocessing is another sort of waste that can happen During DWP. Writing more than required on a subject or a paragraph unrelated to the primary subject or research goal might be considered overprocessing. Cf (Table 3.2, Cell 5C).

Solution/ Establishing a clear and SMART goal and centering your work within its scope helps prevent this type of waste.

It is important to mention that any factor that interferes with the thinking process can potentially cause delays in the writing process. Writing a dissertation heavily relies on the students's thinking process and is primarily a solitary endeavor, where the student holds sole responsibility for the project. That is why they are pivotal in enhancing process efficiency.

These factors differentiate the application of Lean principles to the dissertation writing process (DWP) from their application in other industries Cf (Table 3.2, Cells 6A, 6B, and 6C).

That is why even if student apply Lean principles to their Dissertation Writing Process (DWP) if certain uncontrollable factors disrupt the thinking process, the effectiveness of these Lean principles might not match that seen in manufacturing processes. However, implementing these principles still leads to improvements compared to not using them.

I'll provide personal solutions drawn from my dissertation experience that, while not strictly Lean-related, can be beneficial.

In addressing distractions from social media, the student can adopt a routine resembling the "poka-yoke" approach, as indicated in (Table 3.2, Cell 6A). This entails activating a non-disturb mode on the phone before commencing work. Additionally, the creation of distinct accounts, such as separate Google accounts, can assist in the management of distractions. For instance, dedicating YouTube

exclusively for study-related content helps tailor the platform's algorithms to suggest material relevant to the research, thereby minimizing distractions.

Unfortunately, offering specific solutions for the other two factors is challenging, as each individual faces their own unique issues and circumstances that may disrupt their writing process.

4.3 Discussion

The Lean Dissertation Writing Process Framework (LDWPF) is designed to provide a structured approach to the dissertation writing process, aiming to streamline the process and minimize waste. In this section we discuss when the framework works better, when it does not, potential challenges, how to overcome them, and its alternatives:

When it works better:

Given that this research dissertation proposed a solution and we were unable to secure volunteers to implement our LDWP Framework, we cannot conclusively determine its effectiveness. The research has only been implemented within the scope of this study, and based on this, we can make the following observations:

1. Clarity and Focus: LDWPF may works well when the student needs a clear and focused approach to the dissertation process. It may emphasizes setting specific goals and using tools like SMART Goal Criteria to ensure clarity.

2. Efficiency and Time Management: It might be effective for those who want to manage their time and resources efficiently. Tools like the Gantt Chart and Kanban boards are helpful for task management and progress tracking.

3. Quality Improvement: The LDWPF can lead to improved quality by incorporating tools like the Eisenhower Matrix and Poka-Yoke to reduce errors and enhance the research and writing process.

4. Continuous Improvement: Students seeking continuous improvement through feedback loops and revisions will benefit from tools like the PDCA Cycle and the Andon system.

When it may not work well:

1. Psychological barriers: The Framework may not be suitable for individuals facing personal or psychological hurdles. As this framework is designed for solo workers, emotional and biological factors can potentially introduce delays in the process. Unfortunately, the framework does not provide solutions for addressing these scenarios.

2. Resistance to Change: Some students may resist the changes required to adopt Lean methodologies, in such cases, LDWPF might not be as effective as effective as it could be.

Challenges:

1. Resistance to Lean Principles: Students or advisors may not be familiar with Lean principles, leading to challenges in implementing the framework.

2. Overwhelm: The various tools and techniques can be overwhelming, particularly for students new to Lean concepts.

3. Resource Limitations: Implementing Lean tools may require additional resources, such as project management software for Gantt charts or reference management software for 5S, which may not be as effective as they could be.

Overcoming Challenges:

1. Education: Provide training and resources to students and supervisors to familiarize them with Lean principles and the tools used in the framework, this can be provided by universities or institutes.

2. Gradual Adoption: Implement Lean principles gradually, starting with the most relevant tools for the specific research project.

3. Flexibility: Adapt the framework to the unique needs of the research project and the students involved. Not all tools need to be used in every case.

4. Continuous Learning: Encourage continuous learning and adaptation, which is a core principle of Lean thinking.

Alternatives:

1. Traditional Dissertation Writing: Some students and advisors may prefer traditional dissertation writing methods without a structured Lean framework.

2. Agile Dissertation Writing or Scrum Master: Agile methodologies or Scrum Master, often used in software development, can be adapted to the research process, allowing for flexibility and iterative progress.

3. Customized Approaches: Students can develop customized frameworks based on their unique needs, combining elements from Lean, Agile, and traditional methods.

4. Project Management Tools: Project management tools like normal calendars or to-do lists can be used as alternatives to specific Lean tools like Kanban boards.

In conclusion, the LDWPF can be helpful tool for students who seek a structured, efficient, and error-minimized approach to the dissertation writing process. However, its success depends on factors like the research context, the willingness to adopt Lean principles, and the flexibility to adapt the framework to specific needs. Studentss should carefully evaluate the applicability of the framework to their own projects and consider alternatives if necessary.

CHAPTER 5: CONCLUSIONS

Chapter 5 summarizes the outcomes obtained in this study and discusses the results critically. In addition, an outlook is presented for improvements and further research opportunities.

5.1 Results and Discussion

This dissertation has examined applying lean methodologies to the dissertation writing process (DWP). The study proposes an effective Lean Dissertation Writing Process (LDWP) Framework to help students particularly and researchers generally improve their dissertation or research writing process, By implementing lean tools and approaches in the process of writing a dissertation.

Dissertation writers may simplify their work, reduce non-value-added activities, and concentrate on tasks that directly support the research and writing process by using Lean concepts like waste reduction, and continuous improvement. Lean approaches help students make the best use of their time and resources, eventually resulting in a better-quality dissertation. These methodologies enable the detection and removal of numerous types of waste, such as pointless administrative duties or repetitive literature review procedures.

Lean methodologies encourage a systematic and disciplined approach to DWP, guaranteeing a clear knowledge of the project's goals, milestones, and dependencies. This methodical technique enables students to plan their time more effectively, establish reasonable targets, and keep track of their work as they write. Students may have a clear picture of their progress, identify bottlenecks or areas for improvement, and take immediate corrective action by implementing Lean approaches like visual management and standardized work procedures.

It's important to understand that using Lean methodologies throughout the dissertation writing process is not a one-size-fits solution. A student may need to adjust and modify the Lean techniques according to their environment, subject, and personal preferences. However, the core principles of lean, value creation, waste reduction, and continuous improvement provide a useful foundation for enhancing the dissertation writing procedure.

Revisiting the research questions listed in Chapter 1.2: ***What are the common challenges (barriers) students face during the DWP?*** The questionnaire has been shared with students of

different ages and education levels worldwide. Their main challenges are wasting time, forgetting tasks, and personal issues in their daily lives, such as psychological, economic, health, and social barriers during the DWP.

The second research question ***How can implementing a lean management approach help overcome these barriers?*** The research dissertation has tried to provide the proper lean management tools and techniques that help them overcome challenges like wasting time and forgetting tasks, but since these are reasons for the delays, lean can not 100% help in overcoming the challenges since other factors like psychological factors have a significant role in the situation.

Regarding the third research question, ***what stages and steps are required to implement Lean principles within DWP successfully?*** In the fourth chapter of the dissertation, a lean framework has been provided that includes the best tools and techniques to overcome the challenges, and it will guide the student to go through DWP step by step, from choosing the goal to a road map that helps overcome any confusion or misunderstanding.

In conclusion, by embracing Lean principles and methodologies, students can enhance their dissertation writing journey's efficiency, effectiveness, and overall quality. Using lean methodologies helps individual students advance knowledge and benefits the academic community. As the concept of Lean continues to evolve and expand into new domains, its potential for transforming the dissertation writing process remains promising.

5.2 Outlooks and Potential for Future Research

This study was undertaken theoretically, thoroughly examining and analyzing existing literature on Lean theories and Lean management strategies. Because there are so many Lean methods and tools, only a select portion received in-depth scrutiny. As a result, there is a chance to improve things by examining all Lean methods and tools in more detail to find out how they might work with the dissertation writing process (DWP).

It is important to note that the conclusions drawn from these findings have not been subjected to complete evaluation, nor have they been practically put into action within any DWP context. The next logical step might be to apply this conceptual framework to a real-world DWP. This would show that either it works or not in a practical writing process where variables are always changing.

Still, moving from theory to practice can be very hard because adopting lean thinking requires a significant change in how you think about operations, which can be challenging if you already have certain ideas (Wu, 2003). This problem gets worse for students and think writing dissertation is different from manufacturing tasks. Due to these issues, we suggest that future endeavors work on implementing the plan. Consider the following steps: seek individuals willing to volunteer to use the framework in their DWP and provide ongoing coordination and support throughout the implementation process. This approach could prove highly beneficial.

Furthermore, our dissertation focused on the experience of an individual researcher (student) navigating their writing process. Future endeavors might broaden their scope by addressing the entire research journey, starting from the initial stages of identifying a research topic, securing funding, and continuing through the defining process. In doing so, they can identify and reduce inefficiencies along the way. Alternatively, they could shift their focus towards collaborative group research rather than individual efforts, benefiting research organizations through teamwork and concurrently working to minimize waste in their processes.

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