



Arab American University
Faculty of Graduate Studies

**Investigating the Level of Utilization of Lean
Manufacturing Tools in Palestinian Manufacturing
Enterprises Case Study: Ramallah**

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**This Thesis was submitted in partial fulfillment of the
requirements for the Master in Quality Management**

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Thesis Approval

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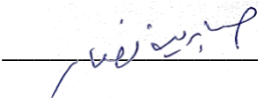
Dedication

I dedicate this work to all my teachers all over the years, my mother who taught me patience and persistence and has been my supporter.

Declaration

I declare that this thesis has been composed solely by my-self and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where stated otherwise by reference or acknowledgment, the work presented is entirely my own.

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Abstract

Lean Manufacturing (LM) principles and tools have been used by manufacturing enterprises all over the world to achieve operational excellence and gain competitive advantage in the market; it is believed that LM can be introduced to assist enterprises in achieving effective and efficient production which will result in better business performance.

This research aims to investigate the extent to which LM tools are utilized by manufacturing enterprises in Ramallah and the relation between some enterprise characteristics and the level of utilization of these tools. The motivation of the research was based on the substantial benefits that can be achieved from the application of the LM in addition to the very limited research in this area in the Palestinian context, where the need for understanding the current state and formulation of an overview of the manufacturing enterprises is an essential step to design future research and interventions.

The research adopted a quantitative approach where a random sample from the manufacturing enterprises was used to collect relevant data from 147 enterprises working in Ramallah governorate. Focusing on the most commonly used LM tools, ten tools were selected associated with LM: (5S, JIT, TPM, VSM, KAIZEN, Standardized Work, Visual management, Cellular design, Setup reduction and SMED, Smaller lot Size). Data were collected using a structured questionnaire consisting mainly of closed-ended questions and was analyzed using descriptive and inferential statistics.

The findings indicate medium to high level of utilization of LM tools in manufacturing enterprises in Ramallah, Palestine. The level of utilization of LM tools depends on a

variety of factors, including the enterprise's size and industry sector, while ownership type doesn't have an influence on the level of utilization.

This research contributes to the existing body of knowledge, especially in the Palestinian context, by providing insights about the LM tools used in the manufacturing enterprises where limited research is available on this topic.

Keywords: Lean manufacturing tools, utilization, Palestinian manufacturing enterprises.

Chapter One

Introduction

1.1 Overview

In this chapter, a general background related to the research area is presented. Moreover, the research problem, research objectives and significance, research scope and thesis structure are presented.

1.2 General Background

Many enterprises are becoming aware of the Lean Manufacturing (LM) concepts and the beneficial effects of integrating this concept in their processes since it is becoming a core competency for surviving in today's competitive markets. According to Garza-Reyes et al., (2012), LM principles and tools have been widely used by manufacturing enterprises to achieve operational excellence and maintain competitive advantages. These concepts and tools have rapidly spread in most industrial enterprises all over the world and in different sectors (Sundar et al., 2014).

LM means utilizing various tools and techniques that identify and eliminate wastes associated with the manufacturing system, focusing on increasing the product value for the customer (Gonçalves, Micael. & Salonities, 2017). While implementing Lean is not devoid of challenges; this thesis seeks to investigate the level of utilization of LM tools in manufacturing enterprises. In order to achieve this, the previous literature has been reviewed, and the most important lean tools have been identified.

1.3 Problem Statement

Lean manufacturing has become a core competency for enterprises all over the world. Womack and Jones (2008) stated that lean principles can be applied in any industry. Different types of organizations have implemented lean manufacturing to enhance their performance by eliminating waste and reducing the variability of suppliers, customers, and internal resources and processes.

In the Palestinian context; for decades enterprises have suffered hardship due to numerous factors such as political and economic instability. With limited access to resources, and hardship of the movement of goods and people which result in increase in the transaction costs and even distort investment decisions, all of this contributes to weaken any sustainable economic growth and development strategy in the Palestinian territories (Mas, 2021).

The Palestinian Central Bureau of Statistics (PCBS) report of 2020 shows that 2993 enterprises were registered in 2019 (2823 of them are manufacturing enterprises), and the industrial survey of (PCBS) 2019 shows that the owners of manufacturing enterprises consider the political situation as the main challenge facing their manufacturing activities, while the high cost of electricity and fuel comes next (PCBS et al., 2020). Thus, enhancing the efficiency and flexibility of the enterprises by controlling the challenges at the enterprise level such as decreasing cost and eliminating waste can be a good strategy for those enterprises to survive in such an environment.

It is noticed that there is limited research on Lean implementation in Palestine; thus, it is important to understand the current level of utilization of LM tools to see how far they are from LM implementation.

1.4 Significance of the Research

The significance of this research stems from the fact that it provides an insight into the current status of manufacturing enterprises with respect to the utilization of the LM tools. The findings will be beneficial for enterprises' owners, practitioners, and people working in the manufacturing sector, as there is a lack of attention and limited study on this topic.

Besides that, these findings can be considered a starting point for further research.

1.5 Research Objectives and Questions

The main objective of this thesis is to investigate the level of utilization of LM tools and examine the extent to which lean manufacturing tools are adopted at manufacturing enterprises in Ramallah.

These objectives can be achieved by answering the following main research questions:

- 1) What is the current level of utilization of LM tools within manufacturing enterprises in Ramallah?
- 2) Does the utilization of LM tools in manufacturing enterprises in Ramallah differ in ISO 9001 certified enterprises compared to non-ISO 9001 enterprises?
- 3) Does the utilization of LM tools in manufacturing enterprises in Ramallah differ according to enterprise size?
- 4) Does the utilization of LM tools in manufacturing enterprises in Ramallah differ according to the ownership of the enterprise?
- 5) Does the utilization of LM tools in manufacturing enterprises in Ramallah differ according to the sector?

1.6 Research Hypothesis

Different hypotheses have been formulated to answer the research questions and achieve the objectives of the research, listed below:

- H1: There is a significant difference (within a 5% level) in the utilization level of LM tools used by ISO 9001 certified enterprises compared to non-ISO 9001 enterprises in Ramallah.
- H2: Enterprises of different sizes (small, medium, large) in Ramallah differ significantly (within a 5% level) in utilization level of LM tools.
- H3: Non-family-owned enterprises in Ramallah differ significantly (within a 5% level) in utilization level of LM tools compared to family owned enterprises in Ramallah.
- H4: Enterprises of different sectors in Ramallah differ significantly (within a 5% significance level) in utilization level of LM tools.
- H5: There is no difference between the level of utilization of LM tools in enterprises in Ramallah.

1.7 Scope of the Research

The scope of the thesis is the results of the research on the level of utilization of LM tools. The thesis does not, however, not examine the success of lean manufacturing implementation. Also, this research is limited to Ramallah governorate and targets enterprises in the formal sector; registered companies at the Ministry of National Economy (MoNE) and members of Ramallah Chamber of Commerce and Industry (RCCI).

On another level, the way of obtaining the needed data about the utilization level of each tool is based on a subjective evaluation of the respondent.

1.8 Thesis Structure

This thesis contains five chapters: the first chapter is the introduction, which provides the background information, the purpose of the research, the significance of it, and the structure. The second chapter is the literature review, which presents the existing literature related to the key topics of this thesis. The third chapter presents the research methodology. The fourth chapter provides the results, analysis, and discussion. Finally, chapter five presents the conclusions and recommendations.

Chapter Two

Literature Review

2.1 Overview

Building upon the literature's relevant articles is essential to effectively achieving this research's defined objectives. For this purpose, a comprehensive literature review was employed; books, journal articles and previous studies were reviewed. Articles related to LM were reviewed with special focus on the following topics: Lean Manufacturing, Lean Manufacturing Implementation, Lean Manufacturing Tools, Lean Utilization to cover the main elements of this research.

2.2 Background of the Research

In the era of global competition, the manufacturing industry is making efforts to survive in the current impulsive and competitive economy. Competition is not limited to prices alone but also involves introducing technological, creative, innovative, and high-quality products, which requires a systematic process of cost minimization and value maximization. According to Garza-Reyes et al. (2012), lean manufacturing principles and tools have been widely used by manufacturing enterprises to achieve operational excellence and gain competitive advantage in the market; thus, it is believed that LM can be introduced to assist enterprises in achieving effective and efficient production which will result in better business performance (Losonci & Demeter, 2013)

Many researchers have covered lean topics, starting from the 1970s, which is considered the discovery phase, to the most recent phase of performance. Due to the superiority of the lean concept in terms of cost, quality, and flexibility, interest in it has grown across

countries and industries (Rose, Rahman, & Nordin, 2010) and it can be applied in every business and every process.

Despite the widespread of the Lean concept, many enterprises have failed to implement LM practices. Management commitment and involvement, training, education, and employee participation and empowerment are considered critical to a successful implementation of LM (Netland, 2016). Barriers such as behavioral and cultural influence, organizational strategy and alignment, leadership commitment, technical limitations, process-based constraints, and resource constraints were identified through a systematic literature review (Leite et al., 2020).

In Palestine, the manufacturing sector is one of the main pillars of the Palestinian economy. It contributes to the process of socio-economic development. Globalization and competitiveness are two of the main challenges that the Palestinian National Economy faces (MoNE, 2020). The industrial sector covers 22% of total employment numbers in Palestine with more than 112 thousand Palestinian employees by the end of 2020. This sector has clearly helped in minimizing the unemployment gap and contributing to economic growth in Palestine. Besides that it is considered a leading sector in terms of exports capacity in reference to the PCBS's report on exports in Palestine (PIPA, 2022). Thus, it is essential to introduce easy-to-use Lean tools that do not require high investment to support Palestinian manufacturers to enhance performance and stay competitive in the local and global markets.

2.3 Lean Manufacturing Definition

Lean manufacturing (LM) is a manufacturing system originally founded by Toyota and previously recognized as Toyota Production System (TPS). It was developed by a

production executive named Taiichi Ohno and used to improve the quality and productivity within Toyota Motor Company (Ohno, 1988). The newly invented Lean concept focuses on finding all kinds of waste and then eliminating them by using Lean principles and tools in order to improve the efficiency and effectiveness of the industry. TPS is defined as a production system which is a quantity control system based on the foundation of quality, and the ultimate goal is cost reduction through the absolute elimination of waste (Wilson, 2010).

James and Womack popularized the term “Lean manufacturing” in 1990; “lean” because it generates products using fewer resources as inputs such as material, investment, inventory, space, and people (Wilson, 2010, p.31). LM is not only a cost reduction program but also a way of thinking and acting for an entire system, and by utilizing it, enterprises can achieve and improve their profitability (Dennis, 2016).

LM is a commitment and a continuous improvement process that can be reflected in operational, administrative, and strategic improvements that enhance the competitiveness of the organization and can change the running priorities of the business environment because it focuses on people, processes and technology (Ramezani & Mahdloo, 2014). More specifically, the implementation of LM is beneficial in many aspects; continuous improvement, process improvement, and improving supplier-customer relationships by reducing lead time, defects, inventory, work in process (WIP), and improving quality and productivity. Besides that, it also provides varieties of strategies for improving performance to compete in today's emerging market (Patel & Patange, 2017).

According to these definitions, LM tools include a powerful wide set of tools for increasing efficiency, competitiveness, and customer value, and is treated as a

comprehensive philosophy with the main focus on continuously eliminating all forms of waste and removing all activities that do not add value.

2.4 Lean Manufacturing Dimensions

Through the analysis of the literature, it can be found that seven main dimensions of LM were identified and used to measure leanness in manufacturing which are the manufacturing process and equipment, manufacturing planning and scheduling, visual information systems, product development and technology, workforce management, supplier relationships and also customer relationships (Wahab et al., 2013). These seven dimensions are illustrated in Table (2.1).

Table (2.1): LM Dimensions and Their Description

Dimension in LM	Description
Manufacturing processes and equipment	Aims to ensure that quality standards are being followed. Reduced setup time to obtain continuous flow-type production. Redesign of the production process according to cell manufacturing
Manufacturing planning and scheduling	Coordinated production with market demand, using production leveling, small lots, and pull systems.
Visual information system	To allow information to flow to the relevant decision-makers, with rapid feedback and action, as well as visualizing performance information on boards.
Product development and technology	Developing product structure, materials, and technical solutions, with innovative practices in product design and advanced methodologies.
Workforce management	The involvement of workers in quality programs increases their job autonomy. Education and training, evaluation and reward systems, employee empowerment, and responsibility.
Supplier relationship	To achieve operational integration between buyer and supplier It influences several aspects of R&D and logistics
Customer relationship	To ensure reliable and prompt output, to develop marketing techniques in order to make predictable and stable demand, and also improve the competence of personnel directly involved with customers

2.5 Lean Principles

Lean is a system that includes procedures, tools, principles, and also the management of thinking (Ramezani & Mahdloo, 2014). Lean thinking has five stages or sets of principles that guide activities for organizations involved in transforming and sustaining lean; the five principles for lean manufacturing implementation are value, value stream, flow, pull, and perfection (Womack & Jones, 1997).

The first principle of Lean is to specify the value from the perspective of the customer (Bicheno & Holweg, 2009, p. 12). It is done by defining customer needs and defining the value of activities, in the sense of identifying activities that add value to the final product, and removing every step, every procedure, and every practice that does not create value.

Manufacturers usually give their customers what is convenient for them (as manufacturers) or conceived as economical for the customers. But in order to define the value it is essential to know who the customer is: "the final customer, the next process, the next company along the supply chain or the customer's customer" (Bicheno & Holweg, 2009, p. 12).

The second principle is the value stream. This refers to the sequence of processes from the early stages of raw materials to the final product delivered to the customer. The supply chain should be viewed and analyzed. Because it is the supply chains that compete, not companies. Value streams are created by grouping similar products together within a company. The grouping of the products should depend on the company but could be centered on the characteristics, demand, and process routings. The value stream should include material, information, and people flow; the material flow focuses on the flow of materials from raw to the final product, the information

flow focuses on the communication flow of customer requirements and orders within a supply chain, and the people flow focuses on how people are able to move within and around the processes. (Bicheno & Holweg 2009, 12; Drew et al. 2004, 36- 38).

The third principle is flow. Ensuring a continuous flow in operations and in the entire supply chain, that is, the focus must be on the process and not just the product. Batch and queue processes should be avoided or continuously reduced so that there is a smooth and quick flow of information, products, and services. "Flow requires much preparation activity. But the most important thing is vision" (Bicheno & Holweg, 2009, p. 12).

When viewed from the perspective of an entire supply chain, it makes sense for activities to be organized in such a way that they allow for the smooth and uninterrupted flow of work at the rate of demand pull from the customer, where any disruption to the supply chain flow affects supply chain throughput, capacity, and cycle time and ultimately "adds little value that the customers appreciate.". (Trent, 2006, p. 6)

The fourth principle is pull. Pull means that production is carried out according to the demands and needs of customers, which indicates short-term response to the customer's rate of demand, and avoids overproducing. Pull is especially useful for a company that finds it difficult to maintain the continuous flow of parts of the value stream. (Drew et al. 2004, 39; Bicheno & Holweg. 2009, 13).

The fifth principle is perfection. When value is defined, value flow is established, and non-value adding activities are removed, the process begins and continues until a state of perfection is reached. Perfection does not only mean a defect-free company – but it also means "delivering exactly what the customer wants, exactly when, at an affordable

price, and with minimum waste" (Bicheno & Holweg, 2009, p. 13). And there is no end to the improvement process.

2.6 Lean Manufacturing and Waste

Lean manufacturing is based on the three famous M's, Muda, Mura, and Muri. These three terms are Japanese terms, Muda means waste, Mura means inconsistency, and Muri means unreasonableness (Womack & Jones, 1997).

In Lean Manufacturing, the main emphasis is on identifying and eliminating all kinds of waste. Waste can be attributed to all the activities that cost but do not add any value to the product. Where value is what the customer is willing to pay for. Waste can be categorized in eight different types defined by Dennis (2016, p.20-24) as follows: defective parts, overproduction, waiting, not utilizing talent, transportation, inventory, motion, excessive processing, (see Table 2.2). When enterprises identify the sources of waste, then LM tools and techniques can be deployed (Abdullah, 2003).

Table (2.2): Eight Wastes (DOWNTIME)

Waste type	Waste definition
Defective parts and scrap	This type of loss includes the customer's dissatisfaction, a negative attitude toward the manufacturer, and the additional costs of rejection, rework, or recycling, and to remanufacture these products further resources will be consumed.
Over production	Producing too much ahead of what's needed by the next process or customer. This affects the costs of production, movement of products, recording and storage of these extra products.
Waiting	Operators standing idle as machines cycle, equipment fails, a production line stops, needed parts fail to arrive, etc. which creates impact on subsequent activities.
*Not utilizing talent	waste as underutilized talent where human potential skills or talent are not properly utilized as a source of waste which could be eliminated through elevating the workers' productivity and efficiency through task scheduling and planning
Transportation	Unnecessary transportation of parts and products. This consumes additional resources and provides no value to the customer.

Waste type	Waste definition
Inventory	Having more than the minimum stocks necessary for a precisely controlled pull system also means that products in the warehouse lose their relevance, demand on the market and cost over time.
Motion	Operators and employees make unnecessary movements which can be avoided, such as looking for parts, tools, documents, etc.
Excessive processing	This includes any further processing or activities that do not add any value, and can be considered unnecessary.

*Some studies consider knowledge disconnection is one of the sources of waste, this occurs when there is a breakdown within the company or between the company and its customers or suppliers. This prevents the flow of information and ideas, creating missed opportunities.

It is obvious that waste sources are all related to each other, the elimination of one can lead to the elimination or reduction of another. With the utilization of proper tools, waste elimination, cost reduction and employee empowerment can be achieved, which contributes to surviving in today's competitive market.

2.7 Lean Manufacturing Tools

While identifying and classifying manufacturing wastes can be the first step in improving a manufacturing organization. Identification is useless if the waste cannot be eliminated. It is therefore important to apply the correct tools to eliminate manufacturing waste (Pavnaskar, Gershenson & Jambekar, 2003).

LM tools are the backbone of lean management and help achieve the objectives of LM: eliminate the eight wastes and create value. There are more than 100 lean practices available for industries in which it is better to implement all or most of them to succeed in LM implementation, while those incapable of implementing all practices due to financial and resource constraints, can start with the feasible practices sequentially (Rose & Rahman, 2010). While some enterprises might choose specific tools to solve a

particular issue, the choice of tools is also dependent on the manufacturing process; the enterprise needs to understand what it must achieve from LM implementation and assess its processes before and after using the tools (Karim & Arif-Uz-Zaman, 2013).

In the literature, there are many tools listed, and researchers propose that these tools are most effective if they are implemented together. However, it can be utilized all alone to solve particular issues in the company, mainly when the company has determined the most significant source of waste. The following are the most commonly used LM tools: 5S, JIT, TPM, VSM, KAIZEN, Standardized work, Visual management, Cellular design, Setup reduction and SMED, Smaller lot size (Al-Najem, 2014). These are also known as LM drivers (Yadav et al., 2020), whereas Ali et al. (2020) considers continuous improvement, VSM, 5S, JIT, TPM, as the most important tools. A short description for each tool is given below.

2.7.1 Five S (5S)

One of the main focuses of LM is the organization of the workplace. The removal of unnecessary equipment will enhance space utilization and reduce injuries, making the tools ready and accessible to workers will require them to do their assigned tasks in less time and effort, and keeping the machines clean will reduce failures that may result from the lack of cleanliness of these machines. This concept has been introduced at Toyota company (Sangwan, 2014) with a main objective of creating a safe, and clean work environment. This concept served as a starting point for continuous improvement programs. It was called 5S.

5S refers to effective housekeeping practices which look for waste and try to eliminate it by focusing on having visual order, organization, cleanliness, and standardization. This

tool is considered one of the most popular lean management tools, characterized by its applicability to almost any space, from storage facilities to the workplace of an employee, and its ease of implementation. 5S can reduce waste, improve variation and improve productivity (Bicheno, J. & Holweg, 2009), 5S is also linked to providing safety in the workspace (Deranek et al., 2017) and extending its effect to ensure the effective operation of the entire system.

This system consists of 5 Japanese words starting with S, Seiri (Sort), Seiton (Straighten), Seiso (Sweep and clean), Seiketsu (Systemize), Shitsuke (Standardize) (Rymaszewska, 2014). Each of these terms is defined below:

Seiri means “sort”: a process of identifying all items in a work area and the appropriate disposition of those items.

Seiton means “set in order”: a process of assigning storage space for all items remaining in the work area: “a place for everything and everything in its place”

Seiso means “shine”: a process of thoroughly cleaning the work area. Workers take pride in a clean work area and take ownership of the equipment and facility. Workers also begin to notice changes or abnormalities in equipment and facilities (Bicheno & Holweg, 2009).

Seiketsu means “standardize”: a process of changing employee value by practicing clear workplace standards and procedures that are repeatable, reliable and capable to ensure successful implantation of 5S (Bicheno & Holweg, 2009).

Shitsuke means “sustain”, this step is considered the most difficult and essential step of the 5S to implement. Employees tend to resist change, and tend to return to the status quo and the comfort zone of the old way of doing things. Sustain focuses on defining a

new status quo and standard for the workplace (Carl, 1984) and continuously striving to improve it.

2.7.2 Just-In-Time (JIT)

Just in Time (JIT) is a tool that enables the internal processes of an enterprise, not only the manufacturing process, to adapt to changes in demand patterns by producing the right product at the right time, and in the right quantities required by customers (Abdullah, 2003), more precisely “what is needed, just when it is needed, in just the amount needed within the shortest possible lead time” (Drew, McCullum, & Roggenhofer, 2004). The application of JIT can contribute significantly to improving the quality of products and reducing waste, mainly those associated with time and inventory.

This tool is critical and requires agreement and support from all those involved on the company level and also from companies involved within the supply chain especially when used to manage external activities such as purchasing and distribution (Lai & Cheng, 2016). It can be further categorized into JIT production, JIT distribution and JIT purchasing.

JIT System have two main components: Kanban and production leveling (Dennis, 2016) explained as follow:

- Kanban is a Japanese word invented by Taiichi Ohno. It has two parts: the word “Kan” means card, and the word “Ban” means signal. It is pronounced as “Kahn-Bahn”. Where the producer begins the production when a user shows the Kanban card/signal (Sundar et al., 2014). Kanban is defined by Berkley (1992) as a visual

card system that lets workers have what they need, where they need it, and when they need it. It is the basis of the implementation of a pull-based system.

- Heijunka or Production leveling, this supports standardized work, working on the same pace every day to minimize peaks and valleys in the workload, it also supports quick adaptation to changes in demand.

2.7.3 Total Productive Maintenance (TPM)

It includes maintenance practices that prevent or reduce the frequency of system breakdowns and help ensure the smooth execution of all production-related activities; TPM has three main components: preventive maintenance, corrective maintenance, and maintenance prevention (Abdullah, 2003). What distinguishes TPM from the traditional concepts related to maintenance is its reliance on the principle of the participation of all employees in the organization to carry out the necessary maintenance work of machines and equipment used in the production process (Singh & Onkar, 2015). This tool is believed to achieve lean manufacturing; it contributes to enhancing performance and increasing customer satisfaction.

2.7.4 Value Stream Mapping (VSM)

It is a tool to assist in visualizing the entire production process, which includes material and information flow (Abdullah, 2003). It includes mapping the current-state activities, then allows the diagnosis of the None-Value Activities (NVA) and after that provides suggestions for developing a future-state activities map (Yadav et al., 2020), where the organization can clearly identify improvement opportunities.

2.7.5 KAIZEN

Kai-Zen is a Japanese word that means continuous improvement, it is an approach that focuses on continuously diagnosing the key areas of improvement; it aids in the elimination of non-value-added activities, the reduction of inventory, and the reduction of defective parts (Abdullah, 2003). It can be applied on the company's internal processes as well as any part of the supply chain (Trent, 2006).

Kaizen processes or events are implemented in multiple-stages preparation, implementation, and evaluation. Preparation can start with identifying the event and those who are involved in it, and there should be a Kaizen leader to lead the rest of the team during the Kaizen process. During the actual Kaizen implementation, the leader and team members evaluate the work area (or process) and “improve the process to solve the performance issue, measure results, and communicate these results to stakeholders” (Trent, 2006, p. 141). After the Kaizen event, the leader ensures that the changes made are reported and sustained. A review every month to ensure that the improvement was successful and more importantly, is continuously improving (Trent, 2006) (Bicheno & Holweg, 2009).

2.7.6 Standardized Work

Standardized work can be achieved by aligning the process operations and adopting standardized procedures. This ensures that each task or activity is organized and achieved in the most effective manner, and shortest time as a result of the effective utilization of resources such as people, machines, and materials (Sundar et al., 2014). This implies also that the job should be of the same level of quality regardless of who does it.

2.7.7 Visual Management (VM)

Correct representation of information can contribute to mitigating the complexity of production processes, especially in chaotic and unpredictable production environments, thus it is essential to find tools that support this representation. Visual management (VM) refers to the visualization of activities for the identification of wastes by the utilization of visual aids and visual information systems, in which several aspects of information and activity should be clearly visible to the workers so that they can understand and process them; this tool will enhance the product flow and is linked with 5S (Al-Najem, 2014). It is also useful in supporting other management efforts such as “production management, safety management, performance management, and workplace management.

Dennis in his book (2016) described VM as a triangle that consists of three elements, knowing as a group (commitment, goals and rules), acting as a group, and seeing as a group which describe access to information.

2.7.8 Cellular Design Manufacturing

George (2003) defined cellular design manufacturing as designing the layout to include a set of machines, tools, and processes at the workstation as a form of work cells producing similar products with similar requirements. Cellular manufacturing design divides the production line into sections and cells, which consists of equipment and workstations with the objective of reducing cycles and inventories in order to respond to the market demand at the required time (Abdullah, 2003). In addition, cellular manufacturing design results in space reduction, quality improvement, reduced labor costs and the use of appropriate machinery (Ramezani & Mahdloo, 2014).

2.7.9 Setup Reduction and Single Minute Exchange of Die (SMED)

It is a setup time improvement that includes the use of standardized procedures, checklists for guiding a rapid and consistent setup, and clear, detailed instructions for changeovers (Sundar et al., 2014). Reducing setup time results in producing smaller batches with a variety of products due to the ease of changing dies and setting up of machines. (Yadav et al., 2020).

2.7.10 Smaller Lot Size

Since Lean is associated with zero inventories to enhance the utilization of capacity and visualize the product flow, smaller lot size, small batches are considered to smooth the material flow and to overcome the quality and lead time issues (Sundar et al., 2014). Lot size can be affected by the impact of many operations decisions, capacity planning decisions, and lot sizing decisions.

2.8 Utilization of Lean Manufacturing Tools

To succeed in implementing LM, this requires the enterprise to apply LM principles in all organizational functions; production, accounting, sales and marketing, and human resources. Most enterprises choose to apply stand-alone lean techniques without making huge changes as a safe strategy. This might not achieve the expected results and should therefore not be a replacement for Lean management as a whole system (Hobbs, 2003).

Leanness is a measurement that describes the level of adoption of a lean philosophy (Wong, 2007). This is important to actualize LM or improve manufacturing tasks by examining the present state and the future state when implementing LM tools (Gonçalves, Micael. & Salonities, 2017).

For assessment methods there is no common agreement between researchers as to whether they are qualitative or quantitative metrics and the ideal unified indicator has not been developed (Tayaksi et al., 2020). In the literature, some surveys were conducted to check the level of implementation of lean manufacturing in the companies. For example, Rose et al., (2010) conducted a survey targeting 60 Malaysian companies. The result was that most of the companies started the implementation, but they have not reached full implementation or achieved all their objectives. In his study (2016), Zahraee measured the implementation level of individual lean tools by surveying 93 companies in Iran. His findings indicate that lean tools such as Kaizen, 5S, setup time reduction, cellular manufacturing, continuous flow, equipment layout, product design simplicity and error-proof equipment are crucial to LM implementation.

It is obvious that there is no unified methodology for assessment. Therefore, there is huge diversity and opportunities in the methodologies used in Lean assessment.

2.9 Enterprise Characteristics Affecting LM Adoption and Implementation

The accomplishment of any management strategy is dependent on organizational characteristics. This indicates that all organizations cannot implement the same set of strategies in their particular case (Shah & Ward, 2003). Some studies revealed that organization size and the type of manufacturing may be significant factors affecting lean manufacturing implementation and adoption.

2.9.1 Quality Initiatives (ISO-9001)

ISO management systems are widely used, their implementation is not only to meet the requirements of the most important customers but also to organize and improve internal

processes in the organization. ISO9001 is based on a number of quality management principles including a strong customer focus, the motivation and implication of top management, the process approach and continual improvement (ISO, 2023).

ISO 9000 is believed to drive organizations towards implementing quality management practices, and it may be the foundation or building block before embracing Lean (Kumar & Antony, 2009).

Lean concepts and practices have been studied in the past, particularly in large organizations such as the automotive industry. Shah & Ward (2003) stated in their study on LM context, practices, bundles, and performance that there is a positive relationship between the size of the organization and the implementation of lean practices. While LM implementation in SMEs moved into focus. Achanga et al. (2006) studied the impact of LM on SMEs in the UK, and the study shows that lean manufacturing is an ideal tool for productivity improvement, while factors related to organizational culture and the personality of the owner/manager may affect the direction of improvements and potentials that they may achieve.

2.9.2 Size

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organizational culture and the personality of the owner/manager may affect the direction of improvements and potentials that they may achieve.

2.9.3 Ownership

Family firms are often considered characteristically different from non-family firms. Family firms exhibit specific behavior due to family influence, more specifically by control over the functioning, direction and culture of the firm. The owner has considerable power over assets, resources and their allocation (Carney, 2005), and families impact the firm's strategic direction (Frank et al., 2010).

Ellington et al. (1996) stated that family businesses are less likely to adopt quality initiatives due to factors such as cost and commitment. In addition, family-owned businesses are mainly characterized by high centralization, low managerial formality and a short-term focus.

2.9.4 Sector

The LM is a system originally founded by Toyota, and due to the superiority of this system many enterprises tried to integrate it within their processes. The utilization of LM tools and practices can vary depending on the sector specific characteristics, processes, and challenges. LM has been continuously developed and adapted in different sectors (Womack & Jones, 2008).

2.10 Previous Studies

Lean Manufacturing (LM) implementations in enterprises have not always been successful; many challenges and obstacles might arise during the implementation

(Nordin et al., 2011). Successful implementation requires understanding the quality initiative, benefits, requirements, and the critical success factors (Achanga et al., 2006). Radnor et al. (2006) illustrate the following three types of barriers that organizations face while implementing LM:

1. The people issue: understanding the effect and gaining the 'buy-in' of the individual occurs when there is a dilemma about persuading people to start the lean journey.
2. The process issue: understanding which processes are applicable for LM tools and techniques.
3. The sustainability issue: is how to maintain Lean, considering it more than a set of tools but a way of thinking and working.

Nordin et al. (2010) performed a study to explore the lean implementation status in Malaysian automotive industries and identified the barriers and driving factors for lean implementation. The study revealed that the main barriers to implementing the LM system are the lack of understanding of lean concepts and shop floor employees' attitudes toward implementing lean.

Alnajem & Garza-Reyes (2019) investigated the factors affecting readiness and lean system adoption within Kuwaiti small and medium sized manufacturing industries. The findings of this study show that nepotism and favoritism, along with other characteristics such as the country's wealth and high dependence on expatriates have prevented them from adopting lean. These study findings cannot be generalized to other Arab non-Gulf countries, but this study assures the vital role of cultural factors in the success of Lean, cultural elements determine strategy, goals, and operation, and cultural adaption is the key to successful lean implementation (Wong, 2007). As described by Achanga et al., (2006), high-performing companies are those with a culture of

continuous and proactive improvement, and thus the creation of a supportive organizational culture is an essential part of the implementation of LM.

Yadav et al. (2020), conducted a study to develop a LM implementation framework to enhance its adoption within manufacturing enterprises in developed economies. This study utilized experts with more than ten years of exposure to LM. The study categorized 31 LM drivers into six groups: shop floor management, manufacturing strategies, quality management, manufacturing processes, supplier and customer management, and workforce management. The study results showed that shop floor management, manufacturing strategies, and quality management practices were the causal drivers, whereas the manufacturing processes, the supplier and customer management, and the workforce management were the effect drivers.

In a systematic literature review performed by Leite et al. (2020), six main barriers to implementing LM emerged from the data analysis: “behavioral and cultural influence”, “organizational strategy and alignment”, “leadership commitment”, “technical limitation”, “process-based constraints”, and “resource constraints”. While top management leadership, suppliers, and customer relations, in addition to financial capability, are the success factors frequently emphasized by researchers (Alnajem & Garza-Reyes, 2019).

2.10.1 Previous Studies in Palestine

Al Raae's (2021) tested the effect of applying the LM system on the cost of products in the food industry sector. The study found that the LM system has a significant effect on the cost of products in the Sarayo Alwadiya Group for Food Industries, and the organization of the workplace is considered the most influential factor on the cost of

production. The researcher recommended that the Sarayo Al Wadiya group should focus on applying JIT-production and cellular manufacturing to enhance their performance.

AlTurk's (2018) study aimed to investigate the degree of implementation of Lean Production system among 30 companies working in manufacturing belonging to the food and plastic manufacturing industries. The study found a high degree of implementation of LM practices. Additionally, it was indicated that the most implemented element of the LM system was "organization of the workplace" while the least implemented element was "cellular manufacturing". The researcher recommended taking steps towards complete implementation of the LM system and benefiting from its various advantages. This is in addition to increasing the awareness of LM concept and culture by training employees and enhancing their capacity in this field.

Dandis' (2018) study aimed to investigate the challenges facing Palestinian SMEs in applying LM principles. By targeting companies that have applied LM in the West Bank through a French-funded project under the Palestinian Federation of Industries. In cooperation with the Federation of Chambers of Commerce, the companies belong to three key sectors in the Palestinian industry: the stone and marble sector, the furniture manufacturing sector, and the leather and footwear sector.

The study was successful in defining 19 major challenges of implementing LM in Palestinian, which were then classified into seven key factors: 1- Challenges related to laborers 2- Challenges related to educational and cultural matters 3- Challenges related to management 4- Challenges related to organizational matters 5- Challenges related to financial matters 6- Challenges related to government matters and occupation 7- Challenges related to the nature of the application of lean manufacturing.

2.10.2 Other Studies in Neighboring Countries

In Jordan

Al-Hyari's (2020) study analyzed the extent to which LM bundles are adopted by manufacturing SMEs in Jordan and studied their effect on their performance. Data were gathered from 278 Jordanian manufacturing SMEs. The results show that Total Quality Management (TQM) and Human Resources Management (HRM) lean bundles are positively associated with manufacturing SMEs' performance.

Al-Jawazneh's (2015) discussed the impact of internal lean dimensions on the manufacturing-based quality of food processing companies in Jordan. For this purpose; variables such as: pull systems, continuous flow, setup time reduction, total productive maintenance, statistical process control, and employee involvement were analyzed.

The study found that the internal lean dimensions have a significant impact on the manufacturing based product quality, resulting in lower food products reprocessing, conforming to high quality standards, a lower defects rate, and fewer interruptive breakdowns, which enabled food processing companies to deliver their products on time and optimize their utilization of manufacturing resources.

El-Khasawneh's (2012) study discussed the challenges faced by enterprises as obtained from interviews with the enterprise managers and owners. The study found that challenges can be categorized into three categories based on who can manipulate them: regional and international, national, and enterprise factors. The enterprise factors are mostly dependent on its technological and managerial capacity, which shapes the response to challenges. Under this factor, the researcher elaborated that the enterprise needs to be agile and lean. Agility enables the enterprise to maneuver, adapt quickly, and react to market needs and conditions. While Lean adoption will minimize or

eliminate waste, enhance efficiency, and maximize productivity, by this the enterprise will become more competitive.

In Egypt

Abdel-Kader et al. (2022) investigated the impact of LM tools on corporate sustainability performance by developing a model representing the relationship between these tools and the three pillars of sustainability: economic, environmental, and social. The study proposed a model that includes the most common LM tools: Value Stream Mapping (VSM); Total Productive Maintenance (TPM); Cellular Manufacturing; 5S; Six Sigma; Just in Time (JIT); Continuous Improvements (Kaizen); and Single Minute Exchange of Die (SMED).

This study provided insights to manufacturing managers about the ability of LM tools to reduce cost and maximize the value provided to customers. It also highlights the importance of implementing LM to manage organizations' activities responsibly in terms of their environmental, social, and economic impact.

Seddik (2017) in his study explored the implementation of 5S in Egyptian garment enterprises by collecting data through a survey questionnaire and on-site observation.

The results of this study conclude that "Sustain" is the most critical element because it requires employee commitment and discipline.

2.10.3 Previous Studies Discussion and Conclusion

It is clear that LM has become a center of attention for many researchers worldwide and since it is applicable to different sectors, interest has grown significantly over time. LM has a wide and powerful set of tools, utilizing them allows enterprises of different

sectors and sizes to excel and enhance financial and operational performance. Many efforts have been made to study the relation between LM implementation and performance, and the relation between LM and other factors, while on the national level, limited studies have been conducted to cover the LM implementation, tools, culture and challenges. This can be the starting point to investigate the current level of utilization of LM tools in manufacturing enterprises in Ramallah and state how far they are from LM implementation.

This study focuses on the utilization of the following tools, which are stated to be the most commonly used lean tools (Al-najem, 2014): 5S, JIT, TPM, VSM, KAIZEN, Standardized work, Visual management, Cellular design, Setup reduction and SMED, and Smaller lot size.

These tools indicate the level of LM utilization. Furthermore, the study examines the relation between the utilization of these tools and other factors such as history of quality initiatives (Certified ISO 9001), size, ownership (family or non-family) and sector.

Chapter Three

Research Methodology

3.1 Introduction

This chapter explains the methodology that the research study adopted. The main objective of this chapter is to provide vivid theoretical descriptions of research design and approach. It further looks at the sampling technique and the sample size, defines the target population, and describes the data processing instruments (SPSS). It also summarizes the analysis and strategy used to test the research schemes, and it finally discusses the data collection considerations.

A questionnaire targeting manufacturing enterprises operating in Ramallah was used to collect quantitative data. According to the MoNE Ramallah governorate field office, there are 340 manufacturing enterprises registered and operating in Ramallah with more than 5 employees (MoNE, Personal communication, 5 January 2023). Random sampling with a confidence level of 95% was utilized.

3.2 Research Design

This research investigates the level of utilization of the most commonly used LM tools in manufacturing enterprises. Moreover, it studies the relation between the levels of utilization of these tools and some enterprises' characteristics, such as size, ownership, history of quality initiatives, and sector.

Based on the nature of this research and the objectives it seeks to achieve, the researcher adopted a descriptive analytical approach used to provide accurate description of phenomenon as it is in reality, in which collecting and analyzing numerical data leads to

finding averages and patterns, testing relationships, and generalizing the results to a larger population (Bhandari, 2022).

The researcher used two sources of information, described below:

Secondary resources: In addressing the theoretical framework of the research the researcher reviewed previous literature on the subject of the research; books, journal articles and previous studies.

Primary resources: In addressing the analytical aspects of the subject of the research, the researcher collected primary data through a questionnaire as a main tool for the research, designed specifically for the study, and distributed to a random survey sample.

3.3 Population of the Study

According to the Ministry of National Economy (MoNE), there are 340 manufacturing enterprises registered and operating in Ramallah and Al Bireh Governorate with more than 5 employees, (MoNE, Personal communication, 5 January 2023) and enterprises contact information were obtained from Ramallah Chamber of Commerce Industry (RCCI) (RCCI, Personal Communication, 24 January 2023).

3.4 Sample of the Study

Based on scientific foundations for surveys with probability samples, the method of systematic random sampling was chosen, and the sample size was calculated through Steven Thompson equation, and the statistical significance at the level of 95%.

$$n = \frac{NP(1 - P)}{(N - 1) \left(\frac{d}{Z_{1-\frac{\alpha}{2}}} \right)^2 + P(1 - P)}$$

whereas:

n: the sample size.

N: the Population size.

d: the error rate is 5%

$Z_{1-\frac{\alpha}{2}}$: The critical value of the standard normal distribution at the level of statistical significance

P: Percentage of availability of the feature and the neutral is 50%

The sample size is 181, and the researcher distributed 25 preliminary questionnaires to test the validity and consistency of the questionnaire; these were excluded from the final analysis. After confirming validity and consistency, the researcher distributed 181 questionnaires.

3.5 Data Collection

The data for this research was collected through an electronic-based questionnaire designed to explain the relationship between the research elements. Personnel who own or work in manufacturing enterprises in Ramallah will complete the questionnaire survey on their behalf.

The collection period lasted ten weeks with a total of 147 completed questionnaires which resembles 81% response rate and this result indicates high response rate for online surveys, were the researcher conducted multiple follow ups for achieving this rate, and this technique is considered powerful in increasing response rates for online surveys (Deutskens et al., 2004)

3.5.1 Questionnaire Design

The researcher used a questionnaire survey as in **Appendix A**, to collect primary data from respondents in this study to investigate the level of utilization of LM tools in Palestinian manufacturing enterprises in Ramallah. A major consideration in the design of this survey tool was to maintain its clarity and brevity.

The survey questionnaire consists of four parts. The first part contains the characteristics of the respondent, such as gender, age, academic level, job level, and previous knowledge on this topic. The second part contains the characteristics of the enterprise, such as: Age of the enterprise, Sector (paper and carton industries, plastic industries, chemicals industries, pharmaceutical industries, furniture and wood industries, food industries, metal industries, textiles, other), Ownership (family or non family enterprise), size (small (5–15 workers), medium (16–25 workers), or large (more than 26 workers), Number of production lines (1, 2, 3 or more), and History of quality initiatives (certified ISO 9001 or not). The third part of the questionnaire contains 10 sections inquiring about the level of utilization of each LM tool (5S, JIT, TPM, VSM, KAIZEN, standardized work, visual management, cellular design, setup reduction, and SMED, and smaller lot size). This section also includes a brief description of each tool. The response format to rate the level of utilization of LM tools using the five-point Likert scale had weights given as follows: 1 (very low), 2 (low), 3 (moderate), 4 (high), and 5 (very high). The fourth part includes one open-ended question to allow the respondent to add any information they believe valuable.

In order to avoid any missing values, the questionnaire was designed to have required fields for all questions; this way, the respondent has to fill out all fields, and only completed questionnaires will be considered.

The survey was reviewed by academics and industry experts to judge the validity and ensure that it achieves the research's main objective, list of experts is available at

Appendix B.

The reliability of the survey was calculated by Cronbach Alpha Formula, to confirm that the data of this research are consistent and of scientific significance, by measuring the internal uniformity or average correlation of items in a survey tool.

3.5.2 LM Tools and their Elements

This research studies the ten most commonly used LM tools. Thus 10 sections inquiring about the level of utilization of each LM tool (5S, JIT, TPM, VSM, KAIZEN, standardized work, visual management, cellular design, setup reduction and SMED, and smaller lot size) described in details as follows:

3.5.2.1 5S

This scale was designed to collect data about the level of implementation of the 5S tool; it consists of 5 parts (Sort, Set in Order, Shine, Standardize, Sustain) described as shown in Table (3.1). This scale achieved proper reliability (Cronbach's alpha of 0.96).

Table (3.1) 5S Items

Sort (Cronbach's Alpha of 0.898)	
S11	Company conduct sorting activities on regular basis
S12	Company conduct sorting activities in organized way
S13	Employees are encouraged to sort out what they don't need
S14	Only important papers, files and equipment are kept and stored
Set in Order (Cronbach's alpha of 0.923)	
S21	Tools, equipment and machine are kept in its specific places
S22	Storage shelves are available
S23	Tags indicating shelves items are available
S24	Visual information are available to indicate work areas and stored items

Shine (Cronbach's alpha of 0.924)	
S31	Cleaning tasks and responsibility are clear
S32	Cleaning schedule is available
S33	Cleaning tools are available and close to working areas
S34	Cleaning activities are conducted on regular basis
Standardize (Cronbach's alpha of 0.913)	
S41	Employees are aware of theirs and their peers responsibilities for organizing he workplace
S42	Fixed procedures are available to control sorting, setting in order and shining activities
S43	Clear procedures for handing shifts (cleaning, organizing, handing in a good condition) are available
S44	Visual tools are utilized to clear working procedures
Sustain (Cronbach's alpha of 0.924)	
S51	Employees receive training on how to organize workspace (5S)
S52	Organizing workspace activities are organized on regular basis
S53	Organizing workspace procedures and results are reviewed and analyzed on regular basis
S54	Employees feels high responsibility towards workspace organizing activities

3.5.2.2 JIT

This scale was designed to collect data about the level of implementation of the JIT tool; which consists of two main parts Kanban and Production leveling. Described in Table (3.2). This scale achieved proper reliability.

Table (3.2) JIT items

Kanban (Cronbach's alpha of 0.918)	
KNB1	Products are produced upon customer demand only
KNB2	Products are produced in time determined by customers
KNB3	Visual tools are utilized to synchronize and provide instruction between departments inside the enterprise (production, sales)
KNB4	Visual tools are utilized to synchronize and provide instruction between the enterprise and its customers
KNB5	Visual tools are utilized to synchronize and provide instruction between the enterprise and its supplier
Production Leveling (Cronbach's alpha of 0.938)	
PL1	Visual tools are available to show daily production plan, when what and how many
PL2	Employee capacity is known
PL3	Proper capacity of people is utilized
PL4	Machines capacity is known
PL5	Proper capacity of machines is utilized
PL6	Conditions that affect production procedures and efficiency are known

3.5.2.3 TPM

This scale was designed to collect data about the level of implementation of the TPM tool; which consists of three main parts: Total Involvement, Reporting and Analysis, and Preventive Maintenance. Described as shown in Table (3.3). This scale achieved proper reliability.

Table (3.3) TPM Items

Total involvement (Cronbach's alpha of 0.820)	
TP11	Production team participate in regular machine checkup
TP12	Production team participate in correcting minor machine stoppage
Reporting and analysis (Cronbach's alpha of 0.881)	
TP21	Machine downtime is recorded
TP22	Machine performance under different operating conditions is measured and analyzed
TP32	Maintenance data are collected and documented
Preventive maintenance (Cronbach's alpha of 0.845)	
TP31	Maintenance team analyze root causes of equipment problems
TP32	Maintenance team conduct preventive maintenance measures

3.5.2.4 VSM

This scale was designed to collect data about the level of implementation of the VSM tool; described as shown in Table (3.4). This scale achieved proper reliability (Cronbach's alpha of 0.942).

Table (3.4) VSM

VSM (Cronbach's alpha of 0.942)	
VSM1	Current state is mapped (including information flow, material flow) by the team
VSM2	Current state is analyzed and improvement opportunities identified by the team
VSM3	Future state map is developed by the team

3.5.2.5 KAIZEN

This scale was designed to collect data about the level of implementation of the KAIZEN tool; Described as shown in Table (3.5). This scale achieved proper reliability (Cronbach's alpha of 0.916).

Table (3.5) KAIZEN items

KAIZEN (Cronbach's alpha of 0.916)	
KZ1	Team members are encouraged to provide suggestion to solve a specific problem
KZ2	Team members are involved in problem solving activities and meetings
KZ3	Presentation of the progress delivered to the management by the team members

3.5.2.6 Standardized Work

This scale was designed to collect data about the level of implementation of the SW tool; Described as shown in Table (3.6). This scale achieved proper reliability.

Table (3.6) Standardized Work

SW (Cronbach's alpha of 0.907)	
STD1	Takt time is calculated, which tells the demand frequency, "how frequently we must produce the product"
STD2	The best way to do the job is defined and shared with the team
STD3	The proper sequence to do the job is defined and shared with the team

3.5.2.7 Visual Management

This scale was designed to collect data about the level of implementation of the VM tool; Described as shown in Table (3.7). This scale achieved proper reliability.

Table (3.7) Visual Management Items

Knowing as a group (Cronbach's alpha of 0.885)	
VM11	The team can easily know delivery commitment (on board/sign)
VM12	The team can easily know the goals and schedules
VM13	Company rules and job rules are available and the team can easily know it
Acting as a group (Cronbach's alpha of 0.869)	
VM21	The team is informed about improvement activities
VM22	The team is involved in improvement activities
Seeing as a group (Cronbach's alpha of 0.912)	
VM31	Anyone in the production/ related personnel process know the production status
VM32	Anyone in the production process/ related personnel know the inventory levels
VM33	Anyone in the production process/ related personnel know machines availability

3.5.2.8 Cellular Design Manufacturing

This scale was designed to collect data about the level of implementation of the CDM tool; Described as shown in Table (3.8). This scale achieved proper reliability (Cronbach's alpha of 0.879).

Table (3.8) CDM Items

CDM (Cronbach's alpha of 0.879)	
CD1	Machines are put side by side
CD2	Minimal inventory between machines
CD3	The piece flows to the next process smoothly

3.5.2.9 STR & SMED

This scale was designed to collect data about the level of implementation of the STR & SMED tool; Described as shown in Table (3.9). This scale achieved proper reliability (Cronbach's alpha of 0.836).

Table (3.9) STR & SMED

STR & SMED		Cronbach's alpha of 0.836
STP1	Setup procedures/ checklist are available to guide rapid and consistent setup	
STP2	Changeover instruction/ checklist is available to guide rapid and consistent setup	

3.5.2.10 Smaller Lot Size

This scale was designed to collect data about the level of implementation of the SLS tool; Described as shown in Table (3.10). This scale achieved proper reliability (Cronbach's alpha of 0.883).

Table (3.10) Smaller Lot Size Items

SLS		Cronbach's alpha of 0.883
SLZ1	Smaller batches are produced	
SLZ2	Customer demands are met on time	
SLZ3	Minimum inventories achieved (no stocking)	

3.5.3 Reliability and Validity of the Research Instrument

As part of the questionnaire design process, a pre-test was conducted as a pilot study with the aim of testing the reliability and validity of the questionnaire as a proper research instrument. Validity and reliability assess the consistency of the research and its capacity to be replicated.

For reliability and internal consistency, the Cronbach's alpha coefficient is the most commonly used test to be utilized to check if multiple-question Likert-scale surveys are reliable, where it indicates that this survey will give the same result if it is redistributed again under the same conditions. The coefficient values range from 0 to 1; and values less than 0.6 are considered bad, between 0.6 and 0.7 are considered acceptable, above

0.7 are good, while higher values indicate higher internal consistency and greater accuracy and reliability of the instrument (Sekaran, 2016).

In this research study, the Cronbach's alpha coefficient value of range is (0.820 - 0.942) which indicate that the questionnaire items provide efficient and real measure of the level of utilization of LM tools, Thus a very high degree of stability and validity to analyze the results of the research questions and test its hypotheses. And the correlation coefficient between the paragraphs and the total score for each item was calculated as shown in Table 3.11 below.

Table (3.11): Pearson Correlation.

Code	Pearson	Sign	Code	Person	Sign	Code	Person	Sign
S11	.792**	.000	KNB2	.856**	.000	KZ2	.832**	.000
S12	.812**	.000	KNB3	.805**	.000	KZ3	.863**	.000
S13	.782**	.000	KNB4	.807**	.000	STD1	.801**	.000
S14	.774**	.000	KNB5	.777**	.000	STD2	.865**	.000
S21	.802**	.000	PL1	.821**	.000	STD3	.850**	.000
S22	.853**	.000	PL2	.781**	.000	VM11	.810**	.000
S23	.782**	.000	PL3	.735**	.000	VM12	.864**	.000
S24	.814**	.000	PL4	.810**	.000	VM13	.827**	.000
S31	.785**	.000	PL5	.802**	.000	VM21	.779**	.000
S32	.829**	.000	PL6	.816**	.000	VM22	.829**	.000
S33	.803**	.000	TP11	.811**	.000	VM31	.788**	.000
S34	.853**	.000	TP12	.858**	.000	VM32	.803**	.000
S41	.810**	.000	TP21	.791**	.000	VM33	.845**	.000
S42	.819**	.000	TP22	.798**	.000	CD1	.807**	.000
S43	.837**	.000	TP23	.835**	.000	CD2	.851**	.000
S44	.819**	.000	TP31	.844**	.000	CD3	.829**	.000
S51	.784**	.000	TP32	.865**	.000	STP1	.846**	.000
S52	.787**	.000	VSM1	.777**	.000	STP2	.830**	.000
S53	.760**	.000	VSM2	.786**	.000	SLZ1	.779**	.000
S54	.816**	.000	VSM3	.734**	.000	SLZ2	.834**	.000
KNB1	.743**	.000	KZ1	.844**	.000	SLZ3	.809**	.000

It is generally recognized that to test reliability utilizing Pearson correlation coefficient, the values needs to be above .70 and for a validity estimate needs to be above .60 to be at an acceptable level (Tritschler, 2000). The data in the table indicates that there is a

high consistency between items. Moreover, the Pearson correlation coefficient scored between (0.734 – 0.865). On the other hand, Validity is an important criterion for this research, and it indicates the degree to which all questionnaire questions measure the variable it intends to measure and it was confirmed by:

- Experts reviewed the survey content. Academics and industry experts' specialists in the research area checked the survey items, questions, and language, and provided their notes; these notes were considered and reflected in the final form of the questionnaire.
- A pilot of 25 pre-test questionnaires was distributed (pilot study) to ensure respondent understanding of the vocabulary and the words used; feedback was taken from some respondents and reflected on the final form of the questionnaire to ensure consistency, clarity and appropriateness.

3.6 Data Analysis and Statistical Methods

In order to process the data, the Statistical Product and Service Solutions (SPSS) software was used to analyze the collected data, **the study hypotheses were examined at the level of statistical significance ($\alpha \leq 0.05$) by utilizing the following tests:**

- Normality test, the skewness test.
- Percentages, Frequencies, and Arithmetic Averages: This command is mainly used for the purposes of knowing the frequency of the categories of a variable and is useful to the researcher in describing the study sample.
- Cronbach's alpha α test to measure the internal consistency of the questionnaire.

- Pearson Correlation Coefficient to measure the degree of correlation: This test is based on studying the relationship between two variables, and the researcher used it to calculate the internal consistency and the structural validity of the questionnaire.
- Two Samples T-test (Independent Sample t-Test).
- One-Way ANOVA to see if there are statistically significant differences between three or more sets of data. The researcher used it for the differences attributable to the variable that includes three groups or more.

3.7 Ethical Consideration

The researcher highlighted the objective of the study at the beginning of the questionnaire, and the confidentiality of the received data from respondents. On the other hand, the respondents were encouraged to provide honest responses through anonymous questionnaire.

Chapter Four

Results and Discussion

4.1 Introduction

This chapter gives a detailed report on the collected data and the outcome of the statistical analysis. It displays the characteristics of the sample used, descriptive data, and then presents statistical analysis needed to achieve the purpose of the study, testing the proposed hypotheses and discuss the results and findings.

4.2 Sample Characteristics

This section describes the profile of the respondents; the analysis was conducted on 147 responses, received from owners/individuals working in production related positions in manufacturing enterprises in Ramallah governorate. The summary of the sample demographic information detailed in Table 4.1.

Table 4.1: Characteristics of Respondents The Demographic Distribution (n=147)

Variable	Variable Levels	Repetition	Percentage
Gender	Male	97	66.0%
	Female	50	34.0%
Age	Less than 20	1	.7%
	21-30	29	19.7%
	31-40	55	37.4%
	41-50	54	36.7%
	51-60	8	5.4%
Education level	Less than secondary education	3	2.0%
	Secondary school	11	7.5%
	Diploma	32	21.8%
	Bachelor	79	53.7%

Variable	Variable Levels	Repetition	Percentage
	Higher Studies	22	15.0%
Position	Company Manager	35	23.8%
	Production Manager	37	25.2%
	Production Worker	54	36.7%
	Other	21	14.3%
Prior knowledge of lean manufacturing	Yes	106	72.1%
	No	41	27.9%
Received training in the lean principles	Yes	69	46.9%
	No	78	53.1%
Enterprise established	Less than 5 y	12	8.2%
	5-10 Y	38	25.9%
	11-15 Y	41	27.9%
	16 – 20 Y	45	30.6%
	More than 20 Y	11	7.5%
Sector	Paper Industries	21	14.3%
	Plastic Industries	20	13.6%
	Chemical Industries	16	10.9%
	Pharmaceutical Industries	17	11.6%
	Wood and furniture	15	10.2%
	Food Industries	46	31.3%
	Metal Industries	10	6.8%
	Others	2	1.4%
Ownership	Family	55	37.4%
	Non-Family	92	62.6%
Size (No. of Employee)	S (5-15)	37	25.2%
	M (16-25)	70	47.6%
	L (more than 25)	40	27.2%
Number of production lines	1	29	19.7%
	2	63	42.9%
	3 or more	55	37.4%
ISO9001 certificate	Yes	92	62.6%
	No	55	37.4%
Total		147	100.0%

The results of the analysis of the sample on the demographic characteristics show the following:

Majority of the respondents are males representing 66%, and 42.1% above 41 years old. The majority of the respondents have a bachelor degree or more. On the other hand, 61.9% work directly in the production field (managers and workers). And while investigating the sample upon knowledge of Lean Manufacturing the result shows that 72.1% have prior knowledge of lean manufacturing and 46.9% received training on lean principles. This indicates that the respondents' group is adequate for the research topic and can provide relevant answers regarding the current state of LM tools and practices in their enterprises.

4.3 Descriptive Statistics

For this research purpose, descriptive analysis is the best way for describing and interpreting data. The central tendency of the responses is investigated by using the mean and the spread of responses by using the standard deviation. Therefore, if the value of the standard deviation is higher, the more the observations are dispersed. Conversely, a low score means that the responses are focused which means overall respondents have a similar opinion of the statement. Likert Scale questions were analyzed by the evaluation criteria by Tekin (2000) given in the below Table 4.2

Table 4.2 Evaluation Criteria for Likert scale questions

Score Interval (Mean)	Evaluation Criteria
1,00 – 1,79	Very low level
1,80 – 2,59	Low level
2,60 – 3,39	Medium level
3,40 – 4,19	High level
4,20 – 5,00	Very high level

What is the current level of utilization of LM tools within manufacturing enterprises in Ramallah?

The survey explained ten Lean Manufacturing Tools and asked questions regarding the level of utilization of these tools, the respondents answered these questions based on 5 Likert scale. The frequencies of the responses are detailed in **Appendix D** for each of the ten Lean Manufacturing Tools, summary as below:

Current level of utilization of Five S (5s)

Appendix D shows the frequencies describing the level of utilization of **Five S (5S)** tool, items mean fluctuates between 3.69 the maximum value, and 3.32 the lowest value. The respondent's opinion about the (Storage shelves are available), have a mean of 3.69, this answer indicates high agreement on this item, the item (Company conduct sorting activities in organized way) have a mean of 3.65, and the item (Cleaning schedule is available) have a mean of 3.61 while the lowest value was for (Visual tools are utilized to clear working procedures) with a mean of 3.32. In summary all items that measure the **Five S (5S) tool utilization**, have an overall average of 3.48 and this represents a high level of utilization. Noticeably, “standardize” and “sustain” have the lowest mean values and represent a medium level utilization, this indicates that efforts have been made in organizing workspace but enterprises may face challenges in defining a standard, fixed and clear procedures and maintaining it, which are the most difficult steps to implement. Where employees tend to resist change, and backslide to the original way of doing things.

Level of Utilization of Just In Time

The Frequencies table in Appendix D shows the results of **Just in Time (JIT) tool**, items mean fluctuates between 3.65 and 3.34. The respondent's opinion about the (Products are produced on time determined by customers) have a mean of 3.65, and (Machines capacity is

known) have a mean of 3.57, and the item (Products are produced upon customer demand only) have a mean of 3.54. While lower mean values for items related to visual tools utilization. In summary all items that measure **Just in Time (JIT)** have an overall average of 3.45 which translates to a high-level utilization.

It is noticed that most of the respondent manufacturing enterprises may succeed to produce on time and upon customer demand but not necessarily by utilizing visual communication tools between departments, customers and suppliers. Most probably that enterprises use traditional methods to tune the production process focusing on internal activities and factors while overlooking the external market instability and supply chain management. Also, it might be due to low willingness of the enterprises to invest in integrated resource planning systems.

The level of utilization of Total Productive Maintenance (TPM) Tool

The frequencies table in Appendix D examines the **Total Productive Maintenance (TPM)**, items mean fluctuates between 3.55 and 3.35. The respondent's opinion about the (Production team participate in correcting minor machine stoppage) have a mean of 3.55, the item (Production team participate in regular machine checkup) have a mean of 3.50, and the item (Maintenance team conduct preventive maintenance measures) have a mean of 3.48. All items that measure **Total Productive Maintenance (TPM)**, have an overall average of 3.45; high level of utilization. This reflects that operators and production teams have a sort of direct involvement in maintenance and monitoring activities, which is an essential role in minimizing delays, machine downtime and even extending the equipment lifespan. On the other hand, most enterprises may be performing under fire fighting strategy thus more effort should be made on predictive and preventive

maintenance, mainly in collecting data and analyzing it, such as root causes for machine downtime and studying different operating conditions to perform the proper measures.

The Level of utilization of Value Stream Mapping (VSM)

The Frequencies table in Appendix D reflects the utilization of **Value Stream Mapping (VSM)**, the items mean values fluctuates between 3.27 and 3.19. The respondent's opinion about the (Current state is analyzed and improvement opportunities identified) have a mean of 3.27, this result express understanding of the current state, also the item (Current state is mapped (including information flow, material flow)) have a mean of 3.22, while the (Future state map is developed) item have a lowest mean value of 3.19, which indicate less interest in designing future improvements. In summary all items that measure **Value Stream Mapping (VSM)**, have an overall average of 3.23 which reflects medium level utilization.

This tool is essential in the lean journey for manufacturing enterprises, as it visualizes the value stream, reflects the commitment to delivering value and reducing wastes in all processes and improving the overall productivity; low respondent results might indicate the lack of visualization effort in designing processes and managing flow of information and material, while visualization helps identifying wastes and bottlenecks.

The Level of Utilization of KAIZEN

The frequencies table in Appendix D reflects answers about the level of **KAIZEN** utilization, items mean values fluctuates between 3.53, and 3.41. The respondent's opinion about (Team members are involved in problem solving activities) have a mean of 3.53, followed by the item (Team members are encouraged to provide suggestion to solve a specific problem) with a mean of 3.49, while (Presentation of the progress delivered to the management by the team members) have a mean of 3.41, in summary

all items that measure **KAIZEN**, have an overall average of 3.48 and reflects a high level of utilization.

KAIZEN focuses on total involvement of workers in identifying and implementing improvements, problem solving activities, decision making, and making small incremental improvements in all aspects of the enterprise. The results show a good state of utilization of **KAIZEN** in the respondents group' while comparing the results to the **VSM** results, this might indicate that involvement only occurs in problem solving activities not in designing processes and improvement activities.

The Level of Utilization of Standardized Work

The respondents' answers about the **Standardized work**, in Appendix D shows that the items mean value fluctuates between 3.62 and 3.50. The respondent's opinion about the (Takt time is calculated, which tells the demand frequency, "how frequently we must produce the product") have a mean of 3.62, and (The best way to do the job is defined and shared with the team) have a mean of 3.56, also (The proper sequence to do the job is defined and shared with the team) have a mean of 3.50, in summary all items that measure **Standardized work**, have an overall average of 3.56. This reflects a high level of utilization and shows that this tool is being utilized heavily among respondents group and reflects good production planning and measures and this tool can be considered as a good baseline for improvements.

The Level of Utilization of Visual Management

The respondents answers about the **Visual Management**, in Appendix D shows that items mean values fluctuates between 3.56 and 3.44, and all items that measure **VM** have an overall average of 3.50. These results indicate a high level of utilization, in which a good communication and flow of information between the related team

members which promote understanding and enhance decision making, and reflect good scheduling.

The Level of Utilization of Cellular Design Manufacturing

The frequencies table in Appendix D shows the level of utilization of **Cellular design manufacturing**; items mean values are 3.52 and 3.51. The respondent's opinion about the (Machines are put side by side), have a mean of 3.52, (Minimal inventory between machines are kept) have a mean of 3.51, and the item about (The piece flows to the next process smoothly) have a mean of 3.51 which is agreed with opinion, in the summary all items that measure **Cellular design manufacturing**, have an overall average of 3.51 which reflects a high level of utilization, more precisely indicates that workstation and equipment are arranged properly to support a smooth flow of material and better usage of the available space to secure minimum inventory in production area.

The Level of Utilization of Setup reduction and Single Minute Exchange of Die (SMED)

The frequencies table in Appendix D reflects the level of utilization of **Setup reduction and Single Minute Exchange of Die (SMED)**, the items mean values are 3.56 and 3.49. Items that measure Setup reduction and Single Minute Exchange of Die (SMED) have an overall average of 3.52 which translates to a high level of utilization of this tool.

In harmony with standardized work tool this reflects that enterprises have benefited from good planning by creating a clear step by step guide or checklist, this ensures consistent work and reduces waste, but there is not enough evidence whether this was for a one-time event or ongoing process.

The Level of Utilization of Smaller Lot Size

The frequencies table shows the level of utilization of **Smaller lot size** items, and the mean values fluctuate between 3.63 and 3.39. The respondent's opinion about the (Customer demands are met on time) have a mean of 3.63, also the item (Smaller and variable batches are produced) have a mean of 3.48, while the item (Minimum inventories achieved (no stocking)), have a mean of 3.39 which is the lowest in this group, in summary all items that measure **Smaller lot size**, have an overall average of 3.50.

This indicates a high level of utilization of this tools and shows that enterprises has the flexibility to produce smaller size lots with variety of products, still enterprises' answers reflects low mean values on achieving "minimum level of inventory" this can be seen as a safe strategy to avoid material or product shortage, mainly due to closures, blockage and unstable situation in Palestine which affects both ends of the supply chain.

Summary of Descriptive Statistics

The researcher investigated the level of the utilization of 10 LM tools in manufacturing enterprises in Ramallah, and the reported results indicated there is a medium to high level of utilization, as most of the tools' average mean values scored between 3.23 and 3.56 on a scale of 5 points. Table 4.3 shows the qualitative scale of tools utilization.

Table 4.3 Qualitative Scale of The Level of Utilization of Each Tool

Tools	Level of Utilization (Qualitative)
5s	High Level
Just in Time	High Level
Total Productive Maintenance	High Level
Value Stream Mapping	Medium Level
KAIZEN	High Level
Standardized work	High Level
Visual Management	High Level
Cellular Design Manufacturing	High Level
Setup reduction & single minute exchange of die	High Level
Smaller Lot Size	High Level

Noticeably, the most utilized LM tools are those related to the standardized or the ideal way of doing things, instructed by a guide or a checklist. While other tools that require more involvement from workers and team members reflected slightly lower level of utilization. This could reveal good planning by the management, still management has to extend their role to improve processes by improving information flow, and ideas flow from workforce to management.

LM Tools utilization level can be ordered as following from least to most utilized tool:

VSM (3.23), JIT (3.45), TPM (3.45), KAIZEN (3.48), 5S (3.48), VM (3.5), SLS (3.5) CDM (3.51), SR & SMED (3.52), SW (3.56) as in Fig.4.1.

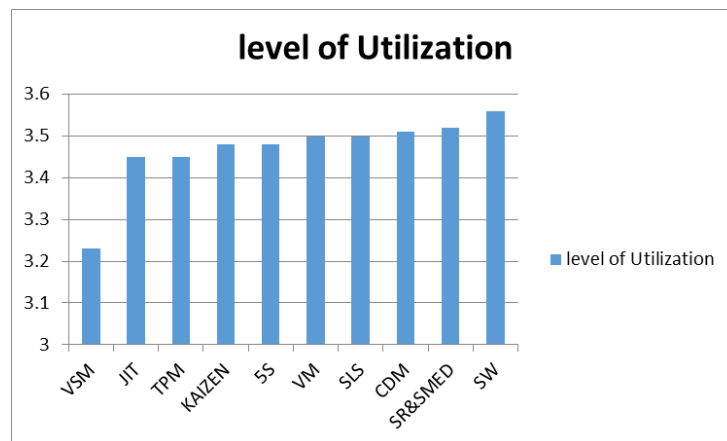


Fig. 4.1 Level of Utilization of LM Tools

4.4 Hypothesis Testing

Some of the enterprise characteristics are tested for their possible influence on the level of utilization of LM tools. These variables were chosen based on previous literature that indicated possible influence on the level of utilization of LM tools.

After confirming normality of the collected data by performing the skewness test (Appendix C), below are the main tests utilized to test the research Hypothesis:

- Independent Sample T-Test is a statistical technique that is used to test the difference between the means of two groups.

- One-way ANOVA is a statistical technique that is used to assess if there is a statistically significant difference in the demographic information (Sector, Size) by the dependent variables. The F- ratio and the associated probability value p-value were calculated to determine the existence or absence of differences among different groups. Once the p-value associated with the F- ratio is smaller than 0.05, the means of all the groups are not equal.

Testing Hypothesis 1

H1: There is a significant difference (within a 5% level) in the utilization level of LM tools used by ISO 9001 enterprises compared to non-ISO 9001 enterprises in Ramallah.

Does the utilization of LM tools in manufacturing enterprises in Ramallah differ in ISO 9001 certified enterprises compared to non-ISO 9001 enterprises?

Table 4.4: Independent Sample T-Test for the Level of Utilization of LM Tools in ISO 9001 Certified Enterprises vs. Non-ISO9000 Enterprises

ISO9001 certificate		N	Mean	Std. Deviation	T	Df	Sig. (2-tailed)
5S	Yes	92	3.3505	.92835	-2.173	145	.031
	No	55	3.6909	.90247	-2.189		
Just-In-Time	Yes	92	3.3073	.87168	-2.590	145	.011
	No	55	3.6960	.89563	-2.572		
Total Productive Maintenance	Yes	92	3.2668	.91421	-3.179	145	.002
	No	55	3.7504	.85429	-3.234		
Value Stream Mapping	Yes	92	3.1228	.92137	-1.574	145	.118
	No	55	3.3998	1.19722	-1.475		
KAIZEN	Yes	92	3.2999	.97441	-2.744	145	.007
	No	55	3.7691	1.04996	-2.693		
Standardized Work	Yes	92	3.3579	.94933	-3.392	145	.001
	No	55	3.8964	.90024	-3.438		
Visual Management	Yes	92	3.3052	.93684	-3.251	145	.001
	No	55	3.8190	.91042	-3.275		
Cellular Design Manufacturing	Yes	92	3.3255	.90413	-3.196	145	.002
	No	55	3.8242	.93402	-3.170		
Setup Time Reduction and Single Minute Exchange of Die (SMED)	Yes	92	3.3587	.90883	-2.883	145	.005
	No	55	3.8000	.87981	-2.907		
Smaller Lot Size	Yes	92	3.3223	.96603	-2.933	145	.004
	No	55	3.7927	.89725	-2.988		
Overall	Yes	92	3.3113	.87400	-2.851	145	.005
	No	55	3.7308	.84493	-2.875		

According to the Independent Sample T-Test, results showed in the Table 4.4 and Appendix E, the significant value is less than 0.05, so we fail to reject that the utilization of LM tools in manufacturing enterprises in Ramallah differ in ISO 9001 certified enterprises compared to non-ISO 9001 enterprises for all tools **except** Value Stream Mapping where we find that significant value is greater than 0.05, which means that there are no differences for this tool. Surprisingly the non-ISO9001 enterprises had

better mean values, this might be referred to the purpose behind implementing quality standards or seeking certification whether it is for enhancing performance indicators or utilized as part of the contractual requirements.

Testing Hypothesis 2

H2: Enterprises of different sizes (small, medium, large) in Ramallah differ significantly (within a 5% level of significance) in utilization level of LM tools.

Does the utilization of LM tools in manufacturing enterprises in Ramallah differ according to enterprise size?

Table 4.5a ANOVA Test for the Level of Utilization of LM Tools in Relation to the Size of Enterprise

		Sum of Squares	Df	Mean Square	F	Sig.
5S	Between Groups	6.715	2	3.357	4.040	.020
	Within Groups	119.681	144	.831		
	Total	126.396	146			
Just-In-Time	Between Groups	5.169	2	2.584	3.308	.039
	Within Groups	112.492	144	.781		
	Total	117.660	146			
Total Productive Maintenance	Between Groups	6.300	2	3.150	3.870	.023
	Within Groups	117.216	144	.814		
	Total	123.515	146			
Value Stream Mapping	Between Groups	4.418	2	2.209	2.081	.129
	Within Groups	152.875	144	1.062		
	Total	157.293	146			
KAIZEN	Between Groups	13.929	2	6.964	7.185	.001
	Within Groups	139.581	144	.969		
	Total	153.510	146			
Standardized Work	Between Groups	8.849	2	4.424	5.020	.008
	Within Groups	126.905	144	.881		
	Total	135.754	146			
Visual Management	Between Groups	6.010	2	3.005	3.389	.036
	Within Groups	127.704	144	.887		
	Total	133.714	146			

		Sum of Squares	Df	Mean Square	F	Sig.
Cellular Design Manufacturing	Between Groups	5.656	2	2.828	3.273	.041
	Within Groups	124.401	144	.864		
	Total	130.056	146			
Setup Time Reduction and Single Minute Exchange of Die (SMED)	Between Groups	5.011	2	2.505	3.040	.051
	Within Groups	118.656	144	.824		
	Total	123.667	146			
Smaller Lot Size	Between Groups	4.211	2	2.105	2.300	.104
	Within Groups	131.804	144	.915		
	Total	136.014	146			
Overall	Between Groups	6.233	2	3.116	4.159	.018
	Within Groups	107.887	144	.749		
	Total	114.120	146			

Source: SPSS

According to One-Way ANOVA results shown in the Table 4.5 and Appendix F, we find that the level of significance is less than 0.05, so we fail to reject H2 that the utilization of LM tools in manufacturing enterprises in Ramallah differs according to enterprise size, for all tool **except** Value Stream Mapping, Setup Time Reduction and Single Minute Exchange of Die (SMED), Smaller Lot Size; where we find that the level of significance is greater than 0.05, which mean that there are no difference in level of utilization for these 3 tools.

In order to investigate the level of utilization at each size group, Table **4.5b** describe the relations, it is obvious that Larger size enterprises has higher mean values for all tools except for VSM and KAIZEN, while the results indicate medium size enterprises have higher values for KAIZEN utilization.

Table 4.5b Descriptive Statistics for Size groups

		Descriptive							
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Mini mum	Maxi mum
						Lower Bound	Upper Bound		
5S	S (5- 15 Employee)	37	3.1257	.81263	.13360	2.8547	3.3966	1.15	4.65
	M (16-25)	70	3.5414	.83869	.10024	3.3414	3.7414	1.60	4.75
	L(more than 25)	40	3.6925	1.10213	.17426	3.3400	4.0450	1.00	4.95
	Total	147	3.4779	.93044	.07674	3.3262	3.6296	1.00	4.95
Just-In-Time	S (5- 15 Employee)	37	3.1328	.83157	.13671	2.8556	3.4101	1.17	5.00
	M (16-25)	70	3.5365	.81266	.09713	3.3427	3.7303	1.84	4.80
	L(more than 25)	40	3.6020	1.03810	.16414	3.2700	3.9340	1.00	4.80
	Total	147	3.4527	.89772	.07404	3.3064	3.5991	1.00	5.00
Total Productive Maintenance	S (5- 15 Employee)	37	3.0974	.78842	.12961	2.8345	3.3603	1.00	4.67
	M (16-25)	70	3.5309	.86451	.10333	3.3247	3.7370	1.67	4.89
	L(more than 25)	40	3.6262	1.05330	.16654	3.2894	3.9631	1.00	5.00
	Total	147	3.4477	.91978	.07586	3.2978	3.5976	1.00	5.00
Value Stream Mapping	S (5- 15 Employee)	37	2.9276	.94985	.15615	2.6109	3.2443	1.00	4.33
	M (16-25)	70	3.3284	1.01919	.12182	3.0854	3.5714	1.00	4.67
	L(more than 25)	40	3.3245	1.11771	.17673	2.9670	3.6820	1.00	5.00
	Total	147	3.2265	1.03795	.08561	3.0573	3.3957	1.00	5.00

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
KAIZEN	S (5- 15 Employee)	37	2.9449	.99835	.16413	2.6120	3.2777	1.00	5.00
	M (16-25)	70	3.6609	.89084	.10648	3.4484	3.8733	1.33	5.00
	L(more than 25)	40	3.6417	1.12024	.17712	3.2835	4.0000	1.00	5.00
	Total	147	3.4754	1.02540	.08457	3.3083	3.6426	1.00	5.00
Standardized Work	S (5- 15 Employee)	37	3.1527	.87301	.14352	2.8616	3.4438	1.00	5.00
	M (16-25)	70	3.6371	.86733	.10367	3.4303	3.8440	1.67	5.00
	L(more than 25)	40	3.7995	1.10432	.17461	3.4463	4.1527	1.00	5.00
	Total	147	3.5594	.96427	.07953	3.4022	3.7166	1.00	5.00
Visual Management	S (5- 15 Employee)	37	3.1497	.90852	.14936	2.8468	3.4526	1.00	5.00
	M (16-25)	70	3.6012	.86343	.10320	3.3954	3.8071	1.72	5.00
	L(more than 25)	40	3.6373	1.09250	.17274	3.2879	3.9867	1.00	4.89
	Total	147	3.4974	.95700	.07893	3.3414	3.6534	1.00	5.00
Cellular Design Manufacturing	S (5- 15 Employee)	37	3.1886	.81436	.13388	2.9171	3.4602	1.00	5.00
	M (16-25)	70	3.5709	.88838	.10618	3.3590	3.7827	1.33	5.00
	L(more than 25)	40	3.7085	1.08687	.17185	3.3609	4.0561	1.00	5.00
	Total	147	3.5121	.94382	.07784	3.3583	3.6660	1.00	5.00
Setup Time Reduction and Single Minute Exchange of Die	S (5- 15 Employee)	37	3.2162	.85424	.14044	2.9314	3.5010	1.00	5.00
	M (16-25)	70	3.5857	.84258	.10071	3.3848	3.7866	1.50	4.50
	L(more than 25)	40	3.7000	1.05490	.16679	3.3626	4.0374	1.00	5.00
	Total	147	3.5238	.92034	.07591	3.3738	3.6738	1.00	5.00

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	
					Lower Bound	Upper Bound			
Smaller Lot Size	S (5- 15 Employee)	37	3.2068	.83995	.13809	2.9267	3.4868	1.00	5.00
	M (16-25)	70	3.5900	.90265	.10789	3.3748	3.8052	1.67	5.00
	L(more than 25)	40	3.6075	1.13437	.17936	3.2447	3.9703	1.00	5.00
	Total	147	3.4983	.96520	.07961	3.3410	3.6556	1.00	5.00
Overall	S (5- 15 Employee)	37	3.1194	.77945	.12814	2.8595	3.3792	1.07	4.73
	M (16-25)	70	3.5524	.80415	.09611	3.3606	3.7441	1.82	4.59
	L(more than 25)	40	3.6439	1.03027	.16290	3.3144	3.9734	1.00	4.77
	Total	147	3.4683	.88411	.07292	3.3242	3.6124	1.00	4.77

Source: SPSS outcome

Testing Hypothesis 3

H3: Non-family owned enterprises in Ramallah differ significantly (within a 5% level) in utilization level of LM tools compared to family owned enterprises in Ramallah.

Does the utilization of LM tools in manufacturing enterprises in Ramallah differ according to the ownership of the enterprise?

Table 4.6: Independent Sample T-Test for Ownership Type and Level of Utilization of LM tools

Ownership		N	Mean	Std. Deviation	T	Df	Sig. (2-tailed)
5S	Family	55	3.4582	.92780	-.198	145	.843
	Non-Family	92	3.4897	.93690	-.198		
Just-In-Time	Family	55	3.4325	.89372	-.210	145	.834
	Non-Family	92	3.4648	.90477	-.211		
Total Productive Maintenance	Family	55	3.4506	.86828	.029	145	.977
	Non-Family	92	3.4460	.95390	.030		
Value Stream Mapping	Family	55	3.1578	1.00418	-.619	145	.537
	Non-Family	92	3.2675	1.06093	-.627		
KAIZEN	Family	55	3.5205	1.10897	.411	145	.682
	Non-Family	92	3.4485	.97733	.398		
Standardized Work	Family	55	3.5813	.89175	.212	145	.832
	Non-Family	92	3.5463	1.00968	.219		
Visual Management	Family	55	3.5079	.95711	.103	145	.918
	Non-Family	92	3.4911	.96212	.103		
Cellular Design Manufacturing	Family	55	3.5758	.88750	.631	145	.529
	Non-Family	92	3.4740	.97871	.647		
Setup Time Reduction and Single Minute Exchange of Die (SMED)	Family	55	3.4455	.88544	-.797	145	.427
	Non-Family	92	3.5707	.94224	-.810		
Smaller Lot Size	Family	55	3.4722	.96803	-.253	145	.801
	Non-Family	92	3.5139	.96847	-.253		
Overall	Family	55	3.4594	.85151	-.094	145	.925
	Non-Family	92	3.4736	.90760	-.095		

Source: SPSS

According to Independent Sample T-Test, results shown in Table 4.6 and Appendix G, we find that the significant value is greater than 0.05, so we **reject** that the utilization of LM tools in manufacturing enterprises in Ramallah differ according to the ownership of the enterprise.

Testing Hypothesis 4

H4: Enterprises of different sectors in Ramallah differ significantly (within a 5% significance level) in utilization level of LM tools. Does the utilization of LM tools in manufacturing enterprises in Ramallah differ according to the sector?

Table 4.7 ANOVA test for the Level of Utilization of LM Tools in Relation to The Sector

		Sum of Squares	Df	Mean Square	F	Sig.
SS	Between Groups	20.413	7	2.916	3.825	.001
	Within Groups	105.983	139	.762		
	Total	126.396	146			
Just-In-Time	Between Groups	16.863	7	2.409	3.322	.003
	Within Groups	100.797	139	.725		
	Total	117.660	146			
Total Productive Maintenance	Between Groups	19.650	7	2.807	3.757	.001
	Within Groups	103.866	139	.747		
	Total	123.515	146			
Value Stream Mapping	Between Groups	14.736	7	2.105	2.053	.053
	Within Groups	142.557	139	1.026		
	Total	157.293	146			
KAIZEN	Between Groups	22.260	7	3.180	3.368	.002
	Within Groups	131.251	139	.944		
	Total	153.510	146			
Standardized Work	Between Groups	21.428	7	3.061	3.722	.001
	Within Groups	114.326	139	.822		
	Total	135.754	146			
Visual Management	Between Groups	20.394	7	2.913	3.574	.001
	Within Groups	113.320	139	.815		
	Total	133.714	146			
Cellular Design Manufacturing	Between Groups	15.973	7	2.282	2.780	.010
	Within Groups	114.083	139	.821		
	Total	130.056	146			
Setup Time Reduction and Single Minute Exchange of Die (SMED)	Between Groups	21.413	7	3.059	4.158	.000
	Within Groups	102.253	139	.736		
	Total	123.667	146			
Smaller Lot Size	Between Groups	20.053	7	2.865	3.434	.002
	Within Groups	115.961	139	.834		
	Total	136.014	146			
Overall	Between Groups	18.786	7	2.684	3.913	.001
	Within Groups	95.334	139	.686		
	Total	114.120	146			

Source: SPSS

According to One-Way ANOVA, results showed in the above table and Appendix H, we find that the significant value is less than 0.05, **so we fail to reject** that the utilization of LM tools in manufacturing enterprises in Ramallah differ according to the sector, for all tools **except** Value Stream Mapping, where we find that the significant value is greater than 0.05, which mean that there are no differ for this tool.

While investigating the sector groups, it is found that Pharmaceutical industries have the higher mean for the level of utilization of LM tools, followed by food industries.

Testing Hypothesis 5

H5: There is no difference between the level of utilization of LM tools in enterprises in Ramallah.

4.5 There is no difference between the level of utilization of LM tools in enterprises in Ramallah

Correlations		Overall
(5S)	Pearson Correlation Sig. (2-tailed) N	.971** .000 147
(Just-In-Time)	Pearson Correlation Sig. (2-tailed) N	.954** .000 147
Total Productive Maintenance)	Pearson Correlation Sig. (2-tailed) N	.962** .000 147
(Value Stream Mapping)	Pearson Correlation Sig. (2-tailed) N	.822** .000 147
KAIZEN)	Pearson Correlation Sig. (2-tailed) N	.915** .000 147
(Standardized Work)	Pearson Correlation Sig. (2-tailed) N	.915** .000 147
(Visual Management)	Pearson Correlation Sig. (2-tailed) N	.932** .000 147
(Cellular Design Manufacturing)	Pearson Correlation Sig. (2-tailed) N	.925** .000 147
(SMED) Setup Time Reduction and Single Minute Exchange of Die	Pearson Correlation Sig. (2-tailed) N	.903** .000 147
(Smaller Lot Size)	Pearson Correlation Sig. (2-tailed) N	.897** .000 147

According to the correlation test results showed in the table 4.8 above, we find that the significant value is less than 0.05, so we reject the hypothesis that there is no difference between the level of utilization of LM tools in enterprises in Ramallah, which mean that there are differences between the level of utilization of LM tools in enterprises in Ramallah.

Summary of Hypothesis Testing

- H1: There is a significant difference (within a 5% level) in the utilization level of LM tools used by ISO 9001 certified enterprises compared to non-ISO 9001 certified enterprises in Ramallah.

We fail to reject that the utilization of LM tools in manufacturing enterprises in Ramallah differ in ISO 9000 certified enterprises compared to non-ISO 9000 enterprises for all tools **except Value Stream Mapping** where for this tool there are no difference in the level of utilization.

- H2: Enterprises of different sizes (small, medium, large) in Ramallah differ significantly (within a 5% level) in utilization level of LM tools.

We fail to reject H2 that the utilization of LM tools in manufacturing enterprises in Ramallah differ according to enterprise size, for all tool **except** Value Stream Mapping, Setup Time Reduction and Single Minute Exchange of Die (SMED), Smaller Lot Size; where we find that significant value is greater than 0.05, which mean that there is no difference for **these 3 tools**.

- H3: Non-family-owned enterprises in Ramallah differ significantly (within a 5% level) in utilization level of LM tools compared to family-owned enterprises in Ramallah.

We reject H3 that the utilization of LM tools in manufacturing enterprises in Ramallah differs according to the ownership of the enterprise. **No difference.**

- H4: Enterprises of different sectors in Ramallah differ significantly (within a 5% significance level) in utilization level of LM tools

We fail to reject H4, that the utilization of LM tools in manufacturing enterprises in Ramallah differ according to the sector, for all tools **except** Value Stream Mapping, which mean that there are no differences for this exact tool.

- H5: There is no difference between the level of utilization of LM tools in enterprises in Ramallah, We reject H5, which indicates that there are significant differences in the level of utilization of LM tools in enterprises in Ramallah.

Chapter Five

Conclusions and Recommendations

5.1 Introduction

This chapter presents the results and the summary of this research, it also contains practical implications of this research, and furthermore, it elaborates to present suggestions for further research.

5.2 Research Findings and Conclusions

In recent times, Lean manufacturing tools have become vital tools for both academics and practitioners and being used widely in manufacturing enterprises. This research aimed to investigate the level of utilization of LM tools in manufacturing enterprises in Ramallah and explore the relation between the level of utilization and some of the enterprise characteristics (ISO9001 Certification, Size, Ownership and Sector of the enterprise) by surveying the manufacturing enterprises in Ramallah on the utilization level of LM tools and further testing the hypotheses of this research, A survey focusing on the level of implementation of 10 lean manufacturing tools was made. In total, 147 completed questionnaires were collected. The resulting level of utilization of each tool indicates that enterprises have some experience with LM or they have started with the LM adoption, on another perspective it might indicate that implementing the practices without knowing that it is representing LM.

And the results are:

- **The Relation Between ISO 9001 and the Utilization of LM Tools**

ISO9001 is a quality management standard that provides a framework for managing quality in organizations, while LM is a set of tools and techniques to eliminate waste and increase efficiency.

According to the results of the study, it shows that the ISO9000 certified enterprises in Ramallah have less mean values in terms of the level of utilization of LM tools. This might indicate that these enterprises believe that their effort is sufficient to meet their business goals and achieve customer satisfaction or they use ISO9001 as a contractual requirement without implementing it to improve their internal operations. Thus integration of LM tools and practices into the enterprise quality management system can be advised to managers to enhance performance and customer satisfaction, by reducing waste, reducing lead times, reducing costs and fostering a continuous improvement culture in their enterprise.

- **The Relation Between the Size of the Enterprise and the Utilization of LM Tools**

The results agree with Shah & Ward (2006) who stated in their study on LM that there is a positive relationship between the size of the enterprise and the implementation of LM practices. Larger enterprises have more resources to invest in training, technology and implement LM tools. The results show that large-size enterprises have a higher level of utilization of LM tools, specifically 5S, JIT, TPM, SW, CDM, SR and SMED, while medium-size enterprises indicated a slightly higher level of utilization of KAIZEN tool. Whereas KAIZEN is believed to require the least investment of resources, has a huge impact on worker satisfaction, and pride of work. Through Kaizen strong small, incremental changes are routinely applied and sustained over a long period

which results in significant improvement in efficiency, quality as well as productivity (Akter et al., 2015).

An opportunity is available for small and medium size enterprises to benefit from the LM tools and may be able to implement them easily due to their smaller size and simpler organizational structure.

- **The Relation Between Ownership (Family/Non-Family Enterprises) and the Level of Utilization of LM Tools**

Both family owned and non-family owned enterprises can benefit from LM tools utilization, both also can be a subject to a different set of challenges while implementing LM, mainly due factors such as leadership style, decision making, communication, and change resistance. Ellington et al. (1996) stated that there are differences in the implementation of lean practices based on the ownership type of the business due to factors such as cost and commitment, while the results show that there is no difference of the level of utilization of LM tools in family owned and non-family owned enterprises in Ramallah, and both have similar level of utilization of LM tools regardless of the ownership type.

- **The Relation Between the Sector and the Level of Utilization of LM Tools**

The result shows that the utilization of LM tools differs according to the sector, Pharmaceutical Industries and Food Industries have the highest mean values for LM utilization respectively. These two sectors are considered of the fast growing sectors in Palestine (PIPA, 2020). Both the pharmaceutical industries and the food industries work under strict quality standards and regulation, such as Good Manufacturing Practices (GMP) to deliver the best quality products for the customer, GMP tends to provide consistency in the operations and a control of the quality to meet the standard

(Chowdary & Damian, 2012). The goal of the GMP is to ensure high product quality and safety. Therefore, only validated processes can be used with minimum deviations. This supports LM where a high process quality is sought after reduction of waste (Sieckmann et al., 2018). On the other hand, the Hazard Analysis and Critical Control Points (HACCP) focus on food safety and considered as a quality assurance method.

“HACCP and Lean are natural allies. Each requires a holistic process mentality. Both are data-driven and result in product quality being built into the production process.” – Phil Cullen. Ultimately, the level of utilization of LM tools depends on a variety of factors, including the enterprise's size and industry sector.

5.3 Research Contribution

This research can be considered as a baseline representing the current state of the LM tools utilization in manufacturing enterprises in Ramallah, Palestine. Furthermore the findings revealed the influence of some enterprise characteristics on the level of utilization such as size and sector. These findings contribute to the existing body of knowledge, especially in the Palestinian context, by providing insights about the tools and practices inside manufacturing enterprises where limited research is available on this topic.

5.4 Research Limitations

There were some limitations for this research. The research was exclusive to Ramallah and Al-Bireh governorate, extending this research to all over West Bank and Gaza will reflect better insight of the utilization of LM tools in the Palestinian manufacturing enterprises, since the literature shows that good efforts have been done in Gaza Strip.

Moreover, the data collection method reflects the view-point of the respondent (subjective evaluation) on the level of utilization of LM tools.

During the research process, mainly data collection, it was clear that there is a lack of cooperation of manufacturing enterprises in research activities such as responding to surveys, providing the needed data and the culture supporting research in Palestine which required the researcher to extend the collection period and conduct multiple follow-ups.

5.5 Future Research

The researcher suggests the following activities in the future:

- Extending the research to cover all over West Bank and Gaza to provide a holistic view on the Palestinian manufacturing enterprises and their practices.
- Studying the impact of implementing LM on enterprise performance in manufacturing enterprises in Palestine.
- Constructing an LM Implementation framework by studying the experiences of enterprises advanced in their utilization of LM.
- Studying the barriers and enablers of becoming lean in the Palestinian context.
- Studying the relation between the knowledge of LM tools and the level of utilization of its tools in the enterprises.

5.6 Recommendations

1. The governmental institutions, universities, and private sector representatives (industry unions and chambers of commerce) are required to take a leading role in spreading awareness about LM, Lean thinking and Lean concepts.

2. The Palestinian Manufacturing Enterprises should utilize and benefit of LM tools, for their high importance in waste elimination, cost reduction and enhance customer satisfaction and also for their compatibility and possible integration with other quality management initiatives.
3. Managers and owners of manufacturing enterprises are encouraged to refer to experts in Lean, to support and guide them in their Lean journey and build the capacity of their staff members in this field.
4. Training the employees on how to utilize LM tools properly and maintain their results can maintain improvement efforts and support workers' involvement and innovation.

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Appendix A: The Questionnaire

الجامعة العربية الأمريكية ARAB AMERICAN UNIVERSITY

كلية الدراسات العليا | برنامج الماجستير في إدارة برنامج

إدارة الجودة

السادة الافاضل

تأتي هذه الدراسة ضمن إعداد رسالة الماجستير واستكمال متطلبات التخرج في برنامج إدارة الجودة في كلية الدراسات العليا في الجامعة العربية الأمريكية. تهدف الرسالة إلى دراسة مستوى استخدام أدوات التصنيع الخالي من الهدر في المنشآت الصناعية في رام الله. ومن أجل تحقيق هذه الغاية، أرجو مساعدتكم في توفير إجابات صادقة، دقيقة وموضوعية على الأسئلة الواردة في هذا الاستبيان، والتي تعتمد على معرفتك بإجراءات العمل في منشأتكم. تحتاجون إلى 15 دقيقة تقريباً من أجل تعبئة هذا الاستبيان.

إن المعلومات التي تجمع من خلال هذا الاستبيان سيتم استخدامها لأغراض البحث العلمي، مع الحفاظ على سرية المعلومات، ومصدرها. إذا كان لديكم أي استفسار، يمكنكم مراسلتي على البريد الإلكتروني الموضح أدناه.

الباحثة: صابرين نصار

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القسم الأول | معلومات المستجيب

معلومات شخصية

الرمز	السؤال (اختر الجواب الأقرب الذي يمثلك)
GND	الجنس: <input type="checkbox"/> ذكر <input type="checkbox"/> انثى
AGE	العمر: <input type="checkbox"/> أقل من 20 <input type="checkbox"/> 21-30 <input type="checkbox"/> 31-40 <input type="checkbox"/> 41-50 <input type="checkbox"/> 51-60 <input type="checkbox"/> 61 فأكثر
EDU	درجة التعليم: <input type="checkbox"/> دون الثانوية <input type="checkbox"/> توجيهي <input type="checkbox"/> دبلوم <input type="checkbox"/> بكالوريوس <input type="checkbox"/> دراسات عليا
OCC	المهنة: <input type="checkbox"/> مدير الشركة <input type="checkbox"/> مدير إنتاج <input type="checkbox"/> موظف إنتاج <input type="checkbox"/> غير ذلك

معلومات تمثل مستوى المعرفة في منهجية التصنيع الخالي من الهدر **Lean Manufacturing**

الرمز	السؤال (اختر الجواب الأقرب الذي يمثلك)
KNW	هل لديك معرفة مسبقة عن موضوع التصنيع الخالي من الهدر <input type="checkbox"/> نعم <input type="checkbox"/> لا
TRN	هل تلقيت تدريب مسبق عن مبادئ التصنيع الخالي من الهدر <input type="checkbox"/> نعم <input type="checkbox"/> لا

القسم الثاني | معلومات المنشأة

الرمز	السؤال (اختر الجواب الأقرب لوضع منشأتك)
EST	عمر المنشأة: <input type="checkbox"/> أقل من 5 سنوات <input type="checkbox"/> 5-10 سنوات <input type="checkbox"/> 11-15 سنوات <input type="checkbox"/> 16-20 سنة <input type="checkbox"/> أكثر من 20 سنة
SEC	قطاع المنشأة: <input type="checkbox"/> صناعات ورقية <input type="checkbox"/> صناعات بلاستيكية <input type="checkbox"/> صناعات كيميائية <input type="checkbox"/> صناعات دوائية <input type="checkbox"/> أخشاب وأثاث <input type="checkbox"/> صناعات غذائية <input type="checkbox"/> صناعات الحديد <input type="checkbox"/> صناعات النسيج <input type="checkbox"/> أخرى ، يرجى التحديد _____
OWN	ملكية المنشأة: <input type="checkbox"/> عائلية <input type="checkbox"/> غير عائلية
SIZ	حجم المنشأة: (بناء على عدد العاملين) <input type="checkbox"/> صغيرة (5-15 عامل) <input type="checkbox"/> متوسطة (16 – 25 عامل) <input type="checkbox"/> كبيرة (أكثر من 25 عامل)
PLN	عدد خطوط الإنتاج: <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 أو أكثر
ISO	هل منشأتك حاصلة على شهادة الجودة ISO9001 سارية المفعول: <input type="checkbox"/> نعم <input type="checkbox"/> لا

القسم الثالث | محاور الدراسة مستوى استخدام أدوات التصنيع الخالي من الهدر
يتكون هذا القسم من 10 أجزاء تمثل 10 أدوات من أدوات التصنيع الخالي من الهدر Lean Manufacturing Tools. الرجاء الإجابة على جميع الأجزاء بوضع دائرة على الاختيار الأقرب لتمثيل تطبيق الأداة في منشأتك، علماً أن المقياس يتكون من خمس درجات من (1-5) حيث أن الدرجة الأعلى تمثل أعلى مستوى تطبيق بينما الدرجة الأقل تمثل المستوى الأقل.

الرمز						البنء					
علي	جءا	متوسء	ط	ضعيف	ف	ضعيف	ف	متوسء	ط	علي	جءا
(5S) وهي تمثل خمسة خطوات لتنظيم مكان العمل											
التصنيف (Sort)											
عملية التصنيف تمثل فرز ما يلزم وما لا يلزم في مكان العمل وإزالة جميع الزوائد											
5	4	3	2	1	تقوم الشركة بنشاطات تصنيف وفرز بشكل دوري	S11					
5	4	3	2	1	تقوم الشركة بنشاطات تصنيف وفرز بشكل منظم	S12					
5	4	3	2	1	يتم تشجيع طاقم العمل على تصنيف وفرز جميع ما لا يلزمهم	S13					
5	4	3	2	1	يتم حفظ وتخزين الأوراق، الملفات، والأجهزة الضرورية فقط	S14					
التنظيم (Set in Order)											
هي عملية تشمل تنظيم وترتيب بيئة العمل بجعل مكان مخصص لكل شيء و وضع كل شيء في مكانه											
5	4	3	2	1	توضع المعدات والأدوات في أماكن مخصصة لها	S21					
5	4	3	2	1	تتوفر رفوف للتخزين	S22					
5	4	3	2	1	تتوفر ملصقات تعريفية على الخزائن والرفوف	S23					
5	4	3	2	1	تتوفر معلومات مرئية توضح مواقع العمل	S24					

التنظيف (Shine)					
تشمل هذه العملية نشاطات التنظيف من تنظيف الأدوات والمعدات، الأرضيات، أماكن التخزين و المناطق المحيطة بمكان العمل					
5	4	3	2	1	S31 مهام و مسؤوليات التنظيف واضحة لطاقم العمل
5	4	3	2	1	S32 جدول نشاطات التنظيف واضح لطاقم العمل
5	4	3	2	1	S33 تتوفر أدوات التنظيف قريباً من منطقة العمل
5	4	3	2	1	S34 يتم تنفيذ نشاطات التنظيف بشكل دوري
التنميط (Standardize)					
تتم هذه العملية بوضع مقاييس للعمل للحفاظ على مكان العمل بشكل جيد وتوضيح الإجراءات والمسؤوليات					
5	4	3	2	1	S41 الموظفين على علم بمسئولياتهم ومسؤوليات أقرانهم بما يخص الحفاظ على مكان العمل
5	4	3	2	1	S42 يوجد اجراءات عمل ثابتة لضبط أعمال التصنيف، الترتيب والتنظيف
5	4	3	2	1	S43 يوجد اجراءات عمل واضحة للموظفين لتسليم مكان العمل بعد انتهاء يوم العمل
5	4	3	2	1	S44 يتم استخدام أدوات مرئية(ملصقات تعريفية) توضح إجراءات العمل
التثبيت (Sustain)					
تمثل هذه العملية الإجراءات اللازمة للحفاظ على جهود تنظيم مكان العمل					
5	4	3	2	1	S51 يتم تدريب وتعريف طاقم العمل على العمليات اللازمة للحفاظ على تنظيم مكان العمل
5	4	3	2	1	S52 يتم عقد نشاطات تنظيم مكان العمل بشكل دوري
5	4	3	2	1	S53 يتم مراجعة الإجراءات ونتائج نشاطات تنظيم مكان العمل بشكل دوري
5	4	3	2	1	S54 يشعر طاقم العمل بمسؤولية عالية تجاه نشاطات تنظيم مكان العمل
الإنتاج في الوقت المحدد (Just-In-Time)					
وهي منهجية تعتمد على أداتين بهدف الإنتاج بالكمية اللازمة بالوقت المحدد بلا تأخير وبدون تكديس في المستودعات					
كانبان KANBAN					
وهي أداة تمثل نظام مرئي يربط بين العمليات من مرسل ومستقبل سواء على مستوى داخل المنشأة أو بين المنشأة والعملاء والموردين					
5	4	3	2	1	KNB1 يتم إنتاج المنتجات بكميات محددة حسب طلب العملاء

5	4	3	2	1	يتم إنتاج المنتجات بالوقت المحدد من قبل العملاء	KNB2
5	4	3	2	1	يتوفر نظام مرئي من إشارات معينة ومفهومة بين دوائر العمل في المنشأة للتنسيق بين دوائر الإنتاج والبيع	KNB3
5	4	3	2	1	يتوفر نظام مرئي من إشارات معينة ومفهومة بين المنشأة والعملاء تفيد بطلب كميات جديدة من المنتجات	KNB4
5	4	3	2	1	يتوفر نظام مرئي من إشارات معينة ومفهومة بين المنشأة والموردين تفيد بطلب كميات جديدة من المواد واللوازم	KNB5
موائمة حجم الإنتاج (Production Leveling)						
وهي عملية توزيع حجم الإنتاج وتنوعه على الوقت بما يتلائم مع التغييرات في طلب العملاء، بحيث تقوم هذه العملية بتقليل الوقت اللازم لتسليم المنتج و تقليل تكديس المنتجات في المستودعات من خلال التخطيط والاستغلال الأمثل للموارد						
5	4	3	2	1	تتوفر أدوات مرئية لتوضيح خطة الإنتاج اليومية حيث تشمل معلومات تخص موعد التسليم، نوع المنتج وكمية الإنتاج المطلوبة.	PL1
5	4	3	2	1	الطاقة الإنتاجية القصوى للموظفين معروفة	PL2
5	4	3	2	1	يتم استغلال طاقة الموظفين بشكل مناسب	PL3
5	4	3	2	1	الطاقة الإنتاجية القصوى لخطوط الإنتاج معروفة	PL4
5	4	3	2	1	يتم استغلال الطاقة الإنتاجية للمعدات بشكل مناسب	PL5
5	4	3	2	1	الظروف والترتيبات التي تؤثر على كفاءة العمليات الإنتاجية معروفة	PL6

الصيانة الإنتاجية الشاملة (Total Productive Maintenance) (
تقوم هذه الأداة على تغيير مفهوم الصيانة العادية بحيث أن مهام الصيانة لا تنحصر بموظفي الصيانة فقط بل تتم بمشاركة جميع الموظفين و تخرج عن نمط الإستجابة للأعطال بل تتعدى ذلك لتحليل الأسباب واتخاذ الإجراءات الاحترازية لمنع حدوث الأعطال						
إشراك طاقم الإنتاج بمهام الصيانة						
5	4	3	2	1	يشارك طاقم الإنتاج بتفقد المعدات بشكل دوري	TP11
5	4	3	2	1	يقوم طاقم الإنتاج بتصحيح أعطال المعدات البسيطة	TP12
التوثيق والتحليل						
5	4	3	2	1	يتم تسجيل المعلومات الخاصة بوقت توقف المعدات عن العمل	TP21
5	4	3	2	1	يتم حساب أداء المعدات و توثيقه ضمن ظروف التشغيل المختلفة	TP22
5	4	3	2	1	يتم الاحتفاظ ببيانات عمليات الصيانة	TP23

الصيانة الاحترافية						
5	4	3	2	1	يقوم فريق الصيانة بتحليل الأسباب الجذرية للأعطال	TP31
5	4	3	2	1	يقوم فريق الصيانة بعمل اجراءات وقائية تمنع حدوث الأعطال	TP32

تخطيط مجرى القيمة (Value Stream Mapping)						
وهي أداة تقوم على إعطاء صورة بصرية للوضع الراهن لخط سير القيمة وتحديد فرص التحسين والعمل لتحقيقها						
5	4	3	2	1	يقوم الطاقم برسم خريطة الوضع الراهن بحيث يشمل مجرى المعلومات ومجرى المواد	VSM1
5	4	3	2	1	يقوم الطاقم بتحليل خريطة الوضع الراهن ورصد فرص التحسين	VSM2
5	4	3	2	1	يقوم الطاقم بتطوير خريطة الوضع المستقبلي المرغوبة	VSM3

كايزن التحسين المستمر (KAIZEN)						
وهي منهجية التحسين المستمر وتشمل نشاطات متعددة لحل المشكلات						
5	4	3	2	1	يتم تشجيع الموظفين لتقديم اقتراحات لحل المشكلات عند حدوثها	KZ1
5	4	3	2	1	يتم إشراك الموظفين بمجموعات عمل لحل المشكلات عند حدوثها	KZ2
5	4	3	2	1	يتم عمل عرض تقديمي للإدارة بالحلول المقترحة لحل المشكلات	KZ3
العمل القياسي (Standardized Work)						
وهي أداة تشمل تطوير العمليات من خلال إعداد إجراءات عمل قياسية						
5	4	3	2	1	يتم حساب وقت الإنتاج للمنتج (Takt time)	STD1
5	4	3	2	1	الطريقة المثلى لأداء العمل محددة ويتم مشاركتها مع الطاقم	STD2
5	4	3	2	1	النتائج الأمثل لسير العمليات محدد و يتم مشاركته مع الطاقم	STD3

الإدارة المرئية (Visual Management)						
تعنى هذه الأداة بالأساس بتوفير وسائل مرئية تسهل عملية الوصول للمعلومات الخاصة بنظام العمل وسير العمل عن طريق استعمال الملصقات و الألواح المعلقة لمشاركة المعلومات						
المعرفة كمجموعة						
5	4	3	2	1	تتوفر المعلومات الخاصة بمواعيد التسليم على لوحات مرئية و يستطيع الطاقم معرفتها بسهولة	VM11
5	4	3	2	1	يستطيع الطاقم معرفة الأهداف وجدول العمل بسهولة	VM12
5	4	3	2	1	تتوفر معلومات حول قوانين الشركة والعمل ويستطيع الطاقم	VM13

					معرفتها بسهولة	
العمل كمجموعة						
5	4	3	2	1	يتم مشاركة فرص التحسين ونشاطاتها مع الطاقم	VM21
5	4	3	2	1	يتم إشراك الطاقم بالنشاطات التحسينية	VM22
الرؤية كمجموعة						
5	4	3	2	1	يتم مشاركة معلومات حالة الإنتاج بحيث يتمكن جميع ذوي العلاقة من معرفتها	VM31
5	4	3	2	1	يتم مشاركة معلومات مستوى المخزون بحيث يتمكن جميع ذوي العلاقة من معرفتها	VM32
5	4	3	2	1	يتم مشاركة معلومات حالة توفر المعدات بحيث يتمكن جميع ذوي العلاقة من معرفتها	VM33
التصميم الخلوي للتصنيع (Cellular Design Manufacturing)						
تعرف هذه العملية باستخدام النمط الخلوي للتصنيع حيث يقوم العمل على مستوى خلية واحدة بانتاج قطعة واحدة من منتج واحد وتهدف الى تقليل المساحة المستغلة للإنتاج و تحسين جودة الناتج						
5	4	3	2	1	يتم وضع المعدات والماكينات بشكل متقارب	CD1
5	4	3	2	1	أقل مستوى من المخزون يتوافر حول المعدات	CD2
5	4	3	2	1	يتم تدفق المواد المصنعة بسلاسة بين المراحل الإنتاجية	CD3

تقليل وقت التشغيل و تغيير القوالب						
Setup Time Reduction and Single Minute Exchange of Die (SMED)						
تهدف هذه العملية لتقليل الوقت الضائع في التشغيل و تغيير القوالب عن طريق توضيح الإجراءات اللازمة لتسريع العملية وضمان نجاحها مما يؤدي الى زيادة فرص انتاج منتجات أكثر بكميات متناسبة مع تنوع الطلب						
5	4	3	2	1	إجراءات التشغيل وقائمة التحقق متوفرة لتسريع عملية التشغيل	STP1
5	4	3	2	1	اجراءات تغيير القوالب وقائمة التحقق متوفرة لتسريع عملية التغيير	STP2

تصغير حجم الحزمة الإنتاجية (Smaller Lot Size)						
تقوم هذه العملية على تصغير حجم الحزم الإنتاجية وتنوع أعلى في المنتجات بهدف تلبية طلب العملاء بالكميات المطلوبة						

والوقت المحدد دون تكديس في المستودعات						
5	4	3	2	1	يتم إنتاج حزم منتجات بكميات صغيرة ومتنوعة	SLZ1
5	4	3	2	1	يتم الاستجابة لطلبات العملاء بالوقت المحدد	SLZ2
5	4	3	2	1	يتم تحقيق أقل مستوى من المخزون (لا يوجد تكديس ومنتجات فائضة)	SLZ3

في حال رغبتك إضافة أي معلومات أخرى، يرجى إضافتها هنا:					

Appendix B – Expert List

No	Expert Name	Expertise Type
1	Dr. Ashraf Abed Alwahab Almimi (Thesis Supervisor)	Academic and Industry Expert
2	Dr. Yahya Saleh Salahat	Academic and Industry Expert
3	Dr. Ayham Jaaron	Academic Expert
4	Eng. Abdulrahman Jobran	Industry Expert

Appendix D - Frequencies

Demographics Table

		Count	Column N %
Gender	1.00	97	66.0%
	2.00	50	34.0%
Age	1.00	1	0.7%
	2.00	29	19.7%
	3.00	55	37.4%
	4.00	54	36.7%
	5.00	8	5.4%
Education level	1.00	3	2.0%
	2.00	11	7.5%
	3.00	32	21.8%
	4.00	79	53.7%
	5.00	22	15.0%
Position	1.00	35	23.8%
	2.00	37	25.2%
	3.00	54	36.7%
	4.00	21	14.3%
Prior knowledge of LM?	1.00	106	72.1%
	2.00	41	27.9%
Received training in the lean principles	1.00	69	46.9%
	2.00	78	53.1%
Enterprise established	1.00	12	8.2%
	2.00	38	25.9%
	3.00	41	27.9%
	4.00	45	30.6%
	5.00	11	7.5%
Sector	Paper Industries	21	14.3%
	Plastic Industries	20	13.6%
	Chemical Industries	16	10.9%
	Pharmaceutical Industries	17	11.6%
	Wood and furniture	15	10.2%
	Food Industries	46	31.3%
	Metal Industries	10	6.8%
	Textile Industries	0	0.0%
	Others	2	1.4%
	Ownership	Family	55
Non-Family		92	62.6%
Size (according to unified definition)	S (5- 15 Employee)	37	25.2%
	M (16-25)	70	47.6%
	L(more than 25)	40	27.2%
Number of production lines	1.00	29	19.7%
	2.00	63	42.9%
	3.00	55	37.4%
ISO9001 certificate	Yes	92	62.6%
	No	55	37.4%

Frequencies

	Statistics				Qualitative Scale
	N		Mean	Std. Deviation	
	Valid	Missing			
S11	147	0	3.4898	.98180	High Level
S12	147	0	3.6463	1.11529	High Level
S13	147	0	3.5034	1.05580	High Level
S14	147	0	3.5646	1.12303	High Level
(Sort)	147	0	3.5510	.93630	High Level
S21	147	0	3.5238	1.08118	High Level
S22	147	0	3.6871	1.22644	High Level
S23	147	0	3.4218	1.06581	High Level
S24	147	0	3.4354	1.18823	High Level
(Set in Order)	147	0	3.5170	1.02856	High Level
S31	147	0	3.5374	1.06161	High Level
S32	147	0	3.6054	1.16194	High Level
S33	147	0	3.5034	1.13701	High Level
S34	147	0	3.5986	1.23676	High Level
(Shine)	147	0	3.5612	1.03723	High Level
S41	147	0	3.4014	1.10825	High Level
S42	147	0	3.3946	1.13208	Medium Level
S43	147	0	3.3537	1.09045	Medium Level
S44	147	0	3.3197	1.22746	Medium Level
(Standardize)	147	0	3.3673	1.01416	Medium Level
S51	147	0	3.3810	1.10002	Medium Level
S52	147	0	3.4218	1.16410	High Level
S53	147	0	3.3265	.99425	Medium Level
S54	147	0	3.4422	1.14754	High Level
(Sustain)	147	0	3.3929	.99485	Medium Level
(5S)	147	0	3.4779	.93044	High Level
KNB1	147	0	3.5374	1.03548	High Level
KNB2	147	0	3.6463	1.13959	High Level
KNB3	147	0	3.3401	1.04355	Medium Level
KNB4	147	0	3.3537	1.08415	Medium Level
KNB5	147	0	3.3605	1.03332	Medium Level
KANBAN	147	0	3.4476	.92731	High Level
PL1	147	0	3.4014	1.06411	High Level
PL2	147	0	3.5238	1.08750	High Level
PL3	147	0	3.4150	1.05235	High Level
PL4	147	0	3.5714	1.13476	High Level
PL5	147	0	3.4354	1.06029	High Level
PL6	147	0	3.4014	1.08955	High Level
(Production Leveling)	147	0	3.4578	.94579	High Level
(Just-In-Time)	147	0	3.4527	.89772	High Level
TP11	147	0	3.5034	1.02285	High Level
TP12	147	0	3.5510	1.17732	High Level
Total Involvement	147	0	3.5272	1.01324	High Level
TP21	147	0	3.3537	.98484	Medium Level
TP22	147	0	3.3878	1.14944	Medium Level
TP23	147	0	3.4218	1.03979	High Level
Reporting	147	0	3.3873	.95049	Medium Level
TP31	147	0	3.3741	.95236	Medium Level
TP32	147	0	3.4830	1.10636	High Level
Preventive Maintenance	147	0	3.4286	.95802	High Level
Total Productive Maintenance)	147	0	3.4477	.91978	High Level
VSM1	147	0	3.2245	1.07140	Medium Level

Statistics					
	N		Mean	Std. Deviation	Qualitative Scale
	Valid	Missing			
VSM2	147	0	3.2653	1.16646	Medium Level
VSM3	147	0	3.1905	1.10623	Medium Level
(Value Stream Mapping)	147	0	3.2265	1.03795	Medium Level
KZ1	147	0	3.4898	1.06865	High Level
KZ2	147	0	3.5306	1.14261	High Level
KZ3	147	0	3.4082	1.11500	High Level
KAIZEN	147	0	3.4754	1.02540	High Level
STD1	147	0	3.6190	.97456	High Level
STD2	147	0	3.5646	1.14717	High Level
STD3	147	0	3.4966	1.02952	High Level
(Standardized Work)	147	0	3.5594	.96427	High Level
VM11	147	0	3.4354	1.10459	High Level
VM12	147	0	3.5102	1.10644	High Level
VM13	147	0	3.5578	1.05421	High Level
Knowing as a group	147	0	3.5006	.98175	High Level
VM21	147	0	3.4762	1.04248	High Level
VM22	147	0	3.5238	1.18399	High Level
Working as a group	147	0	3.5000	1.04685	High Level
VM31	147	0	3.5510	1.02157	High Level
VM32	147	0	3.4898	1.10644	High Level
VM33	147	0	3.4354	1.09211	High Level
Seeing as a group	147	0	3.4916	.98929	High Level
(Visual Management)	147	0	3.4974	.95700	High Level
CD1	147	0	3.5170	.96765	High Level
CD2	147	0	3.5102	1.12486	High Level
CD3	147	0	3.5102	1.06222	High Level
(Cellular Design Manufacturing)	147	0	3.5121	.94382	High Level
STP1	147	0	3.5578	.92254	High Level
STP2	147	0	3.4898	1.06222	High Level
Setup Time Reduction and Single Minute Exchange of Die	147	0	3.5238	.92034	High Level
SLZ1	147	0	3.4762	1.04248	High Level
SLZ2	147	0	3.6259	1.18328	High Level
SLZ3	147	0	3.3946	.99007	Medium Level
(Smaller Lot Size)	147	0	3.4983	.96520	High Level
Overall	147	0	3.4683	.88411	High Level

Appendix E T-test ISO9001 Certificate

Level of Utilization in relation to ISO9001

T-test ISO9001 certificate

Group Statistics

	ISO9001 certificate	N	Mean	Std. Deviation	Std. Error Mean
وهي تمثل خمسة خطوات (5S) لتنظيم مكان العمل	Yes	92	3.3505	.92835	.09679
	No	55	3.6909	.90247	.12169
الإنتاج في الوقت المحدد (Just-In-Time)	Yes	92	3.3073	.87168	.09088
	No	55	3.6960	.89563	.12077
الصيانة الإنتاجية الشاملة (Total Productive Maintenance)	Yes	92	3.2668	.91421	.09531
	No	55	3.7504	.85429	.11519
تخطيط مجرى القيمة (Value Stream Mapping)	Yes	92	3.1228	.92137	.09606
	No	55	3.3998	1.19722	.16143
كايزن التحسين المستمر (KAIZEN)	Yes	92	3.2999	.97441	.10159
	No	55	3.7691	1.04996	.14158
العمل القياسي (Standardized Work)	Yes	92	3.3579	.94933	.09897
	No	55	3.8964	.90024	.12139
الادارة المرئية (Visual Management)	Yes	92	3.3052	.93684	.09767
	No	55	3.8190	.91042	.12276
التصميم الخلوي للتصنيع (Cellular Design Manufacturing)	Yes	92	3.3255	.90413	.09426
	No	55	3.8242	.93402	.12594
تقليل وقت التشغيل وتغيير القوالب (SMED) Setup Time Reduction and Single Minute Exchange of Die	Yes	92	3.3587	.90883	.09475
	No	55	3.8000	.87981	.11863
تصغير حجم الحزمة الإنتاجية (Smaller Lot Size)	Yes	92	3.3223	.96603	.10072
	No	55	3.7927	.89725	.12099
Overall	Yes	92	3.3113	.87400	.09112
	No	55	3.7308	.84493	.11393

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
وهي تمثل (5S) خمسة خطوات لتنظيم مكان العمل	Equal variances assumed	.072	.789	-2.173	145	.031	-.34037	.15660	-.64989	-.03084
	Equal variances not assumed			-2.189	116.311	.031	-.34037	.15549	-.64832	-.03241
الإنتاج في الوقت المحدد (Just-In-Time)	Equal variances assumed	.000	.993	-2.590	145	.011	-.38872	.15011	-.68540	-.09204
	Equal variances not assumed			-2.572	111.296	.011	-.38872	.15114	-.68820	-.08923
الصيانة الإنتاجية الشاملة Total Productive Maintenance))	Equal variances assumed	.509	.477	-3.179	145	.002	-.48359	.15210	-.78421	-.18297
	Equal variances not assumed			-3.234	119.901	.002	-.48359	.14951	-.77961	-.18756

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
تخطيط مجرى القيمة (Value Stream Mapping)	Equal variances assumed	6.445	.012	-1.574	145	.118	-.27699	.17603	-.62490	.07092
	Equal variances not assumed			-1.475	92.155	.144	-.27699	.18785	-.65007	.09609
كايزن التحسين (KAIZEN المستمر)	Equal variances assumed	.957	.330	-2.744	145	.007	-.46920	.17099	-.80716	-.13124
	Equal variances not assumed			-2.693	107.079	.008	-.46920	.17425	-.81463	-.12377
العمل القياسي (Standardized Work)	Equal variances assumed	.084	.773	-3.392	145	.001	-.53843	.15874	-.85218	-.22468
	Equal variances not assumed			-3.438	118.569	.001	-.53843	.15662	-.84857	-.22829
الادارة المرئية (Visual Management)	Equal variances assumed	.109	.742	-3.251	145	.001	-.51379	.15802	-.82610	-.20147
	Equal variances not assumed			-3.275	116.341	.001	-.51379	.15688	-.82449	-.20308

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
التصميم الخلوي للتصنيع (Cellular Design Manufacturing)	Equal variances assumed	.005	.944	-3.196	145	.002	-.49864	.15602	-.80701	-.19027
	Equal variances not assumed			-3.170	110.811	.002	-.49864	.15731	-.81037	-.18691
تقليل وقت التشغيل وتغيير القوالب (SMED) Setup Time Reduction and Single Minute Exchange of Die	Equal variances assumed	.103	.749	-2.883	145	.005	-.44130	.15308	-.74386	-.13874
	Equal variances not assumed			-2.907	116.690	.004	-.44130	.15183	-.74200	-.14061

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
تصغير بحجم الحزم الإنتانية (Smaller Lot Size)	Equal variances assumed	.032	.858	-2.933	145	.004	-.47044	.16039	-.78745	-.15344
	Equal variances not assumed			-2.988	120.451	.003	-.47044	.15742	-.78211	-.15878
Overall	Equal variances assumed	.093	.761	-2.851	145	.005	-.41946	.14714	-.71028	-.12864
	Equal variances not assumed			-2.875	116.816	.005	-.41946	.14589	-.70839	-.13053

Appendix F ANOVA Test (Size)
Level of Utilization in Relation to The Size

Descriptive

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
وهي تمثل خمسة خطوات (5S) لتنظيم مكان العمل	S (5- 15 Employee)	37	3.1257	.81263	.13360	2.8547	3.3966	1.15	4.65
	M (16-25)	70	3.5414	.83869	.10024	3.3414	3.7414	1.60	4.75
	L(more than 25)	40	3.6925	1.10213	.17426	3.3400	4.0450	1.00	4.95
	Total	147	3.4779	.93044	.07674	3.3262	3.6296	1.00	4.95
الإنتاج في الوقت المحدد (Just-In-Time)	S (5- 15 Employee)	37	3.1328	.83157	.13671	2.8556	3.4101	1.17	5.00
	M (16-25)	70	3.5365	.81266	.09713	3.3427	3.7303	1.84	4.80
	L(more than 25)	40	3.6020	1.03810	.16414	3.2700	3.9340	1.00	4.80
	Total	147	3.4527	.89772	.07404	3.3064	3.5991	1.00	5.00
الصيانة الإنتاجية الشاملة (Total Productive Maintenance)	S (5- 15 Employee)	37	3.0974	.78842	.12961	2.8345	3.3603	1.00	4.67
	M (16-25)	70	3.5309	.86451	.10333	3.3247	3.7370	1.67	4.89
	L(more than 25)	40	3.6262	1.05330	.16654	3.2894	3.9631	1.00	5.00
	Total	147	3.4477	.91978	.07586	3.2978	3.5976	1.00	5.00
تخطيط مجرى القيمة (Value Stream Mapping)	S (5- 15 Employee)	37	2.9276	.94985	.15615	2.6109	3.2443	1.00	4.33
	M (16-25)	70	3.3284	1.01919	.12182	3.0854	3.5714	1.00	4.67
	L(more than 25)	40	3.3245	1.11771	.17673	2.9670	3.6820	1.00	5.00
	Total	147	3.2265	1.03795	.08561	3.0573	3.3957	1.00	5.00
كايزن التحسين المستمر (KAIZEN)	S (5- 15 Employee)	37	2.9449	.99835	.16413	2.6120	3.2777	1.00	5.00
	M (16-25)	70	3.6609	.89084	.10648	3.4484	3.8733	1.33	5.00
	L(more than 25)	40	3.6417	1.12024	.17712	3.2835	4.0000	1.00	5.00
	Total	147	3.4754	1.02540	.08457	3.3083	3.6426	1.00	5.00

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
العمل القياسي (Standardized Work)	S (5- 15 Employee)	37	3.1527	.87301	.14352	2.8616	3.4438	1.00	5.00
	M (16-25)	70	3.6371	.86733	.10367	3.4303	3.8440	1.67	5.00
	L(more than 25)	40	3.7995	1.10432	.17461	3.4463	4.1527	1.00	5.00
	Total	147	3.5594	.96427	.07953	3.4022	3.7166	1.00	5.00
الادارة المرئية (Visual Management)	S (5- 15 Employee)	37	3.1497	.90852	.14936	2.8468	3.4526	1.00	5.00
	M (16-25)	70	3.6012	.86343	.10320	3.3954	3.8071	1.72	5.00
	L(more than 25)	40	3.6373	1.09250	.17274	3.2879	3.9867	1.00	4.89
	Total	147	3.4974	.95700	.07893	3.3414	3.6534	1.00	5.00
التصميم الخلوي للتصنيع (Cellular Design Manufacturing)	S (5- 15 Employee)	37	3.1886	.81436	.13388	2.9171	3.4602	1.00	5.00
	M (16-25)	70	3.5709	.88838	.10618	3.3590	3.7827	1.33	5.00
	L(more than 25)	40	3.7085	1.08687	.17185	3.3609	4.0561	1.00	5.00
	Total	147	3.5121	.94382	.07784	3.3583	3.6660	1.00	5.00
تقليل وقت التشغيل وتغيير القوالب (SMED) Setup Time Reduction and Single Minute Exchange of Die	S (5- 15 Employee)	37	3.2162	.85424	.14044	2.9314	3.5010	1.00	5.00
	M (16-25)	70	3.5857	.84258	.10071	3.3848	3.7866	1.50	4.50
	L(more than 25)	40	3.7000	1.05490	.16679	3.3626	4.0374	1.00	5.00
	Total	147	3.5238	.92034	.07591	3.3738	3.6738	1.00	5.00
تصغير حجم الحزمة الإنتاجية (Smaller Lot Size)	S (5- 15 Employee)	37	3.2068	.83995	.13809	2.9267	3.4868	1.00	5.00
	M (16-25)	70	3.5900	.90265	.10789	3.3748	3.8052	1.67	5.00
	L(more than 25)	40	3.6075	1.13437	.17936	3.2447	3.9703	1.00	5.00
	Total	147	3.4983	.96520	.07961	3.3410	3.6556	1.00	5.00
Overall	S (5- 15 Employee)	37	3.1194	.77945	.12814	2.8595	3.3792	1.07	4.73
	M (16-25)	70	3.5524	.80415	.09611	3.3606	3.7441	1.82	4.59
	L(more than 25)	40	3.6439	1.03027	.16290	3.3144	3.9734	1.00	4.77
	Total	147	3.4683	.88411	.07292	3.3242	3.6124	1.00	4.77

ANOVA Test (Size)

		Sum of Squares	Df	Mean Square	F	Sig.
وهي تمثل خمسة خطوات (5S) لتنظيم مكان العمل	Between Groups	6.715	2	3.357	4.040	.020
	Within Groups	119.681	144	.831		
	Total	126.396	146			
المحدد (Just-In-Time) الإنتاج في الوقت المحدد	Between Groups	5.169	2	2.584	3.308	.039
	Within Groups	112.492	144	.781		
	Total	117.660	146			
الصيانة الإنتاجية الشاملة (Total Productive Maintenance)	Between Groups	6.300	2	3.150	3.870	.023
	Within Groups	117.216	144	.814		
	Total	123.515	146			
تخطيط مجرى القيمة (Value Stream Mapping)	Between Groups	4.418	2	2.209	2.081	.129
	Within Groups	152.875	144	1.062		
	Total	157.293	146			
كايزن التحسين المستمر (KAIZEN)	Between Groups	13.929	2	6.964	7.185	.001
	Within Groups	139.581	144	.969		
	Total	153.510	146			
العمل القياسي (Standardized Work)	Between Groups	8.849	2	4.424	5.020	.008
	Within Groups	126.905	144	.881		
	Total	135.754	146			
الادارة المرئية (Visual Management)	Between Groups	6.010	2	3.005	3.389	.036
	Within Groups	127.704	144	.887		
	Total	133.714	146			
التصميم الخلوي للتصنيع (Cellular Design Manufacturing)	Between Groups	5.656	2	2.828	3.273	.041
	Within Groups	124.401	144	.864		
	Total	130.056	146			
تقليل وقت التشغيل وتغيير القوالب (SMED) Setup Time Reduction and Single Minute Exchange of Die	Between Groups	5.011	2	2.505	3.040	.051
	Within Groups	118.656	144	.824		
	Total	123.667	146			

		Sum of Squares	Df	Mean Square	F	Sig.
تصغير حجم الحزمة الإنتاجية (Smaller Lot Size)	Between Groups	4.211	2	2.105	2.300	.104
	Within Groups	131.804	144	.915		
	Total	136.014	146			
Overall	Between Groups	6.233	2	3.116	4.159	.018
	Within Groups	107.887	144	.749		
	Total	114.120	146			

Appendix G T-test (Ownership)
Level of Utilization in Relation to the Ownership

Group Statistics

	Ownership	N	Mean	Std. Deviation	Std. Error
					Mean
وهي تمثل خمسة خطوات (5S) لتنظيم مكان العمل	Family	55	3.4582	.92780	.12510
	Non-Family	92	3.4897	.93690	.09768
الإنتاج في الوقت المحدد (Just-In-Time)	Family	55	3.4325	.89372	.12051
	Non-Family	92	3.4648	.90477	.09433
الصيانة الإنتاجية الشاملة Total (Productive Maintenance)	Family	55	3.4506	.86828	.11708
	Non-Family	92	3.4460	.95390	.09945
تخطيط مجرى القيمة (Value Stream Mapping)	Family	55	3.1578	1.00418	.13540
	Non-Family	92	3.2675	1.06093	.11061
كايزن التحسين المستمر (KAIZEN)	Family	55	3.5205	1.10897	.14953
	Non-Family	92	3.4485	.97733	.10189
العمل القياسي (Standardized Work)	Family	55	3.5813	.89175	.12024
	Non-Family	92	3.5463	1.00968	.10527

	Ownership	N	Mean	Std. Deviation	Std. Error Mean
الادارة المرئية (Visual Management)	Family	55	3.5079	.95711	.12906
	Non-Family	92	3.4911	.96212	.10031
التصميم الخلوي للتصنيع (Cellular Design Manufacturing)	Family	55	3.5758	.88750	.11967
	Non-Family	92	3.4740	.97871	.10204
تقليل وقت التشغيل وتغيير القوالب (SMED) Setup Time Reduction and Single Minute Exchange of Die	Family	55	3.4455	.88544	.11939
	Non-Family	92	3.5707	.94224	.09823
تصغير حجم الحزمة الإنتاجية (Smaller Lot Size)	Family	55	3.4722	.96803	.13053
	Non-Family	92	3.5139	.96847	.10097
Overall	Family	55	3.4594	.85151	.11482
	Non-Family	92	3.4736	.90760	.09462

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
وهي تمثل خمسة (5S) خطوات لتنظيم مكان العمل	Equal variances assumed	.083	.773	-.198	145	.843	-.03149	.15911	-.34597	.28299
	Equal variances not assumed			-.198	114.627	.843	-.03149	.15872	-.34590	.28291
الإنتاج في الوقت المحدد (Just-In-Time)	Equal variances assumed	.006	.939	-.210	145	.834	-.03224	.15351	-.33565	.27118
	Equal variances not assumed			-.211	114.857	.834	-.03224	.15304	-.33538	.27090
الصيانة الإنتاجية الشاملة (Total Productive Maintenance)	Equal variances assumed	1.031	.312	.029	145	.977	.00463	.15731	-.30629	.31555
	Equal variances not assumed			.030	122.267	.976	.00463	.15362	-.29946	.30872
تخطيط مجرى القيمة (Value Stream Mapping)	Equal variances assumed	.279	.598	-.619	145	.537	-.10968	.17729	-.46009	.24072
	Equal variances not assumed			-.627	118.739	.532	-.10968	.17484	-.45589	.23652
كايزن التحسين المستمر (KAIZEN)	Equal variances assumed	1.420	.235	.411	145	.682	.07207	.17527	-.27435	.41849
	Equal variances not assumed			.398	102.655	.691	.07207	.18095	-.28682	.43095
العمل القياسي (Standardized Work)	Equal variances assumed	1.214	.272	.212	145	.832	.03497	.16490	-.29094	.36088
	Equal variances not assumed			.219	124.941	.827	.03497	.15981	-.28132	.35126
الادارة المرئية (Visual Management)	Equal variances assumed	.059	.809	.103	145	.918	.01682	.16367	-.30667	.34031
	Equal variances not assumed			.103	114.216	.918	.01682	.16345	-.30698	.34061

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper	
التصميم الخلوي للتصنيع (Cellular Design Manufacturing)	Equal variances assumed	.291	.591	.631	145	.529	.10180	.16120	-.21681	.42040
	Equal variances not assumed			.647	122.605	.519	.10180	.15727	-.20951	.41310
تقليل وقت التشغيل وتغيير القوالب (SMED) Setup Time Reduction and Single Minute Exchange of Die	Equal variances assumed	.177	.675	-.797	145	.427	-.12520	.15706	-.43563	.18523
	Equal variances not assumed			-.810	119.392	.420	-.12520	.15461	-.43133	.18094
تصغير حجم الحزمة الإنتاجية (Smaller Lot Size)	Equal variances assumed	.001	.981	-.253	145	.801	-.04173	.16504	-.36793	.28447
	Equal variances not assumed			-.253	113.783	.801	-.04173	.16502	-.36865	.28519
Overall	Equal variances assumed	.621	.432	-.094	145	.925	-.01420	.15121	-.31305	.28465
	Equal variances not assumed			-.095	119.539	.924	-.01420	.14878	-.30879	.28040

Appendix H ANOVA (Sector)
The Level of Utilization in Relation to the Sector
Descriptive

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
(SS)								
وهي تمثل								
خمسة								
خطوات								
لتنظيم مكان								
العمل								
Paper Industries	21	3.5262	.92095	.20097	3.1070	3.9454	1.70	4.80
Plastic Industries	20	3.2575	.95756	.21412	2.8093	3.7057	1.40	4.85
Chemical Industries	16	3.1781	1.18279	.29570	2.5479	3.8084	1.15	4.75
Pharmaceutical Industries	17	4.0794	.69238	.16793	3.7234	4.4354	2.55	4.95
Wood and furniture	15	3.2600	.66580	.17191	2.8913	3.6287	1.95	4.05
Food Industries	46	3.6272	.85308	.12578	3.3738	3.8805	1.30	4.95
Metal Industries	10	3.3600	.65524	.20720	2.8913	3.8287	2.40	4.35
Others	2	1.2500	.35355	.25000	-1.9266	4.4266	1.00	1.50
Total	147	3.4779	.93044	.07674	3.3262	3.6296	1.00	4.95
الإنتاج في								
الوقت								
المحدد								
(Just-In-Time)								
Paper Industries	21	3.5200	.88550	.19323	3.1169	3.9231	1.73	5.00
Plastic Industries	20	3.3310	.90877	.20321	2.9057	3.7563	1.27	4.64
Chemical Industries	16	3.2981	1.19131	.29783	2.6633	3.9329	1.17	4.80
Pharmaceutical Industries	17	4.0562	.51554	.12504	3.7911	4.3212	2.57	4.55
Wood and furniture	15	3.2743	.82450	.21288	2.8177	3.7309	1.92	4.45
Food Industries	46	3.4853	.81362	.11996	3.2437	3.7269	1.37	4.80
Metal Industries	10	3.3230	.69822	.22080	2.8235	3.8225	2.37	4.37
Others	2	1.3075	.43487	.30750	-2.5997	5.2147	1.00	1.62
Total	147	3.4527	.89772	.07404	3.3064	3.5991	1.00	5.00

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
الصيانة الإنتاجية الشاملة Total Producti ve Maintenance)								
Paper Industries	21	3.4917	.87446	.19082	3.0937	3.8898	1.72	4.72
Plastic Industries	20	3.3390	.93661	.20943	2.9007	3.7773	1.56	4.89
Chemical Industries	16	3.0206	1.19656	.29914	2.3830	3.6582	1.00	5.00
Pharmaceutical Industries	17	3.9733	.63901	.15498	3.6448	4.3019	2.17	4.67
Wood and furniture	15	3.2478	.80821	.20868	2.8002	3.6954	1.72	4.44
Food Industries	46	3.6257	.85114	.12549	3.3729	3.8784	1.72	4.83
Metal Industries	10	3.2777	.47082	.14889	2.9409	3.6145	2.44	4.11
Others	2	1.2783	.39362	.27833	-2.2582	4.8149	1.00	1.56
Total	147	3.4477	.91978	.07586	3.2978	3.5976	1.00	5.00
تخطيط مجرى القيمة (Value Stream Mapping)								
Paper Industries	21	3.2210	1.03498	.22585	2.7498	3.6921	1.33	5.00
Plastic Industries	20	3.0005	1.13452	.25369	2.4695	3.5315	1.00	4.67
Chemical Industries	16	2.8538	1.27611	.31903	2.1738	3.5337	1.00	5.00
Pharmaceutical Industries	17	3.7641	.71282	.17288	3.3976	4.1306	2.00	4.33
Wood and furniture	15	3.1773	.73298	.18926	2.7714	3.5832	2.00	4.33
Food Industries	46	3.3335	1.07736	.15885	3.0135	3.6534	1.00	4.67
Metal Industries	10	3.2990	.65560	.20732	2.8300	3.7680	2.33	4.33
Others	2	1.5000	.70711	.50000	-4.8531	7.8531	1.00	2.00
Total	147	3.2265	1.03795	.08561	3.0573	3.3957	1.00	5.00
كايزن التحسين المستمر KAIZE (N))								
Paper Industries	21	3.5700	.96256	.21005	3.1318	4.0082	1.33	5.00
Plastic Industries	20	3.2490	1.04137	.23286	2.7616	3.7364	1.00	5.00
Chemical Industries	16	3.1244	1.28142	.32035	2.4416	3.8072	1.00	5.00
Pharmaceutical Industries	17	3.9794	.74029	.17955	3.5988	4.3600	2.00	5.00
Wood and furniture	15	3.1107	.94813	.24481	2.5856	3.6357	1.33	4.67
Food Industries	46	3.6883	.94322	.13907	3.4082	3.9684	1.33	5.00
Metal Industries	10	3.4650	.81937	.25911	2.8789	4.0511	2.33	5.00
Others	2	1.1650	.23335	.16500	-.9315	3.2615	1.00	1.33
Total	147	3.4754	1.02540	.08457	3.3083	3.6426	1.00	5.00

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	
					Lower Bound	Upper Bound			
العمل القياسي (Standardized Work)	Paper Industries	21	3.5386	.96287	.21011	3.1003	3.9769	1.67	5.00
	Plastic Industries	20	3.4665	.95087	.21262	3.0215	3.9115	1.67	5.00
	Chemical Industries	16	3.2081	1.25179	.31295	2.5411	3.8752	1.00	5.00
	Pharmaceutical Industries	17	4.0588	.62590	.15180	3.7370	4.3806	2.67	5.00
	Wood and furniture	15	3.2213	.83299	.21508	2.7600	3.6826	2.00	4.67
	Food Industries	46	3.7600	.87680	.12928	3.4996	4.0204	1.33	5.00
	Metal Industries	10	3.5650	.70458	.22281	3.0610	4.0690	2.33	4.67
	Others	2	1.1650	.23335	.16500	-.9315	3.2615	1.00	1.33
	Total	147	3.5594	.96427	.07953	3.4022	3.7166	1.00	5.00
الإدارة المرئية (Visual Management)	Paper Industries	21	3.5233	.92927	.20278	3.1003	3.9463	1.72	5.00
	Plastic Industries	20	3.3413	.98645	.22058	2.8797	3.8030	1.61	5.00
	Chemical Industries	16	3.1738	1.10040	.27510	2.5874	3.7601	1.00	5.00
	Pharmaceutical Industries	17	4.0224	.75742	.18370	3.6329	4.4118	2.06	4.83
	Wood and furniture	15	3.2513	.83526	.21566	2.7888	3.7139	1.72	4.39
	Food Industries	46	3.6603	.88726	.13082	3.3968	3.9238	1.00	4.78
	Metal Industries	10	3.4780	.74547	.23574	2.9447	4.0113	2.39	4.56
	Others	2	1.1100	.15556	.11000	-.2877	2.5077	1.00	1.22
	Total	147	3.4974	.95700	.07893	3.3414	3.6534	1.00	5.00
التصميم الخليوي (Cellular Design Manufacturing)	Paper Industries	21	3.4119	.89354	.19499	3.0052	3.8186	1.67	5.00
	Plastic Industries	20	3.2670	.94581	.21149	2.8243	3.7097	1.33	4.67
	Chemical Industries	16	3.1450	1.22345	.30586	2.4931	3.7969	1.00	5.00
	Pharmaceutical Industries	17	3.9206	.66184	.16052	3.5803	4.2609	2.33	5.00
	Wood and furniture	15	3.4000	.81922	.21152	2.9463	3.8537	2.00	4.67
	Food Industries	46	3.7465	.91371	.13472	3.4752	4.0179	1.67	5.00
	Metal Industries	10	3.5650	.65046	.20569	3.0997	4.0303	2.33	4.67
	Others	2	1.6650	.94045	.66500	-6.7846	10.1146	1.00	2.33
	Total	147	3.5121	.94382	.07784	3.3583	3.6660	1.00	5.00

ANOVA (Sector)

		Sum of Squares	df	Mean Square	F	Sig.
وهي تمثل خمسة خطوات (5S) لتنظيم مكان العمل	Between Groups	20.413	7	2.916	3.825	.001
	Within Groups	105.983	139	.762		
	Total	126.396	146			
الإنتاج في الوقت المحدد (Just-In-Time)	Between Groups	16.863	7	2.409	3.322	.003
	Within Groups	100.797	139	.725		
	Total	117.660	146			
الصيانة الإنتاجية الشاملة (Total Productive Maintenance)	Between Groups	19.650	7	2.807	3.757	.001
	Within Groups	103.866	139	.747		
	Total	123.515	146			
تخطيط مجرى القيمة (Value Stream Mapping)	Between Groups	14.736	7	2.105	2.053	.053
	Within Groups	142.557	139	1.026		
	Total	157.293	146			
كايزن التحسين المستمر (KAIZEN)	Between Groups	22.260	7	3.180	3.368	.002
	Within Groups	131.251	139	.944		
	Total	153.510	146			
العمل القياسي (Standardized Work)	Between Groups	21.428	7	3.061	3.722	.001
	Within Groups	114.326	139	.822		
	Total	135.754	146			
الإدارة المرئية (Visual Management)	Between Groups	20.394	7	2.913	3.574	.001
	Within Groups	113.320	139	.815		
	Total	133.714	146			
التصميم الخلوي للتصنيع (Cellular Design Manufacturing)	Between Groups	15.973	7	2.282	2.780	.010
	Within Groups	114.083	139	.821		
	Total	130.056	146			
تقليل وقت التشغيل وتغيير القوالب (SMED) Setup Time Reduction and Single Minute Exchange of Die	Between Groups	21.413	7	3.059	4.158	.000
	Within Groups	102.253	139	.736		
	Total	123.667	146			
تصغير حجم الحزمة الإنتاجية (Smaller Lot Size)	Between Groups	20.053	7	2.865	3.434	.002
	Within Groups	115.961	139	.834		
	Total	136.014	146			
Overall	Between Groups	18.786	7	2.684	3.913	.001
	Within Groups	95.334	139	.686		
	Total	114.120	146			

الملخص

استخدمت مبادئ وأدوات التصنيع الخالي من الهدر (LM) من قبل شركات التصنيع في جميع أنحاء العالم لتحقيق التميز التشغيلي واكتساب ميزة تنافسية في السوق. ويعتقد أنه يمكن إدخال مبادئ وأدوات التصنيع الخالي من الهدر لمساعدة الشركات في تحقيق إنتاج فعال وكفاء مما سيؤدي إلى أداء أفضل للأعمال.

يسعى هذا البحث إلى معرفة مدى استخدام أدوات وممارسات التصنيع الخالي من الهدر من قبل المنشآت الصناعية في رام الله ومعرفة العلاقة بين بعض خصائص هذه المنشآت ومستوى استخدام هذه الأدوات. اعتمد هذا البحث على المنهج الكمي، واستخدمت عينة عشوائية لاستهداف 181 مجيب، بينما تمكن 147 مجيب من إتمام وإجابة الاستبيان. تم جمع البيانات باستخدام استبيان منظم يتكون بشكل أساسي من أسئلة محددة ومغلقة وتم تحليلها باستخدام الإحصائيات الوصفية والاستنتاجية. تركز الأسئلة على الأدوات الأكثر استخدامًا من أدوات التصنيع الخالي من الهدر وعليه تم اختيار عشر أدوات مرتبطة بهذا الموضوع وهي: خطوات تنظيم مكان العمل 5s، الإنتاج في الوقت المحدد JIT، الصيانة الإنتاجية الشاملة TPM، تخطيط مجرى القيمة VSM، التحسين المستمر KAIZEN، العمل القياسي Standardized Work، الإدارة المرئية VM، التصميم الخوي للتصنيع CDM، تقليل وقت التشغيل وتغيير القوالب، وتصغير حجم الحزمة الإنتاجية.

يستند الدافع وراء هذا البحث إلى الفوائد العظيمة لاستخدام أدوات التصنيع الخالي من الهدر ومحدودية الأبحاث التي تنطرق لهذا المجال في السياق الفلسطيني، وبالتالي فإن الحاجة إلى فهم الوضع الحالي وصياغة نظرة عامة للمنشآت الصناعية هي خطوة أساسية نحو تصميم وتخطيط البحوث والتدخلات المستقبلية.

تشير نتائج هذا البحث إلى مستوى متوسط إلى مرتفع من استخدام أدوات التصنيع الخالي من الهدر في المنشآت الصناعية في رام الله، ويعتمد هذا المستوى من الاستخدام على مجموعة متنوعة من العوامل، بما في ذلك حجم المنشأة وقطاع الصناعة، في حين أن نوع الملكية (ملكية عائلية، ملكية غير عائلية) ليس له تأثير على مستوى الاستخدام.

يساهم هذا البحث في المعارف الموجودة لا سيما في السياق الفلسطيني، من خلال توفير رؤى حول الأدوات والممارسات داخل المنشآت الصناعية حيث تتوفر أبحاث محدودة حول هذا الموضوع.

(الكلمات المفتاحية: التصنيع الخالي من الهدر، أدوات التصنيع الخالية من الهدر، استخدام أدوات التصنيع الخالي من الهدر، المنشآت الصناعية الفلسطينية).