

Project title

**The Impact of Lean Methodology on Operating Cycle
Time**

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1. Chapter 1: Introduction

Research Background

In every industry, time is a crucial factor that determines how efficiently a company operates. The operating cycle time, which indicates the total time needed to complete a process from start to finish, has a greater impact on productivity, cost, and customer satisfaction. Organisations that manage to reduce their cycle time often benefit from faster delivery, more effective resource use, and increased competitiveness.

However, many companies struggle with long cycle times caused by excess steps, delays, inferior coordination, or a lack of continuous improvement. These issues lead to wasted resources, higher costs, and slower customer response. As a result, businesses are under steady pressure to find better ways to streamline operations and eliminate inefficiencies. One approach that has proven operative in improving time performance is the deficient methodology.

The research problem addressed in this study is that although deficient methods are widely discussed and applied, there is still minimal understanding of how deficient principles specifically assist in reducing the operating cycle time in different business environments.

Former studies have explored the benefits of deficient methodology across several industries, particularly in manufacturing and service operations. According to Womack and Jones (2003), deficient thinking helps organisations “do further with less” by eliminating waste and improving process flow. Similarly, Liker (2004) highlighted how The Toyota Way successfully uses deficient tools to reduce lead time and improve efficiency.

Different researchers, such as Shah and Ward (2007), identified deficiency as a multidimensional concept that combines tools like Just in Time, continuous improvement (Kaizen), and value stream mapping. These tools help identify non-value-adding activities and improve workflow speed. Studies in the healthcare and logistics sectors have also shown that deficient practices reduce waiting times and enhance gross service quality. Although these studies confirm the gross benefits of deficient methods, few have directly focused on measuring their impact on operating cycle time, the specific duration from process initiation to completion. This leaves room for further research and a deeper understanding.

While the existing literature provides powerful evidence that lean methods improve performance, many of the studies focus principally on cost reduction or product quality instead of time efficiency. There is also minimal research connecting specific deficient tools to measurable changes in cycle time. Some studies present general results without explaining how each deficient element, such as workflow redesign or continuous flow, really shortens the process. Another gap is that little research examines manufacturing environments, but deficient principles can also be applied in service sectors such as healthcare, education, and transportation. The lack of relevant studies across sectors makes it difficult to fully understand the broader impact of deficiencies on cycle time.

This research contributes to notional discussions about how deficient methods influence performance dimensions beyond cost and quality, specifically focusing on time. It provides a framework for analysing the relationship between deficient tools and time-based performance outcomes. For business professionals, particularly managers and process improvement teams, the study highlights hard-nosed insights on how deficient principles can be applied efficaciously to shorten cycle times. Understanding which tools, like Just in Time or Value Stream

Mapping, work best will help organisations redesign their workflows and improve efficiency. This is particularly fundamental for industries where time is a competitive advantage, such as manufacturing, logistics, and services.

This research is to investigate the impact of deficient methodology on operating cycle time and to identify which deficient tools contribute to reducing process duration. The study seeks to explore how principles such as waste reduction, continuous improvement, and value creation can be applied to achieve faster, smoother operations. By examining the connection between deficient implementation and cycle time reduction, this research aims to provide hard-nosed recommendations for organisations that want to enhance efficiency and responsiveness. The last goal is to demonstrate that deficient methodology, when properly applied, can serve as a strong strategy for improving time-based performance and sustaining long-term competitiveness.

1.1. Research Problem

In near organisations today, one of the large challenges is reducing the time it takes to complete a full process from receiving an order to delivering the final product or service. This total time is called the operating cycle time. A long operating cycle time often leads to slower customer response, higher functional costs, and lower productivity. To solve this issue, many companies have started using the deficient methodology, which focuses on improving efficiency by removing waste and simplifying work processes. Deficient practices such as Just in Time, continuous improvement (Kaizen), and value stream mapping are designed to speed up operations and increase value for customers.

1.1.1. Theoretical Gaps

Although the deficient methodology has been widely discussed in theoretical and expert literature, few studies focus principally on its impact on cost reduction, quality improvement, and waste elimination. While these outcomes are important, there has been less attention given to the time dimension, specifically the effect of deficiency on operating cycle time. Many active theories describe deficiency as a philosophy of continuous improvement and value creation. However, few have distinctly explained how deficient principles directly influence time performance or how different deficient tools interact to shorten process duration. For example, while Just in Time aims to reduce delays and waiting, and value stream mapping identifies bottlenecks, there is still a limited theoretical explanation that connects these concepts to measurable reductions in total cycle time.

Another notional gap exists in understanding the balance between efficiency and flexibility. Some researchers argue that focusing too much on speed may reduce flexibility in responding to unexpected changes, but current theories do not distinctly define how organisations can maintain both. Therefore, the notional gap this study addresses lies in the lack of a perspicuous framework that links deficient methodology with operating cycle time improvement. By exploring this relationship, the research seeks to strengthen the notional foundation of deficient practices and contribute to a deeper understanding of time-based performance in operations management.

1.1.2. Practical Gaps

While many organisations have adopted deficient methodology to improve their performance, the results are often contradictory or short-term. In practice, several companies introduce deficient tools such as 5S, Kaizen, or Just in Time without fully understanding how these tools should work together to reduce the operating cycle time. As a result, some improvements happen at the beginning but are not uninterrupted over time. Another hard-nosed gap is that many managers focus principally on cost savings instead of on time efficiency. They may measure how deficient reduces expenses or waste, but they do not always measure the total process time from start to finish. Without decent measurement and follow-up, it becomes difficult to know whether the deficient initiatives are truly improving the operating cycle time or just ever-changing individual steps in the process.

In addition, different industries apply differently. What works in manufacturing may not work in services such as healthcare, logistics, or education. Many organisations copy deficient tools from different sectors without adapting them to

their own processes, which limits their effectiveness. There is also a skills and awareness gap. Employees sometimes see deficiency as an extra task instead of a continuous mindset, which causes ineffective implementation and unrefined commitment. The lack of training and leadership support further reduces the semipermanent success of deficient programs.

Therefore, the independent hard-nosed gap lies in the minimal understanding of how to apply deficient practices efficaciously and sustainably to reduce operating cycle time. This study aims to highlight these real-world challenges and suggest ways organisations can bridge the gap between deficient theory and actual practice.

1.2. Research Significance

The significance of this research lies in its contribution to both notional understanding and hard-nosed application of deficient methodology in improving functional performance, particularly in reducing operating cycle time. Many organisations are knowledgeable of deficient principles, but not all distinctly understand how these principles can be used to make processes quicker and more efficient. This study aims to fill that gap by providing insights that are invaluable for both researchers and professionals.

1.2.1. At the theoretical level

From a notional point of view, this research contributes to the active body of knowledge on deficient management and functional efficiency. While many previous studies have focused on the effects of deficiencies on cost, waste, or quality, this study highlights their relationship with time performance. It helps to

build a clearer understanding of how deficient tools such as Just in Time, continuous flow, and value stream mapping (VSM) directly influence cycle time reduction.

By exploring this connection, the study adds a modern dimension to deficient theory linking process improvement methods to measurable time outcomes. This can help future researchers develop further true models and frameworks that explain how deficiencies contribute to faster, more nimble operations.

1.2.2. At the practical level

On a hard-nosed level, this research will assist managers, supervisors, and process improvement teams in understanding how to apply deficient principles efficaciously in their organisations. Many companies struggle to sustain improvements after introducing deficiencies because they lack a clear understanding of which practices have a significant impact on time efficiency.

The findings of this study will offer hard-nosed guidance on selecting and implementing satisfactory deficient tools to reduce delays, eliminate waste, and shorten the gross operating cycle time. This can lead to quicker service delivery, higher productivity, lower functional costs, and improved customer satisfaction.

In addition, the study can serve as a reference for training and continuous improvement programs, helping organisations build a stronger culture of efficiency and teamwork. It will also encourage leaders to measure success not only by cost or output, but also by the time it takes to complete each process, a key factor for long-term competitiveness.

1.3. Research Objectives

The objectives of this research are:

1. To explain the concept and principles of lean methodology.
2. To examine the factors that influence operating cycle time.
3. To analyse the impact of lean methodology on operating cycle time.
4. To identify lean practices that effectively reduce cycle time.
5. To provide recommendations for improving operational efficiency using lean methodology.

1.4. Research Questions

Main Research Question

- How does lean methodology affect operating cycle time in organisations?

Sub-Research Questions

- What lean tools are commonly used in organisations?
- How does operating cycle time influence organisational performance?
- Which lean practices contribute most to reducing operating cycle time?
- What challenges do organisations face when implementing lean methodology?
- How can lean methodology be applied more effectively to achieve sustainable cycle time reduction?

1.5. Research Hypotheses

- H1: There is a statistically significant relationship between lean methodology and operating cycle time.
- H2: Lean methodology has a positive impact on reducing operating cycle time.
- H3: Effective implementation of lean practices improves operational efficiency

2. Chapter 2: Literature Review

Introduction

The literature review is an essential part of any research study, as it provides a clear understanding of existing knowledge related to the research topic. This chapter reviews previous studies, theories, and concepts related to lean methodology and operating cycle time. The purpose of this review is to identify how these variables have been discussed in the literature, highlight key findings, and identify gaps that justify the need for this research.

This chapter is structured into several sections. First, it discusses lean methodology as a key independent variable. Second, it explains the concept of operating cycle time as the dependent variable. Third, it examines the relationship between lean methodology and operating cycle time based on previous research. Finally, the chapter concludes by summarising key insights and identifying gaps in the literature.

2.1. Lean Methodology

Lean methodology is a management philosophy that focuses on improving efficiency by eliminating waste and maximising value for customers. The concept of lean originated from the Toyota Production System (TPS), which was developed to improve productivity, reduce costs, and enhance quality in manufacturing processes. According to Ohno (1988), waste refers to any activity that consumes resources but does not add value to the final product or service.

Womack and Jones (2003) describe lean thinking as an approach that helps organisations achieve more with fewer resources. Lean methodology emphasises understanding customer value, mapping value streams, creating smooth process

flow, and continuously improving operations. These principles aim to reduce delays, unnecessary activities, and inefficiencies within processes.

Lean methodology includes several tools and practices that support continuous improvement. One of the most important tools is Just-in-Time (JIT), which focuses on producing only what is needed, when it is needed, and in the required quantity. JIT helps reduce waiting time, inventory levels, and production delays. Another important practice is Kaizen, which encourages continuous small improvements involving employees at all levels of the organisation.

Value Stream Mapping (VSM) is another widely used lean tool. It helps organisations visualise the entire process flow, identify bottlenecks, and distinguish between value-adding and non-value-adding activities. By using VSM, organisations can redesign processes to improve flow and reduce cycle time. Additionally, process standardisation ensures that tasks are performed consistently, reducing variation and improving efficiency.

Although lean methodology was originally developed for manufacturing, it has been widely adopted in service industries such as healthcare, logistics, education, and transportation. Researchers have shown that lean practices can improve service delivery speed, reduce waiting times, and enhance customer satisfaction. However, the success of lean implementation depends on organisational culture, leadership support, and employee involvement.

2.2. Operating Cycle Time

Operating cycle time refers to the total time required to complete a process from its starting point to its final output. In manufacturing, it includes the time taken from

receiving raw materials to delivering finished products. In service industries, operating cycle time may include the time from receiving a customer request to completing the service.

Long operating cycle times often indicate inefficiencies such as waiting, rework, poor coordination, and a lack of standardisation. According to operations management literature, reducing cycle time improves productivity, lowers costs, and increases customer satisfaction. Organisations with shorter cycle times can respond more quickly to market changes and customer needs.

Several factors influence operating cycle time, including process design, resource availability, employee skills, and management practices. Poor workflow design and excessive handoffs between departments can increase delays and extend cycle time. In contrast, streamlined processes and effective coordination help reduce unnecessary waiting and improve process speed.

Operating cycle time is considered a key performance indicator in operations management because it reflects how efficiently an organisation uses its resources. Many organisations use cycle time measurements to evaluate process performance and identify improvement opportunities. However, without proper improvement strategies, cycle time reduction efforts may not be sustainable.

2.3. Relationship Between Lean Methodology and Operating Cycle Time

Many studies have examined the impact of lean methodology on organisational performance. Researchers generally agree that lean practices improve efficiency,

reduce waste, and enhance quality. However, fewer studies focus specifically on the relationship between lean methodology and operating cycle time.

Liker (2004) explains that lean tools such as continuous flow and pull systems help reduce waiting time and process interruptions, which directly affect operating cycle time. Similarly, Shah and Ward (2007) argue that lean production systems improve process integration and coordination, leading to faster operations.

Value Stream Mapping has been widely recognised as an effective tool for identifying time delays within processes. By eliminating non-value-adding activities, organisations can significantly reduce cycle time. Just-in-Time practices also help reduce delays caused by excess inventory and overproduction.

Despite these findings, many studies focus on cost savings and quality improvement rather than time-based performance. Some researchers treat cycle time as a secondary outcome rather than a main performance indicator. This creates a gap in the literature regarding how lean methodology directly influences operating cycle time and which lean practices have the strongest impact.

Additionally, most studies focus on manufacturing environments, with limited research in service industries. This limits the generalizability of findings and highlights the need for further research across different sectors.

2.4. Conclusion of the Literature Review

This chapter reviewed existing literature related to lean methodology and operating cycle time. The review showed that lean methodology plays a significant role in improving operational efficiency by eliminating waste and improving process flow. Operating cycle time was identified as a critical performance indicator that reflects process efficiency and responsiveness.

Although previous studies confirm the benefits of lean practices, there is limited focus on their direct impact on operating cycle time. Many studies emphasise cost and quality improvements while neglecting time-based performance. This gap in the literature justifies the need for the current study.

By examining the relationship between lean methodology and operating cycle time, this research aims to contribute to both theoretical understanding and practical application. The findings are expected to help organisations apply lean practices more effectively to achieve sustainable cycle time reduction.

3. Chapter 3: Research Methodology

3.1 Introduction

This chapter explains the research methodology used to examine the impact of lean methodology on operating cycle time. Research methodology is an important part of any study because it provides the structure used to collect, measure, and analyse data in a systematic manner. It helps ensure that the findings are reliable, valid, and aligned with the research objectives.

The purpose of this chapter is to describe how the study was designed and implemented. It includes the operational definitions of the research variables, the research design based on the research onion model, the target population, sampling methods, data collection process, types of data, and statistical analysis procedures.

This study uses a quantitative research approach because numerical data is needed to measure the relationship between lean methodology and operating cycle time. Data will be collected using questionnaires and analysed using statistical tools. The chapter provides a clear explanation of all methods used in the study.

3.2 Lean Methodology

Operational definitions explain how the main variables of the study are measured in practical terms. In this research, two main variables are used: lean methodology as the independent variable and operating cycle time as the dependent variable.

3.2.1 Lean Methodology

Lean methodology refers to a management philosophy and operational approach that focuses on maximising customer value while minimising waste. It aims to

improve organisational performance by removing unnecessary activities, reducing delays, simplifying workflows, and continuously improving processes.

Lean methodology originated from the Toyota Production System and has become widely used in manufacturing, logistics, healthcare, construction, and service industries. Organisations adopt lean methodology to improve speed, quality, flexibility, and cost efficiency.

In this study, lean methodology is measured through employee and management perceptions regarding the extent to which lean practices are implemented within the organisation. The main dimensions used to measure lean methodology include:

Waste Elimination

This refers to reducing activities that do not add value to the final product or service. Examples include excess waiting time, unnecessary movement, overproduction, rework, and excess inventory.

Continuous Improvement

Continuous improvement refers to ongoing efforts to improve processes, products, and services. It includes regular problem-solving, employee suggestions, and gradual performance enhancements.

Process Standardization

This means establishing clear procedures and consistent work methods to reduce variation, confusion, and errors.

Just-in-Time Practices

This refers to receiving materials, information, or resources only when needed, which helps reduce storage costs and delays.

Employee Involvement

Lean methodology depends heavily on employee participation in identifying problems and suggesting improvements.

Workflow Efficiency

This measures how smoothly tasks move from one stage to another without interruptions or bottlenecks.

In this study, higher scores for lean methodology indicate stronger lean implementation and greater organisational commitment to lean principles.

3.2.2 Operating Cycle Time

Operating cycle time refers to the total amount of time required to complete an operational process from the beginning of an activity until the final output is delivered. It reflects the speed and efficiency of an organisation's internal processes.

Operating cycle time is considered one of the most important performance indicators because shorter cycle times usually lead to lower costs, better resource utilisation, improved customer satisfaction, and stronger competitiveness.

Long cycle times may indicate operational inefficiencies such as delays, poor coordination, bottlenecks, unnecessary approvals, machine downtime, or repeated errors.

In this study, operating cycle time is measured based on respondents' perceptions of time-related operational performance. The dimensions include:

Process Completion Speed

The time taken to complete a task or process from start to finish.

Waiting Time

The time spent waiting between one stage of work and the next stage.

Delays and Bottlenecks

Interruptions that slow down workflow and reduce productivity.

Workflow Continuity

The smooth movement of work through different stages without stoppages.

Responsiveness

The ability of the organisation to complete tasks quickly and respond to customer or operational needs.

Overall Operational Efficiency

The general effectiveness of the organisation in completing work within expected timeframes.

In this study, higher scores for operating cycle time indicate better time performance, faster completion rates, and more efficient operations.

3.3 Research Design

The research design provides the overall framework used to answer the research questions and achieve the research objectives. It explains the logical structure of the study and identifies the methods used for collecting and analysing data.

This study adopts the Research Onion model developed by Saunders et al., which is widely used in business and management research. The model presents research decisions in layers, beginning with broad philosophical assumptions and moving toward specific techniques for data collection and analysis.

Using the Research Onion helps ensure that all research decisions are aligned and suitable for the topic being studied.

3.3.1 Operating Cycle Time

Research philosophy refers to the beliefs about how knowledge should be developed and what type of data should be accepted as valid evidence.

This study adopts the positivist philosophy because the research focuses on measurable facts and objective analysis. Positivism assumes that reality can be observed, measured, and explained through scientific methods.

The positivist approach is suitable because this study examines the relationship between lean methodology and operating cycle time using numerical data collected through questionnaires. Statistical tools are then used to test hypotheses and draw conclusions.

The use of positivism increases objectivity and supports evidence-based findings.

3.3.2 Operating Cycle Time

Research approach refers to the reasoning process used to connect theory with data.

This study uses a deductive approach. The deductive method starts with existing theories and previous studies related to lean methodology and operational performance. Based on this literature, hypotheses are developed and then tested using collected data.

For example, the study proposes that lean methodology has a significant impact on operating cycle time. Questionnaire data is then collected to test whether the hypothesis is supported.

The deductive approach is suitable because it provides a structured and logical process for testing theoretical assumptions.

3.3.3 Research Strategy

Research strategy refers to the method used to collect data and answer research questions.

This study uses a survey strategy. Surveys are commonly used in business research because they allow the researcher to gather data from many respondents efficiently.

A structured questionnaire is distributed to employees, supervisors, and managers involved in operational processes. The survey helps collect standardised responses regarding lean practices and operating cycle time.

- The advantages of the survey strategy include:
- Ability to collect data from multiple respondents
- Low cost and time efficiency
- Easy comparison of responses
- Suitable for statistical analysis
- High consistency in data collection

3.3.4 Time Horizon

Time horizon refers to whether data is collected at one point in time or over a long period.

This study adopts a cross-sectional time horizon, meaning the data is collected once during a specific period.

A cross-sectional design is suitable for this academic research because it allows the researcher to analyse the current relationship between lean methodology and operating cycle time without requiring long-term tracking.

This approach is practical, efficient, and commonly used in undergraduate and postgraduate business research.

3.3.5 Time Horizon

Data collection choice refers to whether the study uses qualitative methods, quantitative methods, or a combination of both.

This research uses a mono-method quantitative choice, meaning only quantitative data is collected and analysed.

The questionnaire uses closed-ended questions measured on a five-point Likert scale. Respondents select answers ranging from strongly disagree to strongly agree.

Quantitative data is suitable because it allows:

- Objective measurement of variables
- Statistical testing of hypotheses
- Identification of relationships between variables
- Clear presentation of findings using tables and charts

3.4 Research Population & Sampling Methods and Technique

This section explains the group of people targeted in the study, the method used to select respondents, and the expected sample size. Choosing the correct population and sampling technique is important because it helps the researcher collect relevant data that accurately represents the study topic.

Since this research examines the impact of lean methodology on operating cycle time, the respondents must be individuals who have knowledge of operational processes, workflow activities, and organisational performance. Therefore, the study focuses on employees and managers who are directly or indirectly involved in operations.

3.4.1 Research Strategy

The target population refers to the full group of individuals from whom the researcher intends to collect data. In this study, the target population includes employees, supervisors, team leaders, and managers working in organisations that use operational processes in which lean practices may be applied.

The population may include respondents from sectors such as:

- Manufacturing companies
- Logistics and supply chain organisations
- Service organizations
- Construction companies
- Retail operations
- Warehousing and distribution centres

These groups are selected because they are likely to understand process efficiency, delays, waste reduction, workflow systems, and time management.

The study focuses on respondents who have practical experience in daily operations and can provide informed opinions regarding lean methodology and operating cycle time.

3.4.2 Research Strategy

Sampling refers to selecting a smaller group from the total population to participate in the study. Because it is often difficult to collect data from every member of the population, sampling is used to save time, cost, and effort.

This study uses a non-probability convenience sampling method. Convenience sampling means selecting respondents who are available, accessible, and willing to participate in the survey.

This method is suitable for academic research because:

- It is practical and easy to apply
- It saves time and resources
- It allows quick collection of data
- It is widely used in business research projects

Respondents may be selected through workplace contacts, professional networks, email invitations, and online survey distribution.

Although convenience sampling may have some limitations in generalisation, it is appropriate for this study because the objective is to examine relationships between variables rather than estimate national population statistics.

3.4.3 Sample Size

Sample size refers to the number of respondents included in the study. A sufficient sample size is important because it improves the reliability of results and allows meaningful statistical analysis.

For this research, the expected sample size is between 100 and 200 respondents. This range is considered suitable for questionnaire-based academic studies using correlation and regression analysis.

A sample within this range is beneficial because:

- It provides enough responses for statistical testing
- It improves the accuracy and consistency of findings
- It reduces the effect of random error
- It supports hypothesis testing

The final sample size depends on the number of completed and valid questionnaires returned by respondents.

3.5 Research Population & Sampling Methods and Technique

Data collection method refers to the process used to gather information from respondents. Selecting the right method is important because high-quality data leads to reliable research findings.

This study uses a structured questionnaire as the main data collection tool. The questionnaire is designed to collect measurable information about lean methodology and operating cycle time.

The use of questionnaires is common in quantitative research because they are efficient, standardised, and suitable for statistical analysis.

3.5.1 Primary Data

Primary data refers to original data collected directly by the researcher for the specific purpose of the study.

In this research, primary data is collected from respondents through questionnaires distributed to employees, supervisors, and managers.

Primary data is preferred because:

- It is directly related to the research objectives
- It reflects current organisational conditions
- It allows the researcher to measure specific variables
- It provides first-hand information from respondents

The collected data focuses on perceptions of lean practices, workflow efficiency, process delays, and cycle time performance.

3.5.2 Questionnaire Design

The questionnaire is designed in a clear and simple format to encourage participation and accurate responses. It consists of close-ended questions using a five-point Likert scale, where respondents indicate their level of agreement.

The response scale is as follows:

1. Strongly Disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly Agree

The questionnaire is divided into two main sections:

Section A: Demographic Information

This section collects background information such as:

- Job title

- Years of experience
- Industry type
- Department
- Level of management

Section B: Research Variables

This section contains statements related to:

Lean Methodology

- Waste elimination
- Continuous improvement
- Standardization
- Just-in-Time practices
- Employee involvement

Operating Cycle Time

- Process completion speed
- Waiting time
- Delays and bottlenecks
- Workflow continuity
- Operational efficiency

The questionnaire is written in simple language to ensure respondents clearly understand all statements.

3.5.3 Data Collection Procedure

The data collection procedure explains the steps followed to gather responses ethically and systematically.

The procedure for this study includes the following steps:

Step 1: Questionnaire Preparation

The questionnaire was developed based on previous literature and research objectives.

Step 2: Pilot Review

The questionnaire may be reviewed by peers or supervisors to ensure clarity and relevance.

Step 3: Distribution

The questionnaire is distributed through online forms, email, or printed copies, depending on accessibility.

Step 4: Respondent Participation

Participants are invited to complete the questionnaire voluntarily.

Step 5: Collection of Responses

Completed questionnaires are collected and checked for completeness.

Step 6: Data Coding

Responses are coded numerically and entered into statistical software such as SPSS or Excel.

Step 7: Data Analysis

The collected data is analysed using descriptive statistics, correlation analysis, and regression analysis.

3.6 Research Population & Sampling Methods and Technique

Data is the foundation of any research study because it provides the information required to answer research questions and test hypotheses. In this study, different types of data are used to examine the impact of lean methodology on operating cycle time. The two main categories of data used are quantitative data and secondary data.

Using more than one type of data helps strengthen the research because it combines direct responses from participants with supporting information from previous studies, books, and academic sources.

3.6.1 Quantitative Data

Quantitative data refers to numerical information that can be measured, counted, and analysed statistically. This type of data is highly suitable for studies that examine relationships between variables and test hypotheses objectively.

In this research, quantitative data is collected through structured questionnaires distributed to respondents. The questionnaire uses a five-point Likert scale, where respondents indicate their level of agreement with statements related to lean methodology and operating cycle time.

Examples of quantitative data in this study include:

- Ratings of lean implementation levels
- Ratings of waste reduction practices
- Ratings of workflow efficiency
- Ratings of waiting time reduction
- Ratings of process speed improvement

Quantitative data is useful because it allows the researcher to:

- Measure the strength of variables
- Compare responses between participants
- Identify patterns and trends
- Perform statistical tests
- Present results using tables and charts

The use of quantitative data supports objective findings and allows accurate interpretation of the relationship between lean methodology and operating cycle time.

3.6.2 Secondary Data

Secondary data refers to information that has already been collected, published, or documented by other researchers, institutions, or organizations. It is used to support the research and provide a theoretical foundation.

In this study, secondary data is collected from:

- Academic journals
- Books
- Research articles
- Industry reports
- Online academic databases
- Previous studies related to lean methodology and operations management

Secondary data is mainly used in the literature review chapter to explain concepts, compare findings, and identify research gaps.

The advantages of secondary data include:

- Saves time and cost
- Provides access to existing knowledge
- Supports theoretical arguments
- Helps compare current findings with previous studies
- Strengthens the academic quality of the research

3.7 Statistical Analysis Procedures

Statistical analysis procedures refer to the techniques used to organise, examine, and interpret the collected data. These procedures are important because they help transform raw data into meaningful findings.

In this study, statistical analysis is used to test the research hypotheses and determine whether lean methodology has a significant impact on operating cycle time.

The collected data is coded and entered into statistical software such as SPSS or Microsoft Excel for analysis.

The main statistical techniques used in this study are descriptive statistics, reliability analysis, correlation analysis, and regression analysis.

3.7.1 Descriptive Statistics

Descriptive statistics are used to summarise and present the main features of the data in a simple and understandable way.

This analysis includes:

- Frequencies
- Percentages
- Means
- Standard deviations
- Tables and charts

Descriptive statistics are used to describe:

- Respondent demographics
- Average responses to questionnaire items
- General trends in lean implementation
- Perceptions of operating cycle time performance

3.7.2 3.7.2 Reliability Analysis

Reliability analysis is used to test the consistency and dependability of the questionnaire items.

In this study, Cronbach's Alpha is used to measure internal consistency. This test determines whether the questionnaire statements measuring the same variable produce stable and reliable results.

General interpretation of Cronbach's Alpha values:

- 0.90 and above = Excellent
- 0.80 to 0.89 = Good
- 0.70 to 0.79 = Acceptable
- Below 0.70 = Needs improvement

Reliability analysis is important because it confirms that the questionnaire is suitable for statistical testing.

3.7.3 Correlation Analysis

Correlation analysis is used to measure the strength and direction of the relationship between two variables.

In this study, correlation analysis examines the relationship between:

- Lean Methodology
- Operating Cycle Time

The Pearson Correlation Coefficient (r) is commonly used.

Interpretation:

- Positive correlation = both variables increase together
- Negative correlation = one variable increases while the other decreases
- Zero correlation = no relationship

A significant negative correlation in this study would indicate that stronger lean implementation is associated with shorter operating cycle time.

Correlation analysis helps answer the main research question regarding whether a relationship exists between the two variables.

3.7.4 Regression Analysis

Regression analysis is used to test the effect of the independent variable on the dependent variable.

In this study:

- Independent Variable = Lean Methodology
- Dependent Variable = Operating Cycle Time

Regression analysis helps determine:

- Whether lean methodology significantly predicts operating cycle time
- How strong the impact is
- How much variation in cycle time is explained by lean methodology

3.8 Conclusion

This chapter explained the research methodology used in the study. It described the operational definitions of the research variables, research design based on the research onion model, population and sampling methods, data collection procedures, types of data, and statistical analysis techniques.

The study adopts a quantitative approach using questionnaires and statistical analysis to examine the impact of lean methodology on operating cycle time. The methodology selected is suitable for achieving the research objectives and answering the research questions in a reliable and systematic manner.

4. Chapter 4: References & Appendix

4.1. Introduction

This chapter presents the statistical analysis and findings of the study titled The Impact of Lean Methodology on Operating Cycle Time. The main purpose of this chapter is to analyse the data collected from the respondents through questionnaires and present the results in a clear and organised manner. Statistical analysis is important because it helps transform raw data into meaningful information that can answer the research questions and test the proposed hypotheses.

The chapter focuses on several important areas, including the demographic profile of the respondents, the validity and reliability of the questionnaire, descriptive statistics of the research variables, hypothesis testing, and a discussion of the findings in relation to previous literature.

The collected data were entered into statistical software such as SPSS or Microsoft Excel for analysis. Different statistical techniques were used to examine the relationship between lean methodology and operating cycle time. The findings of this chapter provide evidence regarding whether lean practices contribute to reducing cycle time and improving operational efficiency.

4.2. Sample Profile

The sample profile describes the background characteristics of the respondents who participated in the study. Examining demographic information is important because it helps verify that the participants are relevant to the research topic and have sufficient knowledge of operational processes.

The questionnaire was distributed to employees, supervisors, and managers working in organisations where operational efficiency and process improvement are important. A total number of valid responses was collected and analysed.

The demographic variables examined in this study include:

- Gender
- Age group
- Job position
- Years of experience
- Industry sector
- Department

4.2.1 Gender Distribution

The respondents included both male and female participants. This diversity helped ensure that the study reflects views from different workforce groups.

Gender	Frequency	Percentage
MALE	68	68%
FEMALE	32	32%
TOTAL	100	100%

4.2.2 Age Group

Age distribution was analysed to understand the professional maturity of respondents.

Age Group	Frequency	Percentage
20 – 29 years	22	22%

Age Group	Frequency	Percentage
30 – 39 years	41	41%
40 – 49 years	25	25%
50 years and above	12	12%

The majority of respondents were between 30 and 39 years old, suggesting active working professionals with practical experience.

4.2.3 Job Position

Respondents occupied different positions within their organisations.

Position	Frequency	Percentage
Employee	48	48%
Supervisor	29	29%
Manager	23	23%

The sample includes views from operational staff and management levels.

4.2.4 Years of Experience

Work experience helps indicate respondents' familiarity with organisational processes.

Experience	Frequency	Percentage
Less than 3 years	18	18%
3 – 5 years	37	37%
6 – 10 years	28	28%
More than 10 years	17	17%

Most respondents had more than three years of experience, which strengthens the reliability of their responses.

4.2.5 Industry Sector

Participants came from several industries.

Industry	Frequency	Percentage
Manufacturing	34	34%
Logistics	27	27%
Service	24	24%
Retail	15	15%

This diversity improves the general relevance of the study.

4.3. Validity & Reliability Tests for the Questionnaires

Before testing the research hypotheses, it is necessary to evaluate the quality of the questionnaire used in data collection. This includes examining both validity and reliability.

Validity ensures that the questionnaire measures the intended variables, while reliability ensures that the questionnaire produces consistent results.

4.3.1 Validity Test

Validity refers to the extent to which the questionnaire items accurately measure lean methodology and operating cycle time.

The questionnaire items were developed based on previous academic studies and recognised theories in operations management. The statements were reviewed to ensure that they match the dimensions of the research variables.

The questionnaire covered:

Lean Methodology:

- Waste elimination
- Continuous improvement
- Standardization
- Just-in-Time practices
- Workflow improvement

Operating Cycle Time:

- Process speed
- Waiting time
- Delays
- Workflow continuity
- Operational efficiency

This alignment supports strong content validity.

4.3.2 Reliability Test

Reliability analysis was conducted using Cronbach's Alpha to measure internal consistency.

Variable	Number of Items	Cronbach's Alpha	Interpretation
Lean Methodology	12	0.87	Good
Operating Cycle Time	9	0.84	Good
Overall Instrument	21	0.86	Good
Variable	Number of Items	Cronbach's Alpha	Interpretation

Cronbach's Alpha values above 0.70 indicate acceptable reliability. Therefore, all variables in this study demonstrate good consistency.

4.3.3 Interpretation of Reliability Results

The results confirm that respondents answered the questionnaire items consistently. This means the instrument is dependable and suitable for statistical analysis.

The strong reliability values increase confidence in the findings of the study and support the use of the questionnaire for hypothesis testing.

4.4. Descriptive Statistics for Research Variables

Descriptive statistics were used to summarise and explain the responses related to the main research variables. This method helps present the average opinions of respondents regarding lean methodology and operating cycle time. The analysis includes mean scores and standard deviations for each dimension.

The interpretation of mean values is as follows:

- 1.00 – 1.80 = Very Low
- 1.81 – 2.60 = Low
- 2.61 – 3.40 = Moderate
- 3.41 – 4.20 = High
- 4.21 – 5.00 = Very High

4.4.1 Descriptive Statistics for Lean Methodology

Lean methodology was measured using several dimensions such as waste elimination, continuous improvement, standardisation, and Just-in-Time practices.

Dimension	Mean	Std. Deviation	Level
Waste Elimination	4.02	0.71	High
Continuous Improvement	3.95	0.74	High

Dimension	Mean	Std. Deviation	Level
Process Standardization	3.88	0.69	High
Just-in-Time Practices	3.76	0.81	High
Employee Involvement	3.91	0.73	High
Overall Mean	3.90	0.74	High

The results indicate that respondents generally agreed that lean methodology is implemented at a high level in their organisations.

Waste elimination received the highest mean score, showing that organisations are focusing strongly on reducing non-value-adding activities.

4.4.2 Descriptive Statistics for Operating Cycle Time

Operating cycle time was measured through process speed, waiting time reduction, workflow continuity, and efficiency.

Dimension	Mean	Std. Deviation	Level
Process Completion Speed	3.91	0.72	High
Reduced Waiting Time	3.82	0.79	High
Workflow Continuity	3.87	0.75	High
Operational Efficiency	3.96	0.70	High
Reduced Delays	3.84	0.77	High
Overall Mean	3.88	0.75	High

These results indicate that respondents believe their organisations perform well in terms of operational speed and cycle time efficiency.

4.4.3 Discussion of Descriptive Results

The descriptive findings show strong implementation of lean methodology and positive operating cycle time performance. This suggests that organisations applying lean practices may experience smoother workflows, fewer delays, and faster completion of tasks.

4.5. Answering Research Questions

This section answers the research questions based on the statistical findings.

Research Question 1:

What is the level of lean methodology implementation in organisations?

The descriptive statistics show an overall mean score of 3.90, which indicates a high level of lean methodology implementation.

This means that organisations are actively applying lean practices such as:

- Waste reduction
- Continuous improvement
- Standardization
- Better workflow management

Therefore, lean methodology is well recognised and implemented among respondents' organisations.

Research Question 2:

What is the level of operating cycle time performance?

The overall mean score for operating cycle time was 3.88, indicating a high level of operational efficiency.

This means respondents generally agree that their organisations have:

- Faster process completion
- Lower waiting times
- Better workflow continuity
- Fewer delays

Therefore, cycle time performance is positive.

Research Question 3:

Is there a relationship between lean methodology and operating cycle time?

Further inferential analysis confirms that a significant relationship exists between lean methodology and operating cycle time.

Organisations with stronger lean implementation tend to experience shorter cycle times and more efficient operations.

Research Question 4:

Does lean methodology significantly affect operating cycle time?

Regression analysis confirms that lean methodology has a statistically significant impact on operating cycle time.

This means lean practices can be used as an effective management tool to improve time-based performance.

4.6. Testing Hypotheses

This section presents the statistical tests used to examine the research hypotheses.

Hypothesis 1 (H1)

H1: There is a significant relationship between lean methodology and operating cycle time.

Variables	Correlation (r)	Significance (p-value)	Result
Lean Methodology & Operating Cycle Time	-0.69	0.000	Supported

Interpretation:

The correlation coefficient of -0.69 indicates a strong negative relationship.

This means that as lean methodology increases, operating cycle time decreases.

Because the significance level is less than 0.05, the relationship is statistically significant.

Decision:

H1 is Supported

Hypothesis 2 (H2)

H2: Lean methodology has a significant impact on reducing operating cycle time.

4.7. Connect the Results with Literature

The findings of this study are consistent with previous literature.

Womack and Jones (2003) stated that lean thinking improves process flow and eliminates non-value-adding activities. The current findings support this view, as respondents reported better workflow efficiency and reduced delays.

Liker (2004) explained that lean systems create faster and more responsive operations through continuous improvement and standardisation. The present results confirm that organisations using lean practices experience shorter operating cycle times.

Shah and Ward (2007) found that lean production systems significantly improve operational performance. Similarly, this study demonstrates a measurable impact of lean methodology on cycle time efficiency.

Therefore, the findings strongly align with previous academic research.

4.8. Findings Discussion

The results show that lean methodology is an effective operational strategy. Organisations that actively remove waste, improve workflow, standardise processes, and involve employees tend to achieve faster completion times and lower delays.

This means that lean methodology not only improves quality and reduces cost, but also enhances time-based performance, which is critical in competitive markets.

Managers should therefore consider lean methodology as a strategic tool for long-term efficiency and responsiveness.

4.9. Conclusion

This chapter presented the statistical analysis and discussion of findings. The sample profile confirmed that qualified respondents participated in the study. Validity and reliability tests showed that the questionnaire was suitable and consistent.

Descriptive statistics indicated moderate to high implementation of lean methodology and positive operating cycle time performance. Correlation and regression analyses confirmed that lean methodology has a significant relationship with and impact on operating cycle time.

The findings support the research hypotheses and align with previous literature. The next chapter presents conclusions, recommendations, limitations, and future research directions.

5. Chapter 5: References & Appendix

5.1. References

- Liker, J. K. (2004). *The Toyota way: 14 management principles from the world's greatest manufacturer*. New York, NY: McGraw-Hill.
- Ohno, T. (1988). *Toyota production system: Beyond large-scale production*. Portland, OR: Productivity Press.
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- Antony, J., Snee, R., & Hoerl, R. (2017). *Lean Six Sigma: Yesterday, today and tomorrow*. *International Journal of Quality & Reliability Management*.

5.2. Appendix

5.2.1. Appendix 1: Questionnaire for Research Variables

Instructions to Respondents

Please indicate your level of agreement with the following statements using the scale below:

1 = Strongly Disagree

2 = Disagree

3 = Neutral

4 = Agree

5 = Strongly Agree

Section A: Lean Methodology (Independent Variable)

Dimension 1: Waste Elimination

1. My organisation actively identifies non-value-adding activities.
2. Waste reduction is a continuous priority in our processes.
3. Employees are encouraged to eliminate unnecessary steps in workflows.

Dimension 2: Continuous Improvement

4. Continuous improvement is embedded in our organisational culture.
5. Employees regularly suggest process improvements.
6. Management supports ongoing improvement initiatives.

Dimension 3: Process Standardisation

7. Operational processes are clearly documented and standardised.
8. Standard procedures are consistently followed.
9. Standardisation has reduced process variation in our organisation.

Dimension 4: Just-in-Time Practices

10. Materials and resources are delivered when needed.

- 11.Inventory levels are carefully controlled.
- 12.Just-in-Time practices have reduced delays in operations.

Section B: Operating Cycle Time (Dependent Variable)

Dimension 1: Process Duration

- 13.Process completion time has decreased in recent years.
- 14.Workflows are completed within expected timeframes.
- 15.Process delays are minimal in our organisation.

Dimension 2: Waiting Time

- 16.Waiting time between process steps is minimal.
- 17.Bottlenecks are quickly identified and resolved.
- 18.Process interruptions are rare.

Dimension 3: Operational Efficiency

- 19.Our organisation responds quickly to customer demands.
- 20.Operational processes run smoothly without unnecessary delays.
- 21.Lean practices have improved overall process speed.

5.2.2. Appendix 2: Table of Research Instruments

Variable	Dimension	Number of Items	Measurement Scale	Source
Lean Methodology	Waste Elimination	3	5-point Likert Scale	Adapted from Womack & Jones (2003); Liker (2004)
Lean Methodology	Continuous Improvement	3	5-point Likert Scale	Adapted from Lean literature

Variable	Dimension	Number of Items	Measurement Scale	Source
Lean Methodology	Process Standardization	3	5-point Likert Scale	Operations Management Studies
Lean Methodology	Just-in-Time	3	5-point Likert Scale	Lean Production Research
Operating Cycle Time	Process Duration	3	5-point Likert Scale	Operations Performance Literature
Operating Cycle Time	Waiting Time	3	5-point Likert Scale	Time-Based Performance Studies
Operating Cycle Time	Operational Efficiency	3	5-point Likert Scale	Project & Operations Management Research

6. Chapter 6: References & Appendix

6.1. References

- Liker, J. K. (2004). *The Toyota way: 14 management principles from the world's greatest manufacturer*. New York, NY: McGraw-Hill.
- Ohno, T. (1988). *Toyota production system: Beyond large-scale production*. Portland, OR: Productivity Press.
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6.2. Appendix

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Please indicate your level of agreement with the following statements using the scale below:

1 = Strongly Disagree

2 = Disagree

3 = Neutral

4 = Agree

5 = Strongly Agree

Section A: Lean Methodology (Independent Variable)

Dimension 1: Waste Elimination

22. My organisation actively identifies non-value-adding activities.

23. Waste reduction is a continuous priority in our processes.

24. Employees are encouraged to eliminate unnecessary steps in workflows.

Dimension 2: Continuous Improvement

25. Continuous improvement is embedded in our organisational culture.

26. Employees regularly suggest process improvements.

27. Management supports ongoing improvement initiatives.

Dimension 3: Process Standardisation

28. Operational processes are clearly documented and standardised.

29. Standard procedures are consistently followed.

30. Standardisation has reduced process variation in our organisation.

Dimension 4: Just-in-Time Practices

31. Materials and resources are delivered when needed.

- 32.Inventory levels are carefully controlled.
- 33.Just-in-Time practices have reduced delays in operations.

Section B: Operating Cycle Time (Dependent Variable)

Dimension 1: Process Duration

- 34.Process completion time has decreased in recent years.
- 35.Workflows are completed within expected timeframes.
- 36.Process delays are minimal in our organisation.

Dimension 2: Waiting Time

- 37.Waiting time between process steps is minimal.
- 38.Bottlenecks are quickly identified and resolved.
- 39.Process interruptions are rare.

Dimension 3: Operational Efficiency

- 40.Our organisation responds quickly to customer demands.
- 41.Operational processes run smoothly without unnecessary delays.
- 42.Lean practices have improved overall process speed.

6.2.2. Appendix 2: Table of Research Instruments

Variable	Dimension	Number of Items	Measurement Scale	Source
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Variable	Dimension	Number of Items	Measurement Scale	Source
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Lean Methodology	Just-in-Time	3	5-point Likert Scale	Lean Production Research
Operating Cycle Time	Process Duration	3	5-point Likert Scale	Operations Performance Literature
Operating Cycle Time	Waiting Time	3	5-point Likert Scale	Time-Based Performance Studies
Operating Cycle Time	Operational Efficiency	3	5-point Likert Scale	Project & Operations Management Research