



**Arab American University  
Faculty of Graduate Studies**

**The Readiness of the Palestinian Dairy Industry  
towards Implementing Statistical Process Control**

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the Master's degree in Quality Management.**

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**Implementing Statistical Process Control**

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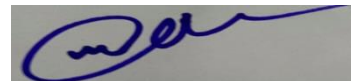
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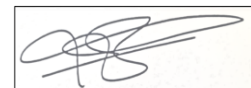
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## Declaration

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*My dearest husband, who light my life, for your support that cheered  
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**"SALAH"**

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**"DIYAA"**

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## Abstract

Statistical process control (SPC) is less practiced by practitioners and less addressed by research in developing countries than in developed countries. This study empirically investigates the readiness of the Palestinian dairy firms to implement the SPC methodology. More specifically, this study aims to detect the perceived determinants of implementing SPC and assess the readiness level of SPC implementation considering two perspectives: the organizational and methodological requirements. Finally, it examines if there are differences in readiness among dairy firms based on their demographic characteristics, including size, quality accreditation, or age.

Both quantitative and qualitative methods are used in this descriptive cross-sectional study; The study population consisted of all the 15 Palestinian dairy companies listed in the Palestinian Ministry of The National Economy (MNE) records. A sample of 10 dairy companies was selected using the convenience sampling method. Eleven semi-structured interviews were conducted with key actors in the sector; interviewees are government officials and industry managers. Then, of the 65 distributed questionnaires, 37 usable questionnaires were returned for quantitative analysis. Descriptive, inferential statistical analyses and regression are used to analyze quantitative data. While thematic analysis is used to analyze qualitative data.

The main qualitative findings show that the Palestinian dairy producers are ready for the SPC implementation process regarding top management commitment, measurement system, process performance, and testing parameters. However, they are not prepared for this process regarding the organizational culture, urgency to change, employee involvement, and quality control tools.

On the other hand, the main quantitative findings show that the respondents have a high level of readiness for the SPC implementation process in terms of top management commitment, process performance, and testing parameters. In comparison, they have a moderate level of readiness for this process in terms of the measurement system and employee involvement. Also, the respondents have a relatively low level of readiness for this process in terms of organizational culture, the urgency to change, and quality control tools.

Palestinian dairy firms differ in their readiness to implement SPC based on their quality system accreditation, but there are no significant differences between the respondents based on their size. Encouraging policies for quality accreditation will position dairy producers closer to SPC implementation. Besides, top managers must play a vital role in achieving a companywide understanding of SPC benefits by recruiting specialists and professionals in data analysis methods and formulating regular training programs about statistical thinking, data collection, and sampling plans for statistical stability and capability. Knowledge and effective implementation of quality control tools to improve their process performance is also required.

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# Chapter 1

## Introduction

### 1.1 Overview

The importance of quality in the food industry has grown implicitly over recent years. This is attributed to the increasing prospects of consumers as they have become more informed and more powerful, and more rigorous governmental regulations (ALquds, 2016). Besides, changes in consumption forms, continuous development of technologies, and increasing market competition raise the need for better quality products. Compared to other industries, food safety and health-relevant risks associated with poor quality add pressure on food producers to seek more efficient and effective managerial methods to improve their processes and products (Lim & Antony, 2019).

The complexity of the food production chain comprising farmers, ingredient producers, manufacturers, wholesalers, retailers, and food services firms drives the challenges facing the food sector to control the quality (Hubbard, 2012). On the other side of the chain, consumers enjoy comprehensive food supply types, enabling more flexible choices and raising their bargaining power (Madanhire & Mbohwa, 2016). Consumers have become very thoughtful about food quality and food safety due to several occurrences of contaminated food. So, quality assurance is of significant importance in the food sector, which builds and maintains consumers' trust in this sector (Luning et al., 2002); the dairy industry is not an exception.

Therefore, looking for ways to improve performance, food companies try to interpret the legal regulations and customer requirements by introducing quality management

systems that may guarantee food safety and quality. However, each company decides to establish a quality program. Yet, food companies may adopt several internationally recognized quality systems.

Organizations evolve flexibly with more coordinative teams and technology-driven business processes to improve their capabilities. Consequently, organizations focus on creating more valued outputs and gaining a competitive position (Abdolvand et al., 2008). Owing to this fact, Statistical Process Control (SPC) is a practical methodology for reducing process variability by identifying special causes of variations, then removing them, and standardizing the process (Junior et al., 2020).

The benefits of SPC implementation in the food industry include, among others, inconsistency reduction, safety control, and cost-saving (Lim et al., 2014). Implementing SPC facilitates the implementation of HACCP or other quality systems (Rique Junior et al., 2020).

Despite the reported successes of implementing SPC in many manufacturing sectors (e.g., automotive, plastic, and semiconductors), the SPC methodology is not widely applied in the food sector (Sarina Abdul Halim Lim & Antony, 2016) and lagging behind other sectors (Dora et al., 2013). Because implementing the SPC methodology is not a mandatory requirement, it is argued that it is less practiced in the food sector.

SPC advocates stress the role of commitment of top-level management as the dominant success factor for implementing SPC. It is worth noting that food producers invested little effort beyond legal requirements in their continuous improvement journey (Waterson et al., 1999). At the same time, Lack of adequate training, lack of awareness of the benefits of implementing SPC, and resistance to change are frequently mentioned

in the literature as forces behind not implementing the SPC methods (Lim et al., 2017; Madanhire & Mbohwa, 2016).

Recently, food industries in developing countries have paid greater attention to the quality of their products. The reasons include facing the global rapid multilayered competition, complying with the government regulations, or meeting the increasing customer demand (Madanhire & Mbohwa, 2016). Even though regardless of the industry type, the deficiencies in implementing SPC in developing countries are not uncommon (Madanhire & Mbohwa, 2016).

Then, a concern among food producers and researchers seems to be valid about the vital role of readiness of food companies to implement the SPC successfully. The dairy industry is not an exception. To improve the likelihood of successful implementation of SPC, it is a valid research inquiry to assess the organizational readiness towards adopting the methodology. Therefore, dairy producers may use the generated information about their preparedness to improve their adoption behaviors and become more likely to harvest SPC adoption benefits while avoiding the associated failure costs.

To sum up, because organizational readiness is an understudied topic in the continuous improvement (CI) literature (Antony, 2014), this thesis aims to explore the status of SPC in the Palestinian dairy industry by gauging SPC implementation and examining the Palestinian dairy companies' readiness to adopt this methodology.

## **1.2 Palestinian Context (Research Setting)**

Israeli policies have intentionally kept the Palestinian business environment far below average and led to a poor investment climate. The Israeli policies are reflected in a multilayer Israeli closure regime that aims to leave the Palestinian economy in a highly

fragmented shape and Israeli control of borders to restrict the movement and access of goods, businessmen, and investors (Paltrade, 2010). Israel has the upper hand in controlling production inputs, about 85% of the raw materials used by the Palestinian industry come from or through Israel (Palestinian Food Industries Union [PFIU], 2016).

Since its establishment in 1994, the Palestinian Authority faced an unregulated economy due to closure and occupational siege policy; thus, rebuilding our national economy requires an intensive development effort and a comprehensive development strategy. The industrial sector has an essential role in pushing the development process and re-correcting the troubles in the structure of the national economy (Algerian Encyclopedia of Political and Strategic Studies, 2018).

The industrial sector played the most considerable role, which requires finding Palestinian manufacturing policies to develop the Palestinian industrial sector, mainly to increase its contribution to the gross domestic product (PFIU, 2016). The industrial sector contributes 13% of the GDP for 2019, as the total Palestinian industrial sector exported around one billion US dollars for 2019. And 21 thousand industrial companies are operating in Palestine, which has grown by 3% compared to 2018; these companies employ 122 thousand workers, an increase of 7.9% compared to 2018. Nevertheless, the sector is underutilized in Palestine; it only works at about 50% of its production capacity. The industrial sector's contribution to the Gross Domestic Product (GDP) was more than 30 years ago, and it was in the range of only 8%, which is a low percentage compared with that percentage in Jordan of about 27%. It is estimated to be 21.5% in Israel during 1993.

The Palestine Standards Institution indicated that there are 4,300 Palestinian standards and 71 industrial companies with quality certificates (Palestinian Central Bureau of Statistics [PCBS], 2020). Despite the remarkable achievements of many Palestinian companies and the evolving institutional role of the government, Palestine has difficult conditions due to the occupation that prevented its development and growth (Algerian Encyclopedia of Political and Strategic Studies, 2018):

- 1 There are problems accessing raw materials, high prices, and delays in receiving them due to the crossings' security checks and continuous closures.
- 2 The high cost of production since most of the machines and equipment used in the factories are either old or outdated in technology. Inefficiency leads to their failure in many cases, which increases the cost of maintenance and the obstacles that industrial facilities face in importing modern machinery and equipment due to Israeli restrictions. Imposing customs duties on it and difficulties in clearing and security checks
- 3 Problems related to the infrastructure services, including water, electricity, and sewage. In addition to communications and transportation, all these services have become necessary for advancing the industrial sector.
- 4 Unfair and unequal competition between products of local industry and products of Israeli industry
- 5 Problems related to the absence of policies, legislation, and laws, especially industrial development policies, and therefore there were no programs and plans for industrial development with clear objectives and milestones

- 6 Narrowing of the external marketing outlets and the lack of sufficient experience of most establishments operating in traditional industries in knowing the procedures and methods of external promotion. In addition to the complexity and disruption of the export process in many cases due to the closure of the crossings and the barriers set up by the occupation authorities

The industry sector is considered a vital sector; it is regarded as the most important sector in any country's economy. Therefore, the development of the industrial sector must be considered in the strategies of governments. Industry growth correlates with economic growth rates, provides local products, and helps develop them to meet internal needs and external export. Besides creating job opportunities, the unemployment rate in the Palestinian workforce (15 years and more) for the year 2019 was about 25% (PCBS, 2019).

### **1.2.1 Palestinian Food Sector**

An estimated 1.6 million Palestinians across the occupied Palestinian territory, or 31.5% of households, are food insecure (as of 2017). This results from high unemployment, low household incomes, and a high cost of living. These refer to the protracted conflict, repeated shocks and continued restrictions on freedom of movement, constrained productive capacities, and lack of economic opportunities. Although food is available, it is priced out of reach for many. Numerous households are food insecure even though they already receive food and other assistance (United Nations Office for Cooperation of Human Affairs [OCHA], 2021).

Thus, to achieve food security for the Palestinian people, the food industry sector is one of the most important transformative industries contributing to economic indicators such

as GDP, employment, and foreign trade in Palestine. Furthermore, the importance of this sector is highlighted through its close association with the agricultural sector as a source of raw materials used in this industry, so any growth in one of them would be reflected in the prosperity of the other industry (Palestine Economic Policy Research Institute [MAS], 2019b).

The food industries sector contributed, on average, about 22.2% of the GDP in Palestine during the period 2010-2016 .Whereas, at the end of 2017, the number of food industry companies was about 3,038. It has increased by 47.4% since 2010, coupled with increased investments in this sector. And many of them have certifications such as ISO and HACCP (MAS, 2019b).

As for the number of workers in the food sector; it increased from 10,098 workers in 2010 to 17,583 workers in 2017, and the food industry employs 5.18% of the total workforce in the industrial production sector. Consequently, it ranked first among the productive sectors regarding workforce employment in 2017 (MAS, 2019b).

The value of exports of manufactured food commodities in Palestine for 2017 amounted to about \$ 117 million, or 11% of the total foreign exports. As for imports of manufactured food commodities, their value in 2017 amounted to about \$ 871 million, or 15% of the entire Palestinian imports (MAS, 2019b).

The Central Bureau of Statistics indicates that the Palestinian family spends approximately (36%) of its budget on food, which allows these industries to grow significantly to meet this large volume of demand (PFIU, 2021).

Many difficulties are affecting the productivity of Palestinian food factories and the competitiveness of their products, including (MAS, 2019b):

- Limited research and development activities for food factories to develop new products is due to the lack of necessary infrastructure. As a result, there is a lack of diversity in local food products compared to imported products, especially Israeli ones. Therefore, the Lack of diversification and development in local products will push the consumer to choose imported products because it provides the diversity that meets all his needs and desires.
- A large percentage of food factories do not adopt quality control systems to ensure the consistency of the quality of the manufactured product. This is evident from the decrease in the number of products that have obtained the Palestinian Quality Certificate due to applying the Palestinian standard issued by the Palestine Standards Institution and the decline in the number of factories that implement the ISO 22000 standard (regarding food safety). Usually, factories that adhere to the ISO 22000 standard incur high costs, making obtaining this certificate more difficult, especially for medium and small factories.
- Consequently, efforts must be made to gain more countries' recognition of the Palestinian Quality Certificate issued by the Palestine Standards Institution PSI to facilitate export and reduce inspection costs when exporting. And increase the acceptance of foreign markets for Palestinian food products. This can be started by expediting the completion of the recognition agreement for the Palestinian Quality Certificate and Export Conformity Certificate.

### **1.2.2 Palestinian Dairy Sector**

Since 1988, the dairy industry in Palestine started as a commercial industry and expanded until it became an essential part of the Palestinian industry (ALquds, 2016). Not long ago, the presence of livestock was a necessary thing in the house to obtain daily sustenance from milk and cheese made inside the house and caring for these sheep and milking them was the task of the household.

There are many dairy companies in Palestine, it's around 15 companies, and the larger market share was occupied by three companies, namely Al-Junaidi, Al-Jabreeni, and Hammouda. Following them, other factories, namely Al-Safa, Al-Pinar, Al-Rayyan, and Al-Marai, these four factories are considered to be approximately the same size in market share (ALquds, 2016). Until 2000, all these companies relied directly on Israeli farms except for the Al-Safa Company. The dependence on Israeli milk reached 80%, except in some factories (ALquds, 2016).

Also, directly and indirectly, 45 factories are operating in the dairy sector and employ about 3 thousand workers, including farmers, plastic packaging manufacturers, veterinarians, and others (Ministry of National Economy, 2018). The dairy products industry comes second in terms of workforce employment at the food industry level, as it employs about 1968 workers, according to 2017 statistics (MAS, 2019b).

Referring to the Ministry of National Economy 2018 statistics, dairy products in the local market acquire 80% of the Palestinian market share, with an investment value estimated at \$ 70 million annually.

PFIU (2018) reported that the production capacity of dairy factories ranges from 550 to 600 tons per day, and essential commodities such as labneh, milk, and white cheese cover about 90% of the local market, and it is the primary commodity in the dairy sector.

On the other hand, according to PFIU, the dairy sector is considered the least qualified sector in terms of international quality certificates and ability to export, as exports do not exceed \$ 5 million. Accordingly, this industry needs to diversify products, introduce new items, and adopt new methods and techniques for managing and controlling product quality, which means there are great opportunities for investment in this field.

Palestinian dairy production requires tools capable of optimizing its processes to reduce the cost of production by following Palestinian and international quality standards of food processed and adopting new technologies in production. So, the SPC is a powerful tool to evaluate and monitor the process concerning its stability.

Only a few research studies cover quality control techniques within developing countries' settings (Rai, 2008). None of these tackles the Palestinian dairy sector, so we tend to fill this gap in this thesis and add to the knowledge of applying SPC tools in Palestine.

### **1.2.3 Palestine Standards Institution (PSI)**

PSI is a public institution established in 1994 according to a presidential decree issued by President Yasser Arafat; however, it started operations in 1997. PSI seeks to ensure high competitiveness of Palestinian products and facilitates trade, contributes to protecting the health and safety of the Palestinian citizen and environment by

developing internationally harmonized Palestinian standards and providing testing, inspection, and metrology services as well as certification and conformity marks (Palestine Standards Institution [PSI], 2021).

The institution develops standards within different Palestinian fields as food, agriculture, cosmetics, chemicals, plastics, textiles, leather, petroleum, construction, engineering products such as hydrologic and mechanical equipment, tools, information technology, management, and environment, in addition to services following the law of standard and metrology NO.6 of 2000 (Palestine Standards Institution [PSI], 2021).

According to PSI, these standards' leading roles and benefits are increasing productive efficiency, improving production quality, reducing costs, and protecting materials and resources (Palestine Standards Institution [PSI], 2021).

The PSI issues four types of certificates which are Quality Mark (PS), Supervision Mark, Halal, and conformity (QMS ISO9001) certificates, according to the internal certifications system (the Palestinian Quality Mark No. 1/2004) and its five annexes (Palestine Standards Institution [PSI], 2021).

A Palestinian Quality Mark Certificate (PS) is the most common certificate within Palestinian markets. It represents proof that the products meet the quality requirements of the Palestinian standards. It is perceived as a tool to achieve total quality management to meet consumer needs. It facilitates access to new markets and the marketing of products outside the country, especially in countries that signed the mutual recognition regarding quality certificates, etc. (Palestine Standards Institution [PSI], 2021).

Seventy companies from various Palestinian sectors hold the PS certificate, 29 are food companies, and 4 are dairy companies. These are “Al-Hamoudeh for Food & Dairy Product Ltd.”, “Al-Juneidi Dairy & Food Stuffs Co.”, and “Azzakat Rehabilitation Dairy Plant (Alsafa),” “Al-Jebrini Investments Co.” (Palestine Standards Institution [PSI], 2021).

Secondly, a Palestinian Supervision Certificate (PSM Mark) is issued for 29 certified companies from various Palestinian sectors, none of which are food companies. Thirdly, a Palestinian Halal Certificate. This certificate is certified by two companies from Hebron and Jericho; they are food companies but not dairy companies. Finally, according to PSI, a pal-QMS ISO9001 certificate has not been issued to any company (Palestine Standards Institution [PSI], 2021).

Also, according to the PSI data, two recent certificates are still under development and have not yet been confirmed: the Service providers Certificate and Personnel certificate (Palestine Standards Institution [PSI], 2021).

### **1.3 Research Problem**

Given the transitional socioeconomic evolution in Palestine during the last decade, the Palestinian dairy industry shows significant growth coping with increasing demand. The market competition also motivates firms to improve quality, develop new products, and look for new business methods. Many quality initiatives are steered to satisfy customers’ needs, and new quality departments are established. Local and international accreditation institutions find their way to the dairy industry in Palestine, such as PSI (Palestine Standards Institution) and ISO. Nevertheless, the number of valid ISO 9001

(Universal Quality Management System) certificates in Palestine lags behind many neighboring countries; 152 ISO certificates are valid in Palestine, 396 in Lebanon, and 6864 in Jordan (ISO, 2016).

Still, adopting the SPC methodology and other quality control techniques lag behind many other countries. This may be attributed to many independent variables that influence decisions and priorities (Massoud et al., 2010). For example, the perceived cost of quality management, the lack of management support, the lack of knowledge, and the lack of measurement tools may explain their performance (Madanhire & Mbohwa, 2016). This research examines these guesses by investigating the Palestinian dairy producers' readiness to implement SPC.

The benefits of implementing (the SPC) methodology are well documented in the literature (Lim et al., 2017). However, evidence shows successful implementation and advantages achieved through SPC in industries like the automotive and less success in the food industry (Van der Spiegel et al., 2003). SPC applications in western manufacturing companies show that SPC application in the food industry is minimal (Noordhuizen & Metz, 2005).

From the above perspective, this thesis targets the dairy food industry to explore the reality of SPC application and adoption in developing economies, namely in Palestine, to help managers capture the gaps and areas for improvement.

#### **1.4 Research Questions**

This research work attempts to answer the following research questions:

RQ1) What are the perceived determinants of implementing SPC in the Palestinian dairy industry?

RQ2) How well prepared, regarding organizational requirements, are the Palestinian dairy firms to implement SPC?

RQ3) How well prepared, regarding methodological requirements, are the Palestinian dairy firms to implement SPC?

RQ4) Are there differences between dairy firms based on their size or accreditation regarding the level of readiness to implement SPC?

## **1.5 Research Objectives**

This research investigates the readiness of Palestinian dairy firms to implement SPC methodology as part of continuous improvement efforts. This effort searches for the barriers and possible potentials among Palestinian firms in the dairy industry. The following procedural steps may briefly describe the researcher's plan:

- To detect the perceived determinants to implement SPC in the Palestinian dairy industry.
- To assess the readiness extent of SPC implementation regarding organizational requirements of the Palestinian dairy firms.
- To assess the readiness extent of SPC implementation regarding methodological requirements in the Palestinian dairy firms.

- To examine if there are differences between dairy firms based on their size or accreditation regarding readiness to implement SPC within the Palestinian dairy sector.

## 1.6 Research Significance and Justifications

Despite the evidence of the benefits achieved by implementing SPC in the food industry (Lim et al., 2017), it has been observed that its implementation in this field is lagging behind other manufacturing industries (Dora et al., 2013). The dairy industry is highly susceptible to incidents affecting products' public image; therefore, the sector actors' awareness of improving quality is essential for its growth. This is where SPC helps control the production processes within acceptable levels (Ittzés, 2001; Madanhire & Mbohwa, 2016).

The benefits of SPC implementation as a proactive approach to control quality are well documented (Halim Lim et al., 2017). SPC tools are widely applied to improving manufacturing processes, but very few studies have reported on the successful implementation of SPC in the food industry (Dweekat et al., 2013; Lim et al., 2017)

The Palestinian food industry contributes 4% of the country's GDP and 22% (more than one-fifth) of the overall manufacturing contribution. The dairy industry employs 11.4% of the manufacturing labor (1968 employees in 2017). Notably, despite the decrease in the food industry's market share from 50.8% in 2010 to 39.59% in 2017, the dairy industry showed a remarkable increase in market share from 45.82% in 2007 to 57% in 2017 (MAS, 2019a).

This research may enhance understanding of the basics to employ the SPC methodology among Palestinian dairy producers. It is expected to generate information that helps managers capture areas for improving their products while reducing the assignable causes in their production processes. The results may also help managers gauge their position concerning SPC implementation and estimate budgets for quality enhancements.

### 1.7 Research Methodology

A mixed research methodology (Qualitative & Quantitative) was employed to answer the research questions. The researcher obtains data from different sources and compares them to reach the most truly reliable sources to achieve the study objectives.

### 1.8 Definitions

**Statistical Process Control (SPC):** SPC is a powerful problem-solving valuable tool in achieving process stability and improving capability by reducing variability (Montgomery, 2012).

**SPC Readiness:** the organizational ability to accept and support SPC initiation as common practice for successfully implementing SPC and sustaining the stability of their processes (Lim & Antony, 2019).

**Adoption** is taking up or starting to use, following, and getting the benefits.

**Dairy Companies:** refer to active companies that produce dairy products (transform milk and other ingredients into dairy products), and it is registered within the Palestinian Ministry of the National Economy.

## 1.9 Organization of the Thesis

This thesis is structured as follows.

**Chapter 1** introduces the food industry, the dairy sector's unique characteristics, and the Palestinian context in specific. Research problem, significance, justification, research objectives, and finally, research questions are introduced.

**Chapter 2** provides a theoretical background to summarize theories and frameworks for the successful implementation of SPC. An overview of SPC methodology, SPC readiness, SPC in the food industry, SPC benefits, challenges, and limitations within the food industry, SPC application in the food sector, (SPC) application in the dairy company, and Palestinian dairy industry overview. **Chapter 3** covers the research methods, design, the generation of questionnaire items, and the data collection process. **Chapter 4** presents the data testing and the results of data analysis.

**Chapter 5** discusses the results considering previous studies, introduces managerial implications, and presents the primary conclusion of this research work.

## Chapter 2

### Literature Review

#### 2.1 Introduction

Talking about ‘quality’ often means the ‘excellence’ of a product or service. In some manufacturing companies, quality indicates that a product conforms to identified physical characteristics. So, if we want to manage quality, we must recognize the acceptable requirements for the customer. To produce an output that meets the customer requirements, it is necessary to define, control, and analyze the process and what the inputs and outputs are once (the voice of the customers) is heard and satisfied (Oakland & Oakland, 2018).

The major factors in the process that cause variability in the quality of the finished product are people, equipment, and methods or technologies employed in the process (Edith & Ochubiojo, 2012). The continuous rejection of finished products, product scraping, and product recalls have severe financial impacts and let down the company’s image and public trust (Edith & Ochubiojo, 2012; Loader & Hobbs, 1999).

In identifying errors and defects during inspections, (Shingeo, 1986) defined inspection as an effort to detect the ‘unacceptable’ products found within the manufacturing process. Product inspection is not the route to good quality management; it’s based on detection, not prevention. Detection is costly and neither efficient nor effective, but, to gain successful quality management, prevention thinking is the main route (Oakland & Oakland, 2018).

In general, the inspection provides only ‘defective/non-defective facts without providing any insight on the variability; this drives companies to search for alternative techniques such as SPC. SPC investigates variability in food production to prevent product defects from happening earlier in the process and get a stable production process (Antony & Taner, 2003; Lim et al., 2014). Furthermore, based on Deming’s reaction chain, the SPC implementation can decrease product variability and translate it to fewer defects, less rework, reduced cost of poor quality, and subsequently allows product and process quality improvements.

Bearing in mind, SPC is not about plotting charts and pinning them to the walls of a plant or office; it must be a part of a company-wide adoption of ‘total quality and as the focal point of continuous improvement in business performance (Oakland & Oakland, 2018).

To successfully implement the SPC methodology, it must ensure that the company's environmental culture is ready for this change by identifying the essential requirements before the adoption process. According to Lim & Antony, 2019, the top management support, capable measurement system, organizational culture, the urgency to change, and employee involvement all represent the component of SPC implementation readiness. This thesis aims to explore the readiness for SPC implementation in developing countries, namely, within the Palestinian context.

## **2.2 Quality Control within Food Industry**

The food industry is known as highly perishable products. The source of variability and complexity may refer to that the food production chain has special characteristics such as a short shelf-life, heterogeneous raw materials, seasonality effects, and varied

harvesting conditions. These factors hugely affect storage, conditioning, processing, packaging, and quality control, making food quality management more complicated (Dora et al., 2013).

The food industry is expected to grow rapidly, especially in developing economies around the world. The branded supermarket and hypermarket chains, mainly from Europe and the United States, have increased their presence in developing countries. This increases the competitiveness among the different food manufacturers and suppliers since there would be more pressure to produce and manufacture better quality products. The use of more sustainable methods of making food supplies to ensure long-term business outcomes like quality control tools such as SPC becomes a request (Murray, 2007).

Today, food companies are working hard to improve the quality of their products. Therefore, the SPC methodology is used to maximize the effectiveness of production quality to ensure that the final product meets the pre-determined guidelines for safety, functionality, and overall customer expectations. Using this methodology, maintaining quality guidelines and all types of waste can also be reduced (Tamam & Abdelhaq, 2015).

Developed countries have introduced many advanced applications into the food industry (Bro, 1999; Martens & Martens, 2001). Some have incorporated SPC as an enhancing tool for engineering process control and improvement purposes (Mevik, Færgestad, Ellekjær, & Næs, 2001; Montague, Glassey, & Willis, 2003). Unfortunately, SPC techniques are still not widely used in the food industry, probably due to their

complexity and the lack of resources, particularly in small and medium scale food manufacturers (Srikaeo et al., 2005).

On the other hand, relatively little has been written on the successful application of SPC in the food industry (Grigg et al., 1998). The primary reason for the low usage of SPC tools is a lack of knowledge of process variation and its importance, particularly among senior managers. Although they recognize quality as an essential part of corporate strategy, they do not know what effective steps to take to carry out the strategy (Oakland & Oakland, 2018).

With the strains on resources and rising manufacturing costs in the manufacturing industry in developing countries, it becomes increasingly apparent that decisions must be made based on facts, not just opinions. Consequently, data must be gathered and analyzed. This is where SPC tools come in to help decision-making and determine if the process is operating at an acceptable level (Madanhire & Mbohwa, 2016).

## **2.3 Statistical Process Control: An Overview**

### **2.3.1 Statistical Process Control Background**

SPC was initially popularized in 1950 in the Japanese manufacturing industry by Deming, who elaborated on Shewhart's principles in 1920. However, it was not until 1980 that the western manufacturing industry rapidly adopted its applications (Srikaeo et al., 2005).

SPC applies statistical monitoring methods to ensure that processes operate at their full potential to produce a conforming product (Kanji, 2002). Any variations in the process that may affect the product's quality can be detected and corrected (Madanhire &

Mbohwa, 2016). The SPC methodology has been used to classify the process variations as either common (random) or assigned. One of the advantages of SPC is its ability to detect any particular cause variation or process shift; therefore, effective corrective action can be taken before any defective product is accrued.

Hence, SPC is a powerful problem-solving tool useful in achieving process stability and improving capability by reducing variability (Montgomery, 2012). The main indicator of an effective SPC application is a stable process (Lim & Antony, 2019).

According to Madanhire & Mbohwa (2016), The critical steps for implementing SPC are:

- Identify defined processes
- Identify measurable attributes of the process
- Characterize natural variation of attributes
- Track process variation
- If the process is in control, continue to track
- If the process is out of control - identify the assignable cause - remove assignable cause - return to 'track process variation.'

Understanding the meaning of SPC is vital in implementing SPC in the food industry. There have been attempts to expand the concept of SPC beyond the process monitoring technique (Lim & Antony, 2019). As Oakland and Oakland, 2018 declare: SPC is not really about statistics or control; it is about competitiveness. This must start with the

senior management and flow down through the organization levels, the teamwork culture, and the management system used to drive SPC through an organization.

### **2.3.2 SPC Implementation Tools**

To maintain the consistency of a process and reduce production variability, it is assumed that the tools related to SPC are broad enough to include all techniques. There is no standard set of tools within SPC (Lim & Antony, 2019); however, there is a general agreement on seven tools; (1) Process flowcharting (what is done?). (2) Check sheets (how often it is done?). (3) Histograms (pictures of variation), graphs (pictures of variation with time). (4) Pareto analysis (prioritizing). (5) Cause and effect analysis (what causes the problem?). (6) Scatter diagrams (exploring relationships). (7) Control charts (monitoring variation over time). Understanding the tools and how to use them may provide helpful guidance in prioritizing the critical processes in implementing SPC (Oakland & Oakland, 2018).

The most popular tools in developing countries were the Check Sheets and Flow Charts, followed by Pareto Analysis as the third. The other five SPC tools did not have a significant application (Madanhire & Mbohwa, 2016). The poor application of Histograms, variable charts, cause& effect diagrams, and scatter diagrams calls for a need to restructure the companies' policies regarding SPC tools.

SPC control charts are the most popular tools for determining whether a process is under statistical control (Souza & Rigão, 2005). It is noteworthy that SPC uses control charts to indicate when there is something wrong with a process and that it is out of statistical control. A control chart is composed of three parallel lines; one central represents the target value (CL), the lower represents, the lower control limit (LCL), and

the upper one represents the upper control limit (UCL). Are presented on points representing the samples taken at various times of the process (Mason & Antony, 2000)

The control chart mechanism clarifies a process in the state in control by ensuring that the entire sample points fall between the control limits, indicating that there is no corrective action required. However, suppose the point falls outside of the control limits. In that case, the process is interpreted as an out-of-control state, indicating that they need investigations, feedback plans, and corrective action (Lim & Antony, 2019).

### **2.3.3 Types of Process Variation**

At the basis of the theory of SPC, it mainly belongs to the two categories of variation: firstly, the chance or random variation, which come from common causes, and secondly, the assignable or 'special' causes of variations. It is essential to differentiate between them. When only common causes of variation are present, the process is said to be stable or 'in statistical control.' Special reasons lead to an unstable or 'out of statistical control' process (Oakland & Oakland, 2018).

When random variations only exist, it will not be possible to trace their causes. For example, the common causes may include random variations such as atmospheric pressure or temperature changes, passing traffic or equipment vibrations, electrical or humidity fluctuations, and changes in operator physical and emotional conditions that produce variation in the quality of products. So, when only common causes of variations are present in a process, the process is considered to be 'stable,' 'in statistical control,' or 'in control'(Oakland & Oakland, 2018).

On the other hand, causes of variation that are relatively large and identified are classified as 'assignable' or 'special' causes. When special causes of variation are present, variation will be identified and reduced, and the process is classified as 'unstable', 'out of statistical control,' or beyond the expected random variations. Special causes include variations caused by the four seasons and tampering or unnecessary adjusting of the process when it is inherently stable (Oakland & Oakland, 2018).

All processes can stay 'under control' by gathering and using data for measurements of the performance of the process and the feedback required for corrective action. Once we have established an 'in control' process, we can meet the requirements (Oakland & Oakland, 2018).

To successfully implement SPC, there must be a commitment to quality, starting with the top management. It is essential to set down a quality policy and documented quality management system to manage variation and ensure that processes are under control. Thus eliminating assignable or special causes of variations in materials, methods, equipment, and information. Otherwise, there will be unjustifiable claims to customers or management, and no process control system will survive the lack of total management commitment. The failure to understand this will lead to a very high cost (Oakland & Oakland, 2018).

## **2.4 SPC Adoption Readiness**

There are complex and numerous factors required for the SPC implementation process. These factors are prerequisites for creating a suitable environment for SPC use (Antony

et al., 2000); hence, we are looking for in the scope of this study to assess the readiness of the Palestinian dairy industry to the implementation of SPC methodology.

Organizational studies investigate readiness under organizational change theories, where several researchers provide different definitions of readiness. Amongst them, SPC readiness refers to “*the organizational ability to accept and support the initiation of SPC as common practice for successfully implementing SPC and sustaining the stability of their processes*” (Lim & Antony, 2019).

In organizational studies, readiness is an essential concept under organizational change theories where several researchers provide different definitions of it, as shown in Table 2.1. Nevertheless, the readiness concept has been an understudied topic until now; there is no general definition of readiness given, as cited by (Lim & Antony, 2019).

Table 2.1 The Concepts of Readiness

<b>Readiness Concept / References</b>	<b>Definition</b>
<b>Organizational Change</b> (Armenakis et al., 1993)	Readiness as the cognitive precursor to the behaviors whether to support or resistant to the changes.
<b>A Study of Expanding Understanding of Change Message</b> (Bernerth, 2004)	Readiness is a state of mind reflecting a willingness or receptiveness to change the way one thinks.
<b>Technology Readiness</b> (Parasuraman, 2000)	Readiness is people’s propensity to embrace and use new technologies for accomplishing goals in home life and work.
<b>Organizational Change Readiness</b> (Weiner, 2009)	A state of being both psychologically and behaviorally prepared to take action (i.e., willing and able).
<b>Readiness of Higher Education Sector towards LSS</b> (Antony, 2014)	Readiness of Higher Education Sector towards Lean Six Sigma.

Source: (Lim & Antony, 2019)

Nevertheless, the SPC implementation in the food industry is relatively slow despite the success of SPC in the manufacturing industry (e.g., the automotive industry) (Lim et al., 2014). Organizational readiness is essential for the effective and sustainable use of SPC.

Similar to SPC implementation, which is considered a new technology to be adopted in the food company, resistance to change was the most significant barrier to a successful SPC implementation in the food industry (Lim, Antony, & Albliwi, 2014; Surak, 1999).

The majority of the companies in the food industry refuse the fact that changes are needed in their process management practices. Hence, the food industry considers a conservative industry regarding quality improvement (Hubbard, 2012; Paiva, 2013). Therefore, accurate performance measurements, such as yield, scrap, rework, and customer satisfaction, are imperative in this step in the decision to implement SPC (Woodall & Montgomery, 2014).

Managing change is very important at each level. Moreover, it is more critical for the management to assess the organizational readiness before managing the transition. Nevertheless, the company-wide SPC adoption is challenged by employees' resistance to organizational changes (Surak, 1999). Therefore, it is crucial to consider organization preparedness to undertake SPC (Abdolvand et al., 2008; Antony, 2014; Coch & French, 1948; Lee & Lee, 2014; Self & Schraeder, 2009).

Regardless of the direction of changes, consecutively, it is imperative to assess:

- The readiness of the people;
- The willingness to embrace change; and
- The capability to implement change.

- How ready are people for the change?
- How willingly do people embrace change?
- How capable are people of implementing the change?

Therefore, based on the organizational theories explained above, the ‘readiness’ phase is significant to overcoming the resistance to change (Figure 2.1). Hence, a three-stage change model must be initiated at the ‘unfreezing phase’ to change the traditional employees' mindset and motivate the changing process (Lim & Antony, 2016; Lim & Antony, 2019).

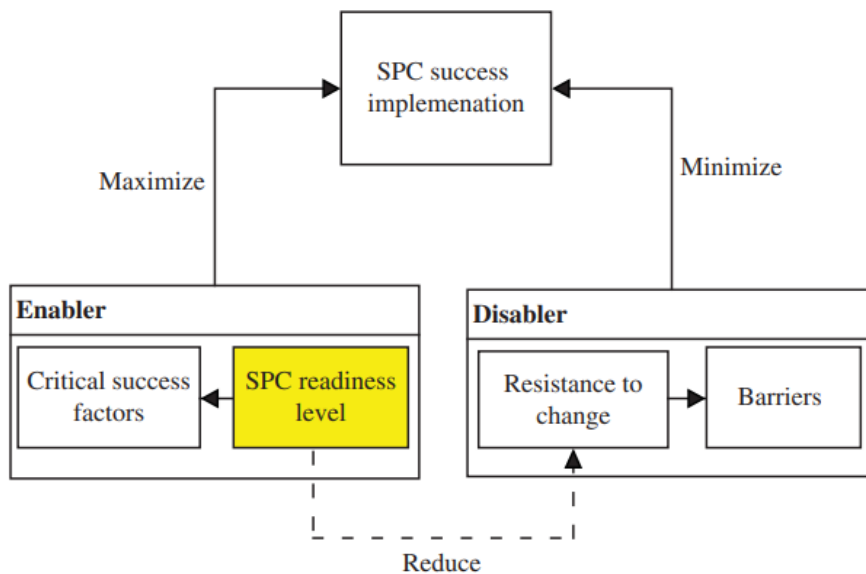


Figure 2.1 positioning SPC Readiness in SPC Implementation

Source: (Lim & Antony, 2016; Lim & Antony, 2019)

Lim & Antony, 2019 in their book “Statistical Process Control for the Food Industry,” addressed another approach to assess SPC readiness; this approach proposed key components for SPC readiness to evaluate the level of SPC implementation, which are: Top management support, Capable measurement system, Organizational culture, Urgency to change, and Employee involvement.

## 2.5 SPC Adoption Benefits (Drivers)

The benefits of applying statistical process control methods are many and varied. The improved process consistency reduces external failure costs – warranty claims, customer complaints, and loss of goodwill'. The reduction in internal failure costs – scrap, rework, wasted time, etc., leads to increased productivity by reducing the size of non-conforming products or services. The effective process control allows an overall reduction in the checking/inspection/testing efforts, often resulting in a reduction of total quality-related costs. A significant benefit is an improved reputation for consistent quality products or services. This ultimately results in expanding market share or improved effectiveness/efficiency (Oakland & Oakland, 2018).

Mainly, the benefits of the SPC implementation in the food industry are reduced process variation, improved food safety control, improved knowledge about the process variation, and cost savings (Lim et al., 2014).

The SPC implementation is vital to increasing understanding among employees of the processes and employees' ability to do troubleshooting and process diagnosis. There will also improve work efficiency and reduce the cost per production unit. The relationship with a customer will improve, reducing customer concerns and complaints (Lim et al., 2017).

When comparing companies based on their SPC adoption, SPC adopters outperform. Outperformance is supported by waste reduction, product consistency improvement, customer complaints reduction, defect rate reduction, productivity enhancement, and fewer rework percentages (Lim et al., 2014).

## 2.6 The SPC Adoption Barriers, Limitations, and Challenges

Previous evidence shows that many barriers to SPC implementation exist. They are resistant to change, lack statistical knowledge, lack management support, poor measurement system, lack practical guidelines to implement the SPC, lack employee empowerment, Lack trained employees, and Lack experience in using quality tools (Lim et al., 2017).

Furthermore, the most cited limitation of implementing SPC for the food industry was the lack of a fundamental mindset for statistical thinking. In addition, the SPC methodology is considered too advanced, existing manuals cannot comprehend food manufacturing applications, the Lack of usable and practical SPC guidelines for the food industry, and the SPC is regarded as a costly option (Lim et al., 2017; Lim et al., 2014).

Based on the Pareto analysis, the three common factors may limit food companies from gaining complete advantage of SPC implementation in their organizations. These are the lack of statistical thinking (ST), lack of usable and practical SPC guidelines for the food industry, and SPC perceived as too advanced for the use of food companies (Lim et al., 2014).

Additional, there are many reasons for failure when it comes to implementation of SPC, some of which are: lack of training and education, management commitment, not understanding the potential benefits fully, failure to interpret control charts and take any necessary actions, lack of knowledge of which product/process characteristics to monitor and measure and inadequate measuring system in place (Antony & Taner, 2003).

The most common reasons for not applying SPC were that most food companies were not aware of the benefits of its applications and had a lack of statistical knowledge to use SPC (Lim et al., 2017).

## **2.7 Quality Control within Dairy Industry**

Dairy products are easily polluted and deteriorate rapidly compared with general food products. During dairy processing, microorganisms from several sources (e.g., personnel, water, equipment, additives, and packaging materials) may contaminate products. In addition, dairy products are also potential to continue veterinary drugs, chemical pollutants, and microbial toxins (Papademas & Bintsis, 2010). Because dairy products are perishable foods, safety procedures need technical support (Tan et al., 2013), and the assurance of organization quality systems is also required. Thus, it is essential to analyze the features of the dairy supply chain to improve the safety and quality of dairy products (Wu et al., 2018).

The quality of food, such as milk and dairy products, may be defined as the sum of characteristics that enable the food to satisfy definite requirements fitness for consumers (Molnar, 1993; Mostert & Jooste, 2002). Milk is one of the main foodstuffs consumed by humans and a solid starting base in different human productive activities (Robinson 1994; Grădinaru et al., 2015).

Quality and safety issues occur more frequently upstream of the supply chain in the dairy industry, such as at the milk sources. The quality and safety of dairy products directly affect consumer health and safety, product brand image, and the dairy supply chain's competitive advantage and sustainable development. The increased consumer

awareness about food safety has imposed the dairy industry to improve the safety and quality image of dairy products (Pant et al., 2015; Valeeva et al., 2007)

In today's competitive global business environment, the dairy supply chain's quality and safety controllability requires an integrated strategy that addresses issues in supply chain design, traceability, informational visibility, regulatory environment, and coordination and cooperation. The quality control of raw milk sources is a prerequisite for assuring quality control throughout all dairy production stages (Ding et al., 2019).

## **2.8 Influence of Company Size and Accreditations on Food Quality Management (FQM)**

FQM refers to the approaches used to investigate food quality (Luning & Marcelis, 2007). SPC, one of the powerful techniques under FQM, is understood as a continuous and long-term improvement technique (Dora et al., 2013; Grigg & Walls, 2007). However, SPC implementation in the food industry is still low compared to other quality control tools as an effective roadmap. Hence, the implementation of SPC requires commitment and knowledge and a systematic strategy (Lim et al., 2015).

SPC is viewed as a component of other quality techniques implemented in the food industry, including Total Quality Management (TQM), Six Sigma, Lean Six Sigma, and various methodologies that are used to reduce waste through controlling process variation (Dalgiç et al., 2011; Dora et al., 2013; Pable et al., 2010; Paiva, 2013)

### **2.8.1 Influence of Company Size on FQM**

The agreed-upon differences between SMEs and large manufacturers concerning structure, policy-making procedures, resource utilization, staff patterns, culture, and

patronage (Welsh & White, 1981) pave the differences in adopting quality systems or quality levels.

Evidence from Greece suggests that the challenges of implementing quality assurance systems (QAS) in small food enterprises are more complex than in large ones because of their small size and limited resources (Aggelogiannopoulos et al., 2007; Lo & Humphreys, 2000). To adopt a QAS, small food enterprises need to believe that performance improvements are guaranteed because they are unwilling to invest in systems that promise only “potential” returns (Briscoe et al., 2005; Rodrìnges-Escobar et al., 2006).

Referring to (Anonymous, 1999; Bolton, 1997; Rodrìnges-Escobar et al., 2006), the main difficulties that small enterprises face in adopting and implementing a QAS are three. First, small enterprises do not often have a professional quality manager, which creates the need to hire external consultants. At the same time, the organization does not have the internal business qualifications (skills) to evaluate and select these consultants. Second, small enterprises lack the qualified personnel needed to implement such a system. Third, in most cases, the necessity of documentation is not well understood by the executives of small enterprises.

On the other hand, the extent of the difficulties that small enterprises face when adopting and implementing a QAS is reflected in the fact that the cost of implementing ISO refers to increasing the high fixed costs of quality system development, installation, and certification. This perception is also confirmed by some later research findings from the food and drink and the non-food industry (Aggelogiannopoulos et al., 2007; (Poksinska et al., 2006).

The primary factors which may motivate small food companies to adopt QAS are their positioning in the marketplace compared to the competition, the effect of poor quality, the quality culture, and the effectiveness of activities aiming to achieve quality goals (Karipidis et al., 2009).

In the developing economies, namely in Pakistan, small and medium-sized enterprises (SMEs) face challenges in adopting Quality Management practices since they have some characteristics that distinguish them from large businesses. Being resource constrained by nature, they usually cannot invest in formal certifications and the establishment of Quality Management systems. Particularly, SMEs' performance and business practices in developing economies remain much lower than those in developed economies (Kureshi et al., 2009).

Therefore, the company's size is a significant factor concerning quality management implementation, as medium-sized companies were more mature in FQMS implementation than their small and micro counterparts (Dora et al., 2013).

### **2.8.2 Influence of Accreditation on FQM**

In the food industry, several Quality Assurance systems (QAS) are available, like GMP (Good Manufacturing Practice), HACCP (Hazard Analysis Critical Control Points), ISO (International Organization for Standardization), and the international technical standard of BRC (British Retail Consortium). These systems and others are applied to assure food quality (Van der Spiegel et al., 2003).

Hence, food enterprises implementing QAS are driven by either their customers' pressure or by public authorities/government to ensure food safety and protect public

health, or by their belief that the benefits exceed all associated costs (Karipidis et al., 2009). Whereas Quality Assurance (QA) (e.g., HACCP, ISO) satisfies regulatory requirements and improves food quality safety (Dora et al., 2013).

### **2.8.2.1 Economic Benefits of the FQMS**

On the other hand, the main motivating factor for implementing the food quality management systems (FQMS) is improved product quality and safety, increased employee skills, improved company image, increased product sales, increased market share, and access to new markets. Besides that, it was observed that the companies that had FSMS implemented exported their food products to regional and/or international markets (Macheka et al., 2013).

By adopting a food quality and food safety management system (FSS) and signaling it to the consumers, a company gains marketing advantages and competitive advantages (Cao et al., 2004).

On the other hand, the legal requirements, the improvement of a firm's reputation, improved relationship with its customers, and reduced costs may motivate many businesses for HACCP implementation (Khatri & Collins, 2007). Many companies still implement the ISO 9001 for external reasons, meaning that their motivation for obtaining the certificate as a marketing tool (Martínez-Costa et al., 2008)

The application of HACCP within an ISO 9001 QMS can result in a food management system that is more effective than the application of either ISO 9001 or HACCP alone, leading to enhanced customer satisfaction and improving organizational effectiveness (Sparling et al., 2001).

The five critical areas that should be considered by food companies that seek to implement both the ISO 9001 and HACCP systems effectively are: “product quality,” “operational performance,” and “financial performance.” These areas constitute the underlying structure of the critical factors that require attention (Kafetzopoulos & Gotzamani, 2014). Naser et al., 2004 found a positive relationship between ISO 9001 certification and financial performance.

According to Capmany et al., 2000, it has been observed that after a company received ISO 9000 certification, the marketing benefits (competitiveness) are more obvious than the company had expected they would be before accreditation. The impacts of implementing quality systems on agriculture and food products include customer satisfaction, product traceability, and better information on quality and sales (Karipidis et al., 2009).

When companies introduce quality assurance systems (QAS) become able to add a price premium for a high-quality product, then attract more buyers by creating consumer confidence and reputation, or a marketing edge (Hooker & Caswell, 1999). Also, the introduction of a QAS often leads to enhanced relationships with customers and suppliers, leading to increased sales and increased market share (Buttle, 1997; Karipidis, Tsakiridou, & Tabakis, 2005; Wenmoth & Dobbin, 1994).

Quality management systems such as ISO 9000 and QS 9000 have played an important role in advancing SPC usage in several industries (Rai, 2008).

### **2.8.2.2 Implementation Barriers of FQMS**

Companies from developing countries and emerging economies have problems complying with quality safety standards, mainly increasing additional costs of accreditation as certification, auditing, and quality assurance, which puts pressure on company profits in manufacturing countries. These effects need new strategies that help reevaluate the certification and accreditation system (Trienekens & Zuurbier, 2008).

In developing countries, mainly in Harare Province and Zimbabwe as an example, the main barriers to the implementation of a food safety management system (FSMS) include lack of financial resources, size of the organization, inadequate infrastructure and facilities, and lack of top management commitment (Macheka et al., 2013).

HACCP is part of an FSMS (Al-Kandari & Jukes, 2011). It is widely acknowledged as the best method of assuring product safety while becoming internationally recognized as a tool for controlling foodborne safety hazards (Khandke & Mayes, 1998; Wallace et al., 2005). Therefore, HACCP is the most used system in the food sector.

Many developing countries have seen the growth of many Small and Medium Enterprises (SMEs). But, the SMEs tend to have a poor understanding of FSMS, resulting in limited adoption of HACCP (Fielding et al., 2005). Most developing countries reported weak food safety legislation and control (Kiilholma, 2008; Nguzi, 2007), and also the implementation of an FSMS is not compulsory. However, implementing HACCP in food industries is mandatory in most developed countries (Fielding et al., 2005).

Typical factors contributing to improper behavior when adopting the HACCP system involve a lack of understanding of the HACCP system (Motarjemi & Kaferstein, 1999; Taylor & Kane, in press). Inadequate training (Howes et al., 1996). Misperceptions on safety risks (Clayton et al., 2002). The poor commitment of management (often reflected in insufficient support in time, money, training of employees, and motivation) (Vela & Fernández, 2003), psychological barriers to HACCP implementation (like, HACCP is perceived as complicated, burdensome, unnecessary, and hindered by staff and external problems) (Taylor & Taylor, 2004), and lack of validation and verification of the HACCP system (Taylor & Kane, in press).

## **2.9 Empirical Studies**

### **2.9.1 SPC in Developed Countries**

There are 12 Critical Success Factors (CSFs) for SPC implementation identified from the literature related to SPC implementation among the small and medium enterprises in the UK. Based on a survey of 33 manufacturing small and medium enterprises (SMEs), the results of the analysis, in order of their importance, are: management commitment, process prioritization, control charting, teamwork, measurement system evaluation, in addition to other less important factors as documentation and update the knowledge of the process, identification of critical quality characteristic, SPC training and education, use of SPC software and use of SPC facilitators. Moreover, this research has revealed that the least important factor is using a pilot study in SMEs (Rungasamy et al., 2002).

One published model (related to SPC implementation) was established on Brazilian companies to analyze the relationships between critical success factors (CSF) and the generated benefits. The aim is to analyze the relationships between the three

independent constructs (Support, Training, and Application) and the dependent construct (Benefits). A cross-section survey was used as a research method to collect information on samples from Brazilian companies in the auto-parts sector. The results of this model indicated that senior management support considerably affected the way companies develop their training. This training affects how companies apply techniques, reflecting on the benefits of the program's implementation (Lim et al., 2017).

In another paper, the MEST diagram discusses the ingredients that are needed for the successful implementation of SPC; in this research, two surveys were reported. The first survey aimed to identify the practical difficulties experienced when introducing SPC. The second showed the main barriers when applying SPC and its further development. The study concluded that there are many reasons for failure when it comes to implementation of SPC, some of which are mentioned in this study: lack of training and education, management commitment, not understanding fully the potential benefits, failure to interpret control charts, and take any necessary actions, lack of knowledge of which product/process characteristics to monitor and measure and inadequate measuring system in place. (Antony & Taner, 2003)

Another research revealed that top management commitment is the most critical factor that helps a successful SPC Implementation. While the lack of SPC training is the most challenging, the lack of awareness of SPC and its benefits are the main reasons the food companies do not implement SPC (Sarina et al., 2015; Lim et al., 2017).

Therefore, in this thesis, based on a related conceded literature review that addresses the issues associated with SPC implementation, the methodology used is descriptive cross-sectional design; quantitative and qualitative data are collected. Semi-structured

interviews is employed to detect the requirements influencing SPC implementation readiness by considering the Palestinian context. Then questionnaires are distributed to a representative sample of top-level managers, production managers, quality directors, and process operators in 9 dairy firms working in West Bank to collect data.

### **2.9.2 SPC within the Palestinian Context**

Few studies address and adopt the SPC tools application in the Palestinian context-specific. Two published articles adopt the SPC methodology within Palestinian companies from the literature.

One case study addressed the Al-Safa Dairy plant in 2015; in this project, the researchers aim to implement the SPC methodology as a continuous improvement tool to decrease or eliminate the percentage of out-of-control points and variance within the plant production process. Subsequently, implement the possible quality tools (Pareto chart, cause, and effect diagram, control charts, histogram, check sheets, scatter diagram, process flow diagram). The methodology is done based on (25 samples) to make the control charts and models on Minitab to check out control points and then eliminate them directly during the process. After that, new input data (new 25 samples) are taken to establish new control charts and diagrams. When observed variability of the attributes of a process is within the range of variability from natural causes, the process is said to be under statistical control. The practitioner of SPC tracks the variability of the process to be controlled. When that variability exceeds the range to be expected from natural causes, one then identifies and corrects assignable causes. And so the quality of products will be increased and increase customer satisfaction, which might help the company improve its level of reputation (Tamam & Abdelhaq, 2015).

The main results clarify some significant issues, such as frozen water in refrigerators on raw milk during the logistics process. Some points were recorded lower than specification limits (LSL); the freezing point percentage is underlined in the accepted range (0). So, the freezing point of the raw milk is primarily affected by the percentage of the water. Furthermore, it was discovered that the Lactose isn't affected by any of the other gradients of milk except water and so it can keep its percentage almost constant. About the process capability of solids, half of the samples were down to lower specification limits (LSL). This is because of the decline in the nutritional value of the sample and the low proportion of solids that are non-fat from the minimally approved of an 8.20. This is linked to the conditions of dairy cattle farms in terms of the type of food, the size of milk per cow, and the disparity between the two semesters of summer and winter. These factors affect the ratio of the constituent materials for milk ups and downs (Tamam & Abdelhaq, 2015).

Another case study addresses the AZIZA poultry slaughterhouse. AZIZA doesn't have any indicators about their production progress and the causes for non-conforming products. That probability is because the company does not have an effective quality system so they have a lot of data that haven't been analyzed. The researchers decided to implement the seven tools of SPC (Pareto chart, cause, and effect diagram, control charts, histogram, check sheets, scatter diagram, process flow diagram) to improve quality. Their works on measuring the progress of the process, measuring the process capabilities, Monitoring and optimizing the microbiological quality of products, basically decreasing the percentage out of control point. The methodology was done based on taking about 25 slaughters through 9 months. The control charts were used for microbiological tests to analyze the data over time and detect the out-of-control points.

A fishbone diagram is another tool used to define the causes and effects of the out-of-control points. To eliminate or omit unimportant, time-consuming frequencies of the tests, the analysis was done in the Minitab program to give the real situations and detect the out-of-control manners. This program provides the X-bar R, X-bar S, and other control charts to monitor variable data when samples are collected at regular intervals from a business or process. The Process Capability is a measurable property of a process to the specification, expressed as a process capability index (e.g., Cpk or Cpm) or as a process performance index (e.g., Ppk or Ppm) (Dweekat et al., 2013).

The researchers concluded that the company should take into consideration the following: steps 1: The company must use the seven tools to increase their awareness about the problems, try to solve any problem that may happen in the future, detect the main sources of variability, and measure the progress of the process. Step 2: The analysis shows that implementing the SPC method will benefit the company in saving money and time consumption. Step 3: The advanced quality plan must be implemented to save a new frequency of tests. Step 4: Increase the number of samples taken for the microbiological tests because the cost to test another example is almost ignored (Dweekat et al., 2013).

No other studies related to the SPC method have been published within the Palestinian settings. Above all, little is known about the readiness factors for the SPC methodology implementation in developing countries. Hence, this study seeks to address the gap in the research on factors influencing the performance of SPC.

Therefore, most SPC applications in the food industry in developing or developed countries focus on SPC technical issues (SPC tools application). However, this thesis

investigates the major influential factors on the readiness to implement the SPC methodology.

This thesis addresses the Palestinian food industry, namely, the dairy sector. Hence, to achieve quality and consistency in their products, the dairy sector is expected to prepare requirements to implement SPC technics, a prerequisite to achieving quality. The newly established Palestinian dairy companies are not familiar with these issues. Therefore, it's essential to test, examine, and investigate the degree of SPC implementation readiness and assess SPC implementation's reality within this sector.

## **2.10 The Research Gap**

Food production sectors have already implemented integrated quality assurance for many developed countries. Examples are cattle quality management programs in Australia and Scandinavia (Noordhuizen & Metz, 2005). In Europe, few food SMEs implement a food quality management system in its proper form, and many food SMEs are limited to quality assurance methods such as HACCP, IFS, and ISO. Other quality management methods are less prevalent in European Union food SMEs (Dora et al., 2013). On another side, most developing countries have weak food safety legislation and control (Kiilholma, 2008; Nguzi, 2007). The implementation of a food safety management system is not compulsory.

In developed countries, the companies that partially implemented food quality management could reduce costs and customer complaints and increase their productivity and profitability (Dora et al., 2013). However, there is still a lack of knowledge of food quality management (FQM) methods among the majority of the micro-, small- and medium-sized food companies. So, there is a need to investigate the successful food

quality management implementation to propose new technics that help increase the level of readiness for quality management implementation.

Related to the SPC method in specific, this method is extensively used in industries for monitoring and improving process performance (Rai, 2008). In developing countries, namely Zimbabwe, the usage of the SPC tools was very low due to economic challenges. Some high motivation is required to awareness the manufacturing industry to adopt SPC initiatives to compete well in regional and global markets. If an organization competes on a worldwide scale, embracing SPC is necessary. When SPC is utilized properly, it enables the manufacturer to prevent problems, control their production processes, and ultimately increase profits and customer satisfaction (Madanhire & Mbohwa, 2016).

However, in developing countries, all related previous studies that have addressed the SPC emphasize the application of the SPC tools (technical issues), regardless of the readiness factors essential for this practical implementation before the SPC adoption process. It must prepare effective management for this change before the implementation process. This thesis tends to fill this gap and add to the knowledge of applying SPC tools in the state of Palestine.

Many studies address the SPC as an implementation tool in developed economies. Furthermore, other studies address the requirements, ingredients, perquisites, and readiness factors for SPC implementation. This research work considers these studies to understand better how organizational and methodological factors may impede SPC implementation within the Palestinian dairy industry.

## 2.11 Theoretical Frameworks

This section introduces the various theoretical frameworks that understand the preparedness process for SPC implementation that help the researcher to build own conceptual framework.

### **The organizational and methodological framework for SPC implementation (Does et al., 1997);**

This framework suggests splitting the SPC implementation process into two areas, organizational and methodological, since both aspects are complementary and important to the successful implementation of SPC. The methodology of this paper depends on the author's practical experience was acquired through the active involvement in various projects where the presented approach was used to implement SPC.

The organizational area addresses the structural level, which means implementing the SPC throughout the organization (companywide). This approach emphasizes the need for the environmental culture to the SPC implementation process, support of top management, a delegation of tasks, and responsibilities, authority between levels, training of SPC techniques, and essential for teamwork and project management.

The organizational part has been divided SPC implementation process into the following four phases: Awareness, Pilot projects, Integral implementation in production, and finally the Total quality (Figure 2.2).

To successfully implement SPC, the awareness comprises that good preparation is necessary, and an external consultant's assistance can be beneficial. After the awareness meeting, a steering committee is formed, and top management gives them the

assignment to plan for the implementation. The plan is based on interviews with staff members from all departments involved and should include processes to be dealt with in the pilot projects. The processes used in the pilot phase should be known as problematic (but not too extensive and complex) to achieve accurate results. It is necessary to give one person within the company the task of SPC coordinator to provide SPC with training to all people involved to achieve SPC Integral implementation. Then, other steering committees, chaired by the managers of the corresponding departments, should be installed to guide the performance in the various departments; this approach leads to TQM.

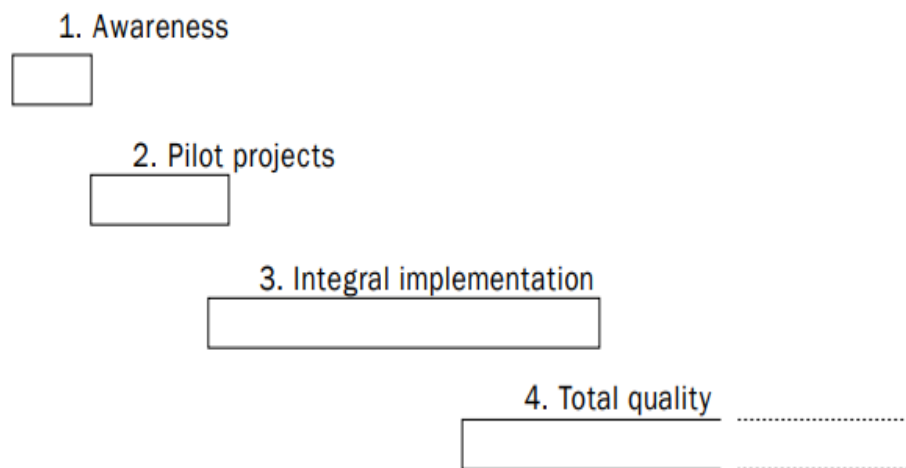


Figure 2.2 Phases of SPC Implementation  
Source: (Does et al., 1997)

However, the methodological area that addresses the planning for actual implementation phases focuses on SPC tools by describing practical guidelines is the limited flexibility of some guidelines. Especially methodological guidelines, which are often directed to a specific situation. The methodological part of the approach consists of a ten-step method to implement SPC (Figure 2.3).

Steps 1, 2, and 3: to describe the process and search for weak points; through Process description, Cause and effect analyses, and Risk analysis.

Steps 4 and 5: to search for improvements for weak points and implement them through Improvements and Define measurements.

Steps 6, 7, and 8: Define effective measurements and control loops to control the process—repeatability and reproducibility study (R&R study), Control charts, and Out of control action plan.

Steps 9 and 10: Assess the performance and arrange for continuous improvement through process cap: study and Certification.

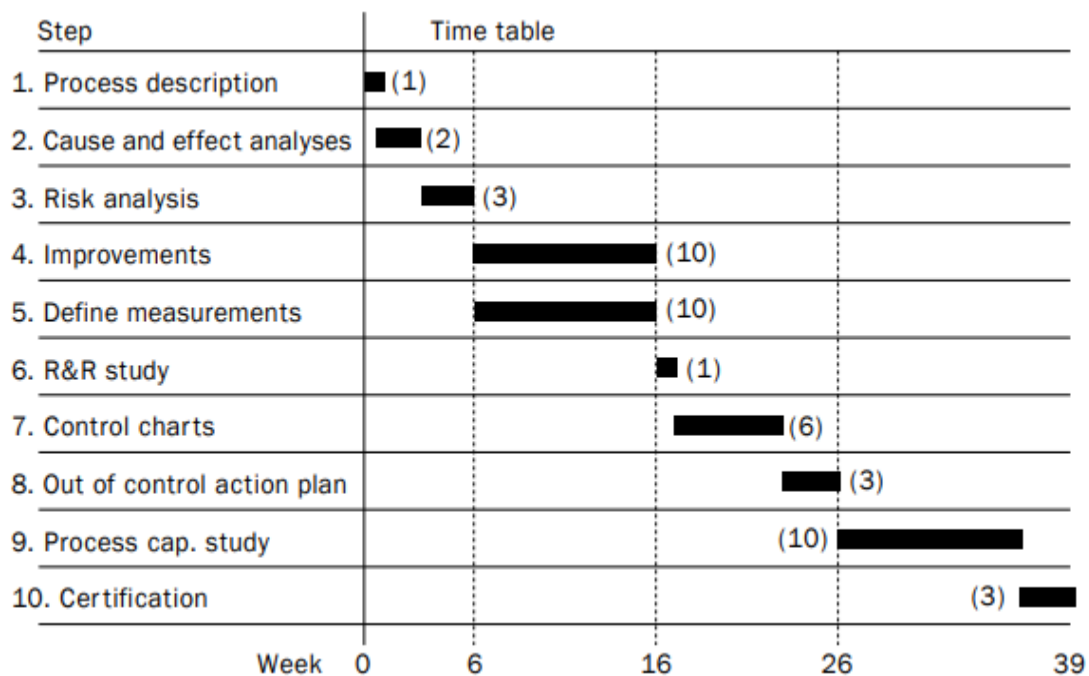


Figure 2.3 Steps and Typical Time Path of SPC Methodology

Source: (Does et al., 1997)

**MEST framework: a diagram defining prerequisites for successful SPC implementation (Mason & Antony, 2000);**

This framework (Figure 2.4) illustrates the essential ingredients for a successful introduction and application of the SPC program. The framework identifies four dimensions of requirements.

(1) The (Management issues) include total company commitment, necessary resources for training and education, creating a responsive environment for actions on the processes/systems, etc. (2) the (Engineering skills) include understanding the benefits of SPC, measurement system analysis, responsiveness to changes, actions are taken for out-of-control situations, prioritizations of processes, etc. (3) the Statistical skills include statistical stability and capability, selection of control charts, interpretation of out-of-control situations on control charts, etc. (4) the teamwork skills include the formation of process action teams for out-of-control situations, company-wide understanding of SPC, its benefits and rewards, etc. (Mason & Antony, 2000).

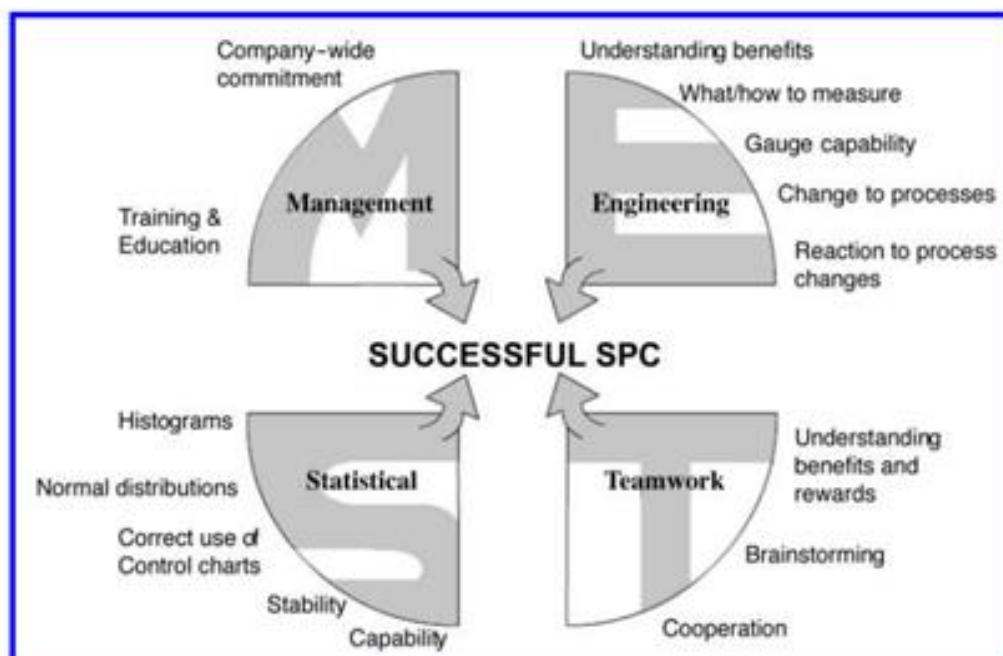


Figure 2.4 MEST Defining for Successful SPC Implementation  
Source: (Mason & Antony, 2000)

**Components of SPC Readiness (Lim & Antony, 2016; Lim & Antony, 2019).**

The framework (Figure 2.5) builds on a literature review of qualitative and quantitative studies. A three-round Delphi study involving the SPC experts (academics, industry, and consultants), the Delphi study is used to manage, structure, and analyze the experts' comments. It can be used to validate the result of the literature. The literature review and Delphi study results resulted in five readiness factors: top management support, sense of urgency, measurement system, employee involvement, and organizational culture readiness (Lim & Antony, 2016; Lim & Antony, 2019).

These factors were structured for developing a conceptual self-assessment readiness tool (Table 2.2). That enables food practitioners to identify the current state of organizational readiness and help companies plan strategic changes and preparation activities to adopt SPC in their businesses (Lim & Antony, 2016; Lim & Antony, 2019).

Table 2.2 Example of Self-Assessment Readiness Scoring

Mean of score	Level of readiness
>3	<b>Ready</b> In the right state to initiate implementation
2–3	<b>Moderately ready</b> Company should continue in its plan to adopt SPC but needs to reassess the readiness factors that gave a low score
<2	<b>Not ready</b> Most of the factors score very low, indicating that the company may not be fully prepared to commit to the adoption and implementation of SPC

Source: (Lim & Antony, 2016; Lim & Antony, 2019)

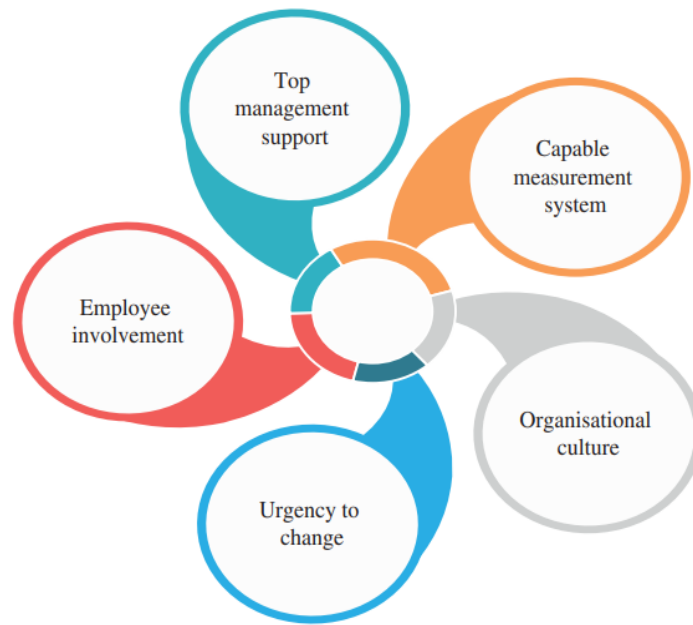


Figure 2.5 Component of SPC Readiness  
Source: (Lim & Antony, 2016; Lim & Antony, 2019)

### **SPC Readiness Framework (SPCRF) (Lim & Antony, 2013).**

Based on the literature review, the qualitative approach by systematic exploratory review builds a framework consisting of nine readiness dimensions in SPC deployment. Based on the mapping of SPC's CSFs, the SPC readiness factors are leadership, top management, people management, culture readiness, Process management, measurement and feedback, Strategic Planning, Customer Focus, and Project management. Each of the dimensions in the framework consists of RF for measuring the dimensions (Lim & Antony, 2013).



Figure 2.6 SPC Readiness Framework (SPCRF)  
Source: (Lim & Antony, 2013)

### **The SPC Conceptual Roadmap (Lim et al., 2015)**

The proposed SPC conceptual roadmap developed from the literature would guide a successful SPC implementation, specifically in the food industry. The authors would recommend the following ingredients (Figure 2.7) to facilitate the implementation in the food industry. It reflects the general movement of food manufacturing practices from quality control and assurance to continuous learning and quality improvement. The proposed five phases (awareness, preparedness, initiation, institutionalization, and sustainability) SPC implementation roadmap will facilitate the food manufacturing companies to apply SPC systematically for the successful deployment and sustainability of SPC technique. Although this roadmap highlighted the 12-steps pilot project

roadmap, the authors would like to accentuate that sustainability of SPC is pretty challenging to most food companies, which necessitates further research on such topic (Lim et al., 2015).

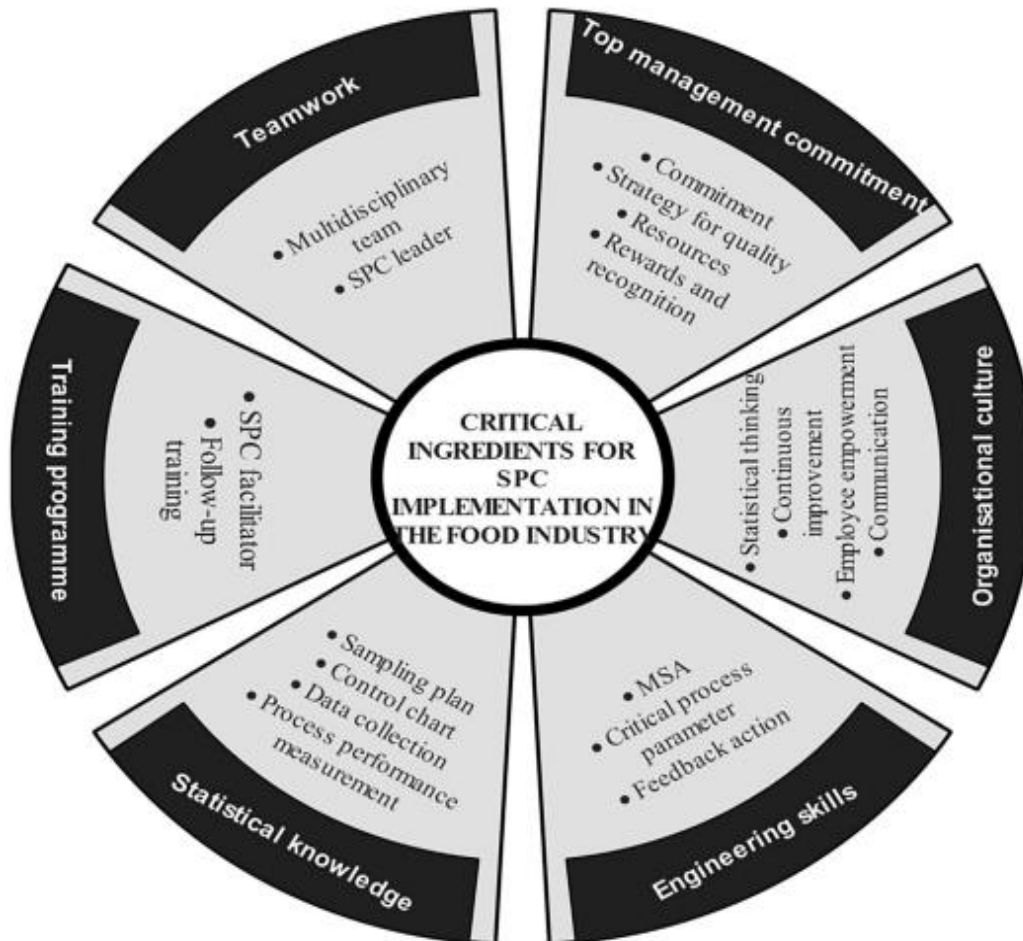


Figure 2.7 Critical Ingredients of SPC Implementation in the Food Industry

Source: (Lim et al., 2015)

## 2.12 Conceptual Framework

In the Palestinian context, up to this date, little known studies addressed the requirements or prerequisites for the successful SPC deployment. Still, in developed countries, many articles address these issues and discuss how to prepare for this change. So, the researcher adopted some of the developed frameworks tested and applied in

previous studies to establish the thesis conceptual framework for assessing the SPC implementation readiness in the Palestinian dairy industry.

The conceptual framework shows a visual representation that helps us to illustrate the expected relationship among collected variables (dependent & independent variables).

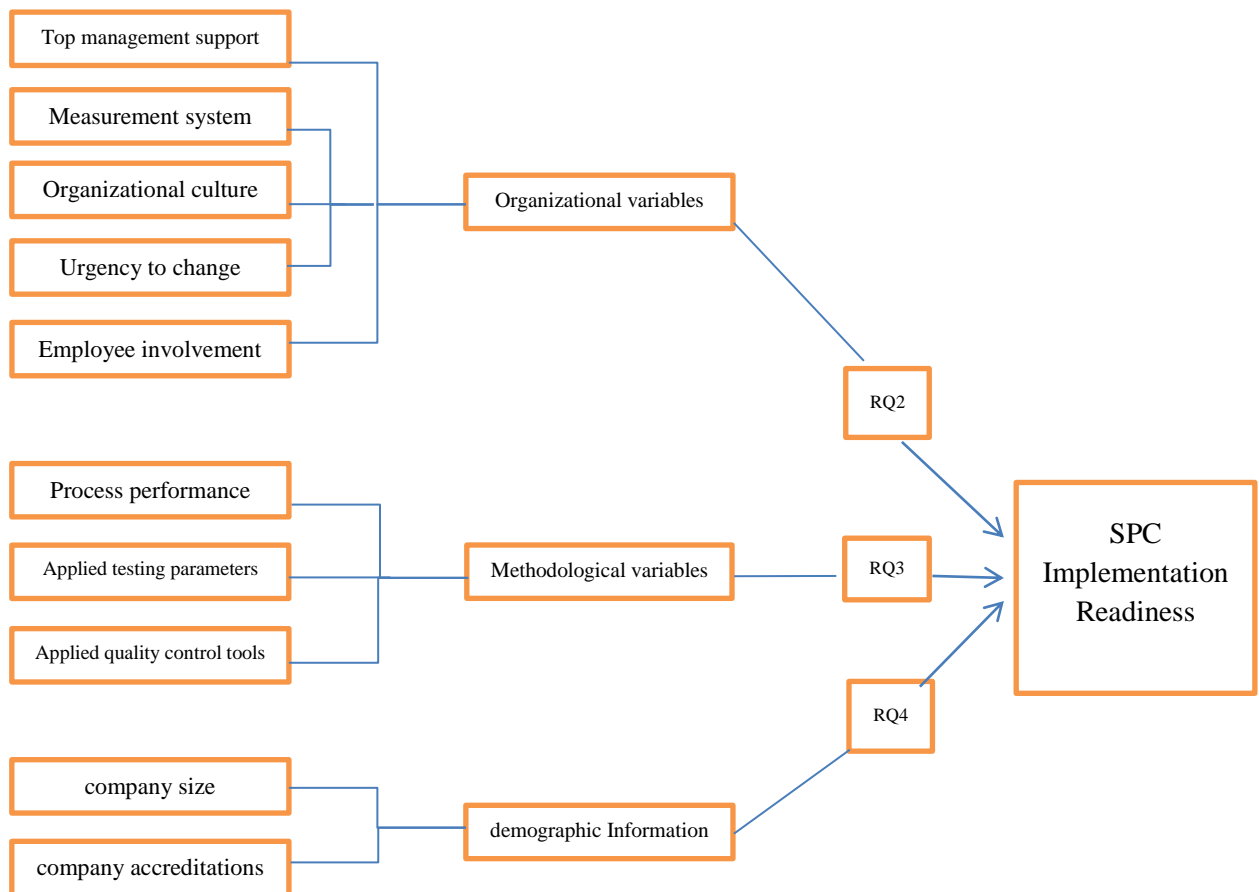


Figure 2.8 The Proposed Conceptual Framework for the Readiness of SPC Implementation This thesis develops a conceptual framework for the SPC implementation readiness that will assist the Palestinian dairy sector in adopting SPC. The framework will take the form of a systematic methodology for the effective implementation of SPC in any dairy company within the Palestinian context.

The proposed conceptual framework consists of two complementary areas for SPC's successful implementation readiness. The organizational area includes five dimensions, and the methodological area consists of three dimensions and the demographic information (size, accreditation), as illustrated in Figure 2.8.

## Chapter 3

### Research Methodology

#### 3.1 Introduction

This chapter explains the methodology adopted throughout the thesis to investigate SPC readiness among a selected Palestinian dairy companies' sample. The chapter's structure introduces the research questions, research method, research approach, research population, the sample of the study, selected sample, study tool data collection, and the type of data analysis. Moreover, the questionnaire questions, which were developed from the literature review, were presented.

#### 3.2 Research Questions

This thesis aims to answer the following research questions:

RQ1) What are the perceived determinants of implementing SPC in the Palestinian dairy industry?

RQ2) How well prepared, regarding organizational requirements, are the Palestinian dairy firms to implement SPC?

RQ3) How well prepared, regarding methodological requirements, are the Palestinian dairy firms to implement SPC?

RQ4) Are there differences between dairy firms based on their size or accreditation regarding the level of readiness to implement SPC?

### 3.3 Research Method

This research is a descriptive cross-sectional, where quantitative and qualitative data are surveyed (Macheka et al., 2013). Semi-structured interviews are employed to revise the selected factors influencing SPC implementation by considering the Palestinian context. The interviews phase aims to understand better dairy industry characteristics (the processes) on the researcher's side (RQ1). Participants in the interviews are key actors in the Palestinian dairy industry.

Then questionnaires are distributed to a representative sample of top managers, production managers, quality directors, and process operators in 10 dairy firms working on West Bank to collect data.

### 3.4 Data Allocation Method

#### ➤ First, Secondary Data

To collect data about research questions, the researcher started collecting data from books, published previous research work, and reports.

#### ➤ Second, Primary Data

The researcher uses different techniques to collect primary data: conducting interviews with directors and employees of Palestinian dairy companies' quality/production departments (Table 4.1).

Moreover, building on the literature and the interviews, a questionnaire is used for collecting quantitative data. Respondents score their perceptions on a five-point Likert, providing the necessary data to generate information (RQ2, RQ3, RQ4).

In general, data collection includes surveying three groups of actors: (1) the management, (2) production managers and quality directors, and (3) operators. This applies to interviews and questionnaires.

### **3.5 The Research Population**

A list of (45) Palestinian dairy companies in the West Bank was received from the Palestinian Ministry of The National Economy (see Appendix A). The list consisted of (companies' names, addresses, and phone numbers), and the Ministry provided no other data about the dairy sector. The researcher filtered the list to keep the dairy companies. A new list of 33 firms was created. Phone calls were conducted with every firm to request their operational status.

The information involves the current number of employees, production capacity, company ownership, and addresses. All the active dairy producers were selected. Yet, the excluded companies are permanently closed or suspended temporarily. Besides companies that have changed their commercial activity to another area away from dairy, duplicate companies under more than one name, companies out of service contact numbers, companies under wrong contact numbers, and unanswered contact numbers were also excluded. The final list of active dairy companies become (15) dairy companies operating in the West Bank, as shown below in Table 3.1.

So, the study population consisted of (15) Palestinian dairy Companies listed in the Palestinian Ministry of the National Economy located in different cities. i.e.: (Hebron, Nablus, Jericho, Qalqilya, Ramallah, Tubas, Tulkarm). Table 3.1 shows the distribution of dairy companies according to the data collected from phone calls.

Table 3.1 The Research Population

#	Company Name	Employees	Daily Production Capacity (ltr/day)	Company's Ownership
<b>Hebron</b>				
1	Al-Jebrini Company	500	-	Family
2	Al-Safi Company	21	5000-6000	Family
3	Al-Juneidi Company	700	120,000	Non- Family
4	Karaja Modern Company for Agricultural Trading	10	2000	Family
<b>Nablus</b>				
5	Mahmoud Talal Saqr Company for Dairy production	2	50-100	Family
<b>Jericho</b>				
6	Arab Construction Project Association	12	5000	NGO
<b>Qalqilya</b>				
7	Baladi Company for Food and Animal Production	2	80	Family
<b>Ramallah</b>				
8	Hidmi Food Industries Company	20-25	1500	Family
9	Hamoda Food Industries Company	120	130,000	Family
10	Al-Rayan Dairy Products Company	20	5000	Non- Family
11	National Dairy Company (al-maraai)	12-10	3000	Family
12	Al-Binar General Trading Company	100	30,000	Non- Family
13	Tal Al-Asour Dairy Company	7-8	3000-4000	Non- Family
<b>Tubas</b>				
14	Aqaba Dairy Industry Association	7	1000-2000	NGO
<b>Tulkarm</b>				
15	Al-Tayf dairy company (Candia)	125	50,000	Non- Family

Source: researcher (collected via phone calls)

### 3.6 Sample of Research

The sample of the study is selected from the population of the study. To determine the sample size of the study population, a convenience sampling method (also known as availability sampling) was applied. Convenient sampling is a non-probability sampling method that relies on data collection from the population which is close at hand and

easily accessible to participate in the study (Dudovskiy, 2018). Therefore, the researcher chose this sampling method due to the lockdown during the Covid-19 pandemic, limiting our reachability to many candidate participants.

Out of the (15)Palestinian dairy companies, (3) companies were excluded because they have their household manufacturing process manually without any production lines, employees or machines. Also, one company was excluded because it is currently closed temporarily for maintenance purposes, and another company was excluded due to inaccessibility to reach it. So that the final number for analysis included companies becomes (10) companies (as shown in Table 3.4).

Note: The names of companies included in the study sample were also anonymously coping with the request of the companies within the sample study.

The PCBS, 2017 developed a formal establishments size classification based on the number of employees (as shown in Table 3.2).

Table 3.2 The Establishments Classification According to PCBS.

<b>Classification</b>	<b>Number of employees</b>
Micro Establishments	1- 4
Small Establishments	5-19
Medium- Sized Establishment:	20-49
Large Establishments	Above than 50

Source: (PCBS, 2017)

The classification of the (PCBS 2017) does not reflect the nature of our data. There is a large gap between the companies regarding the number of employees and the production capacity. So the researcher modified the classification from four categories

to two categories (shown in Table 3.3) so the following classification is adopted for the thesis target sample in terms of size:

Table 3.3 The Adopted Establishments Classification

<b>Classification</b>	<b>Number of employees</b>	<b>Production capacity (Liter/day)</b>
Small Establishments	Equal or less than 50	Equal or less than 6000
Large Establishments	Above than 50	Above than 6000

So, according to the new classification, the distribution of the target sample regard to size classification is shown in Table 3.4.

Table 3.4 The distribution of Target Sample with Regard to Size Classification

<b>#</b>	<b>Company</b>	<b>City</b>	<b>Size Classification</b>
1	C A	Hebron	Large Establishment
2	C B	Hebron	Small Establishment
3	C C	Ramallah	Large Establishment
4	C D	Ramallah	Large Establishment
5	C E	Ramallah	Small Establishment
6	C F	Hebron	Large Establishment
7	C G	Ramallah	Small Establishment
8	C H	Jericho	Small Establishment
9	C I	Tulkarm	Large Establishment
10	C J	Hebron	Small Establishment

Source: (The Adopted Establishments Classification as Table 3.3)

### 3.7 Study Tool

#### 3.7.1 First: Questionnaires

To collect data from the sample, the researcher designed a questionnaire as a study tool, considering that a questionnaire takes (71 statements) on a five-point Likert scale. The questionnaire comprises demographic, readiness, and implementation Table 3.5 and Table 5.6 correspond to Likert scale scoring.

Then questionnaires respondents represent top-level managers, production managers, quality directors, and process operators in 10 dairy companies working in West Bank to collect data.

Table 3.5 Likert Scale

Very low (Strongly Disagree)	Low (Disagree)	Moderate (Neutral)	High (Agree)	Very high (Strongly Agree)
1	2	3	4	5

### 3.7.1.1 The Questionnaire Characteristics

Despite the lack of research within the Palestinian context addressing requirements for the successful SPC deployment, many studies address these issues and discuss how to prepare for the change in the developed countries.

The researcher screened a set of variables considering the SPC readiness topic in previous studies. These variables are tested to assess the preparedness of dairy companies to implement SPC. Appendix B lists the relevant studies.

Based on the conceptual framework (see Figure 2.8), the construction of the questionnaire (sections, dimensions, questions) was mainly based on the readiness factors for SPC implementation excelled from the literature.

The questionnaire comprises three Sections with 71 statements related to the specific research objectives, also toward answering a research question, and these parts are:

**Section one** addresses the RQ4 in 13 Statements related to the general information for the company and respondents (Gender, Age, Academic qualification, academic specialization, positions, years of experience, company size, and city location).

**Section two** discusses the readiness of Palestinian dairy companies to implement SPC; this section answers the RQ1 and RQ2 in five dimensions. The first dimension explores the top management commitment and comprises six statements. The second dimension explores the measurement system and shall consist of five statements. The third dimension explores the organizational culture and comprises seven statements. The fourth dimension explores urgency to change and comprises four statements. Finally, the fifth dimension explores employee involvement and comprises five statements.

**Section three** tackles the reality of SPC practices among Palestinian dairy companies. This section answers the RQ1 and RQ3 in three dimensions. The first dimension explores the process performance and comprises eight statements. The second dimension explores the applied testing parameters and comprises five statements. The third dimension explores the applied quality control tools and comprises seven statements. The additional attachment was included to familiarize respondents with the seven quality control tools. A copy of the questionnaire is shown in Appendix C and Appendix D in Arabic and English languages.

### **3.7.1.2 Pilot Study**

The study's questionnaire was manipulated after a pilot study, which was made to measure the simplicity of filling the questionnaire and the required time to fill it and to measure the validity and reliability of the questionnaire's paragraphs. After that, some questions were deleted, and others were replaced or modified.

### **3.7.1.3 Questionnaire Validity**

Validity is the ability of an instrument to measure what it is intended to measure. The questionnaire's content validity was checked by presenting the questionnaire to two

experts in quality from the Palestinian dairy sector, one manager in the Palestinian Standards Institution, and one academic professor. They reported that the questionnaire is valid and appropriate to achieve the purpose of the study. Yet, few statements were deleted, and others were replaced or modified (see Table 3.7).

Table 3.6 List of Arbitrators

#	Arbitrators	Company	Specialization
1	Haitham Mhaisen	Palestine Standers Institution	Hebron Office Manager – Quality Auditor
2	Romal Qdemat	Al-Jebrini Company	Quality Manager
3	Nafez Mujahid	Al Safi Company	General Manager
4	Dr.Suhail Sultan	Beirzeit University	Associate Professor –Operation Management

#### 3.7.1.4 Questionnaire Reliability

Table 3.7 Reliability Coefficients of Questionnaire's Sections

Section's Number	Section's Tittle	Cronbach's Alpha
2	The readiness of Palestinian dairy companies to implement SPC	0.962
3	Assessing the reality of SPC implementation among Palestinian dairy companies	0.920

Table 3.8 Reliability Coefficients of Questionnaire Dimension's

Dimension's Number	Dimension's Tittle	Cronbach's Alpha
1	Top Management Commitment	0.720
2	Measurement System	0.890
3	Organizational Culture	0.898
4	Urgency to Change	0.810
5	Employee Involvement	0.853
6	Process Performance	0.896
7	Applied Testing Parameters	0.523
8	Applied quality control tools	0.899

The internal consistency test checked the questionnaire's reliability, and it calculated the extraction reliability coefficient (Cronbach's alpha) for each section and the whole questionnaire. The reliability coefficient for the entire questionnaire equals 0.941, which is a good reliability coefficient for research. It is evident in Table 3.8 that the reliability coefficient of all sections is acceptable and meets the study's objectives.

#### **3.7.1.5 Survey Administration**

The researcher administered the survey, identifying the sample and defining the number of questionnaires to be distributed. The researcher personally delivered the printed version of the questionnaire to all respondents. After contacting and taking a particular appointment, delivered by hand, in a personalized envelope to be more accurate of several copies for each company, then distributed it and explained the questionnaire to the respondent to provide them with additional information. Furthermore, a researcher gives companies two ways to respond: sending it by mail or coming back to collect it a few days later. After many reminders, this situation took a time frame from one day to one week and more for some companies. Data collection was conducted in October 2021.

#### **3.7.1.6 Survey Responses**

Fifty-three questionnaires were returned from respondents; despite that, a researcher went to respondents several times with extra questionnaires copies and pens to give them a new one because many received questionnaires were incomplete. Of the 53 responses received, (16) were invalid.

Therefore, a total number of 37 questionnaires from 10 companies were valid for statistical analysis. Table 3.10 shows the number of questionnaires distributed, returned, unusable, and the final number of useful questionnaires from each company.

### 3.7.2 Second: Interviews

The researcher uses the qualitative approach to understand the extent of statistical process control implementation within Palestinian dairy companies.

Since the thesis is based on the mixed research methodology, which combines both quantitative & qualitative approaches, interviews are used to achieve the qualitative objective of the study.

Table 3.9 The Number of Questionnaires Distributed, Return, Invalid, and Valid

N	company	Distributed questionnaires	Returned questionnaires	Invalid questionnaires	Valid questionnaires
1	C A	14	7	0	7
2	C B	3	3	1	2
3	C C	10	8	2	6
4	C D	9	8	4	4
5	C E	2	2	0	2
6	C F	12	9	2	7
7	C G	2	2	1	1
8	C H	3	3	0	3
9	C I	10	9	6	3
10	C J	2	2	0	2
<b>Total</b>		<b>67</b>	<b>53</b>	<b>16</b>	<b>37</b>

Qualitative data was collected through conducting individual interviews in a semi-structured form, including standardized questions asked by the researcher as interviewer using a set of pre-established questions (Appendix E). The researcher used a semi-

structured interview because it is easy to analyze. Moreover, the interview questions were designed to adapt each specific research question and connect what is asked in each interview in the sector to the overall research design.

The interviews start with a general conversation between researchers and interviewees to explain the purpose of the study and the importance of the answer to achieving research objectives.

Furthermore, the researcher starts asking the open-ended questions which were prepared and validated before being conducted by the thesis supervisor; additionally, the researcher provides an opportunity for the interviewees to indicate any additional information they considered relevant. After each interview, a researcher summarizes, outlines, and reviews main subjects, thoughts, or topics arising from the interview. Using a summary allowed the researcher and interviewees to modify what occurred in the interview. Discussions were held and documents related to the extent of adopting and applying a statistical process control among Palestinian dairy companies. To gain an outline of SPC implementation, the researcher interviewed the selected companies from the dairy sector. Eleven interviews participated; a complete list of the interviewees' information is provided in Chapter 4 (in Table 4.1).

### **3.8 Research Model**

To achieve thesis objectives, the researcher developed the thesis conceptual framework mainly by following the framework of (Does et al., 1997); to understand each dairy company's organizational and methodological aspects within the Palestinian context.

To achieve the **first and second objectives** for this thesis, the organizational aspect of dairy companies were explored by following the framework of (Lim & Antony, 2016). This framework contains five dimensions: top management support, capable Measurement system, organizational culture, employee involvement and urgency to change.

To achieve the **first and third objectives** for this thesis, the methodological aspects were explored based on (Lim et al., 2017; Lim & Antony, 2019) to measure the process performance for the SPC and non-SPC companies within dairy companies by a set of criteria: Waste reduction, Product consistency, Customer complaints reduction, Competitive advantage, Defects percentages reduction, Productivity improvement, Rework percentages, Company image, Quality awareness, Customer loyalty, Process cycle time, Cost of Quality, Customer satisfaction, Pp/Ppka, Cp/Cpka.

Additionally, the researcher asked about the applied testing parameters to understand how the dairy companies control the product quality consistency within the production process, such as (taste, color, PH smell, density, dry matter, temperature, closure, and shelf life) based on instructors of (PSI, 2016; PSI, 2017; PSI, 2020)

Moreover, the researcher asked about the 7 SPC tools to understand the extent of knowledge and usage among Palestinian dairy companies, which are: process flowcharting, check sheets, histograms, Pareto analysis, cause, and effect analysis, scatter diagrams, control charts (Oakland & Oakland, 2018).

To achieve this thesis's fourth objective, demographic information (such as company size and accreditation) was identified for each dairy company to understand the relationship between them and the level of readiness to SPC implementation.

Concerning (Lim et al., 2017) the Company size has a significant impact on the SPC implementation in the food manufacturing sector. In another regard (Rai, 2008), quality management systems played an important role in advancing SPC usage in several industries.

### **3.9 Data Coding Process**

On SPSS (Statistical Package for Social Sciences), the researcher coded primary data collected after inserting it and gave each statement a specific code to simplify the coding process on the software sheet. In addition, she defined the dependent and independent variables by giving each variable a particular code to determine the relationship between it through appropriate statistical tests to reach the valuable outcomes and indicators that support the subject of the study.

### **3.10 Data Analysis**

The data obtained were analyzed using SPSS for quantitative data; the results were presented using Tables in Chapter 4 in detail. The qualitative data was analyzed through a different technique.

### **3.11 Statistical Analysis**

The statistical approaches that are used in data analysis are:

- Descriptive Statics (Mean, Standard Deviation, Frequencies)
- A one-Way ANOVA Test
- Linear Regression Analysis

## Chapter 4

### Data Analysis and Discussion

#### 4.1 Introduction

This chapter displays and discusses the quantitative and qualitative data analysis. The first section describes the demographic characteristic of the sample under study. The following three areas have analyzed the factors that influence SPC implementation. Then, exploring the significant relationships between variables under investigation through the ANOVA and Regression Analysis is presented.

#### 4.2 Demographic Characteristics for Interviewees

The researcher conducted interviews with some of the top-level managers, production managers, quality directors, and process operators in the dairy firms working in West Bank to collect data because these managers have all information related to applying a SPC for evaluating the readiness of Palestinian dairy companies to adopt and apply SPC in their companies.

A list of the interviewees and the duration and date of each interview are illustrated in Table 4.1.

#### 4.3 Demographic Characteristics for Companies Under Study

To analyze purposes, the researcher split the demographic characteristics of the Palestinian dairy companies under study in terms of location, ownership, legal form, daily production capacity, number of employees, and age and obtained accreditations to

some categories. Table 4.2 shows the list of companies' attributes and the classifications categories and frequencies for each one as SPSS analysis.

It must be noted, concerning attribute of daily production capacity classification, the researcher split it into two categories, which are, the small category that included the companies with production capacity 5000 liter/day and less, and the large category that included the companies with production capacity above than 5000 liter/day.

Additionally, the researcher split the Palestinian dairy companies under study in terms of the number of employees into two categories: the small category that included the companies with employees' number less than 50, and the large category that included the companies with employees number 50 or above.

The adoption of these classifications refers to reasons related to the nature of the target sample characteristic.

#### **4.4 Demographic Characteristics for the Respondents**

To analyze purposes, the researcher split the demographic characteristics of the employees for Palestinian dairy companies' under-study in terms of positional level experience, age, gender, qualification, and job category to some categories. Table 4.3 shows the list of employee attributes and the categories and frequencies of the classification for each one as SPSS analysis.

Table 4.1 The Interviews Hold

<b>Interviewee</b>	<b>Company</b>	<b>Specialization</b>	<b>Is a family member?</b>	<b>Time For Interview</b>	<b>Date of Interview</b>
<b>P 1</b>	Palestine Standers Institution (PSI)	Hebron Office Manager – Quality Auditor	Non-Family Member	Hour	8-9-2021
<b>P 2</b>	Palestinian Ministry of National Economy	Hebron Office Manager	Non-Family Member	Half Hour	8-9-2021
<b>P 3</b>	Al-Jebrini Company	Quality Manager	Non-Family Member	Hour	27-9-2021
<b>P 4</b>	Al Safi Company	General Manager	Family Member	Half Hour	29-9-2021
<b>P 5</b>	Al Safi Company	Quality Auditor	Non-Family Member	Half Hour	29-9-2021
<b>P 6</b>	Al Pinar Company	Production Manager	Non-Family Member	Half Hour	20-10-2021
<b>P 7</b>	Nation Dairy Company	General Manager	Family Member	Half Hour	20-10-2021
<b>P 8</b>	Al Hidmi Company	Production Manager	Family Member	Hour	26-10-2021
<b>P 9</b>	Arab Construction Company	Production Manager	Non-Family Member	Hour	27-10-2021
<b>P 10</b>	Arab Construction Company	Quality Auditor	Non-Family Member	Half Hour	27-10-2021
<b>P 11</b>	Al Juneidi Company	Quality Systems Manager	Non-Family Member	Hour	30-10-2021

Table 4.2 The Demographic Characteristics of the Companies Sample Study, N= 10

<b>Attribute</b>	<b>Classifications</b>	<b>Frequency (%)</b>
<b>Location</b>	Southern	4 (40%)
	Middle	5 (50%)
	Northern	1 (10%)
<b>Total</b>		<b>10 (100%)</b>
<b>Ownership</b>	Family	7 (70%)
	Non-Family	3 (30%)
<b>Total</b>		<b>10 (100%)</b>
<b>Legal Form</b>	For Profit	9 (90%)
	Not for Profit	1 (10%)
<b>Total</b>		<b>10 (100%)</b>
<b>Daily Production Capacity</b>	Small (< = 5000 liter/day)	5 (50%)
	Large (> 5000 liter/day)	5 (50%)
<b>Total</b>		<b>10 (100%)</b>
<b>Number of Employees</b>	Small (< 50)	5 (50%)
	Large (> = 50)	5 (50%)
<b>Total</b>		<b>10 (100%)</b>
<b>Age</b>	Less Than 20 Years	1 (10%)
	20 To 50 Years	5 (50%)
	Above Than 50 Years	3 (50%)
<b>Total</b>		<b>9 (90%)</b>
		<b>1 (10%) Missing Data</b>
<b>Obtained Accreditation</b>	ISO 45001	0 (0%)
	ISO 22000	0 (0%)
	ISO 9001	0 (0%)
	HACCP	0 (0%)
	PS	2 (20%)
	Other	1 (10%)
	Nothing	5 (50%)
	ISO 9001& PS	1 (10%)
ISO 22000 & Other	1 (10%)	
<b>Total</b>		<b>10 (100%)</b>

Table 4.3 The Demographic Characteristics of the Employees Sample Study, N= 37

<b>Variable</b>	<b>Classifications</b>	<b>Frequency (%)</b>
<b>position</b>	High administrative position	12 (32.4%)
	Other	25 (67.6%)
<b>Total</b>		<b>37 (100%)</b>
<b>Years of Experience</b>	Equal or less than 5 years	19 (51.4%)
	More than 5 years	18 (48.6%)
<b>Total</b>		<b>37 (100%)</b>
<b>age</b>	Equal or less than 30 years	20 (54.1%)
	More than 30 years	17 (45.9%)
<b>Total</b>		<b>37 (100%)</b>
<b>Gender</b>	Male	22 (59.5%)
	Female	15 (40.5%)
<b>Total</b>		<b>37 (100%)</b>
<b>Qualification</b>	School education	4 (10.8%)
	University education	27 (73.0%)
	Postgraduate education	5 (13.5%)
<b>Total</b>		<b>36 (97.3%)</b>
		<b>1 (2.7%) Missing Data</b>
<b>Job category</b>	Technical	23 (62.2%)
	Administrative	10 (27.0%)
	Technical & administrative	3 (8.1%)
<b>Total</b>		<b>37 (100%)</b>

#### 4.5 Factors that Influence SPC Implementation

Eleven interviewees within Palestinian dairy companies participated in the structured interviews and openly answered the discussion questions in Appendix C; 37 usable questionnaires were analyzed. The researcher based on the result of interviews and questionnaires to detect the level of agreement and linkages between qualitative and quantitative data collected for this study, with some confirmations and evidence from the literature review.

Concerning the proposed conceptual framework, there are three aspects to the successful implementation of SPC; as Figure 4.1, the researcher produced ten codes

categorized into three major aspects: organizational, methodological, and demographic characteristics. These themes provided a structure to examine the target sample's views about central research questions. Figure 4.1 shows the coded conceptual framework for successful SPC implementation readiness.

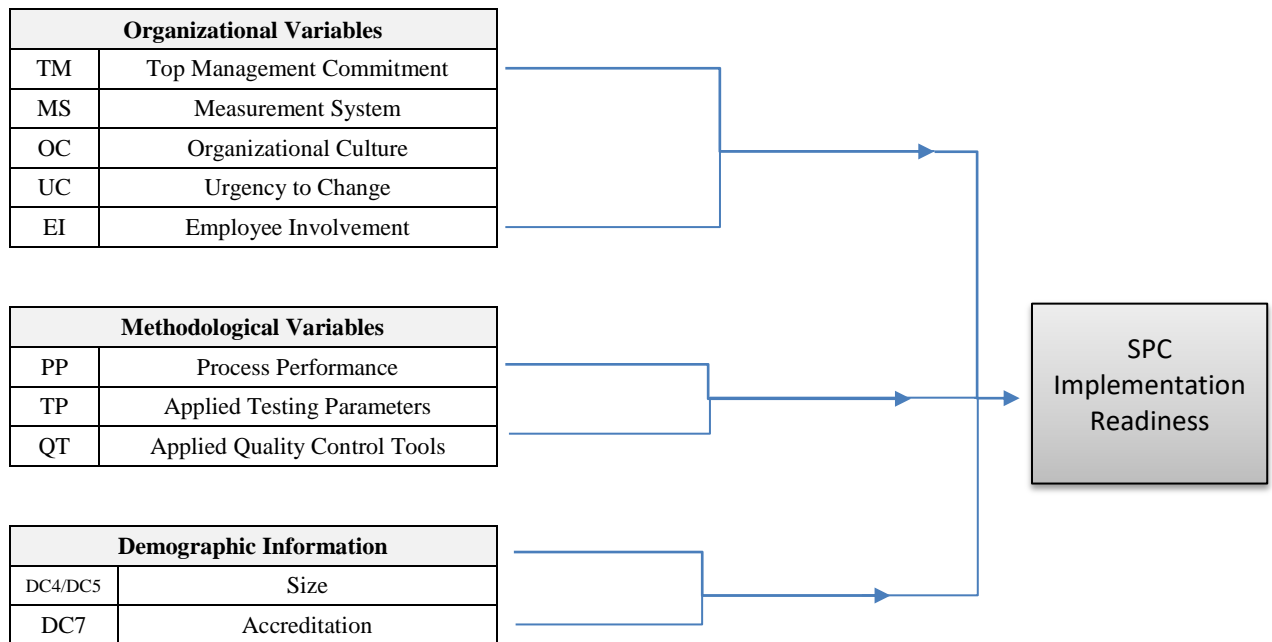


Figure 4.1 The Coded Conceptual Framework

#### 4.5.1 Organizational Aspect

The organizational aspect refers to assessing the SPC readiness at the structural level (Does et al., 1997). The researcher split this aspect into five dimensions regarding (Lim & Antony, 2016; Lim & Antony, 2019): Top management support, Measurement system, Organizational culture, Urgency to change, and Employee involvement.

To qualitative and quantitative data analysis, this aspect answers the first and second research questions, which are (What are the perceived determinants to implement SPC in the Palestinian dairy industry?) through qualitative data analysis. And, (How well prepared, regarding organizational requirements, are the Palestinian dairy firms to

implement SPC?) through quantitative data analysis. To assess the readiness of organizational aspects within Palestinian dairy companies. The data analysis finding for this aspect is presented in the following manner.

### **Top Management Support**

Lim et al., (2014) described that top management support and commitment is the critical success factor for SPC implementation in the food industry, therefore, top management is one of the key organizational factors that influence the SPC implementation process.

- **Qualitative Data Analysis**

As P1 & P3 explained:

*“There are different kinds of support required by the top management before the SPC implementation process”.*

above quotation agreed with (Lim & Antony, 2019) that there are two significant forms of support to ensure that the company is ready for a successful SPC implementation, which provides a supportive climate and allocates necessary resources and investments for SPC.

*“The top management should also provide clear and understandable information about SPC methodology and the benefits or returns after implementation”* (P1, P3, and P6).

This quotation is agreed with (Kafetzopoulos & Gotzamani, 2014). It must create actions that improve the employee's acceptability of the SPC technique and reduce the company's resistance to the SPC implementation.

As interview analysis, the top management doesn't allocate adequate financial resources or allow for sufficient time for SPC implementation, so the SPC is not recommended

methodology by top management, but, there are a lot of quality control technics are already implemented as sampling and testing process, data collection and documentation, defects investigation and corrective actions in some cases.

- **Quantitative Data Analysis**

Respondents to the questionnaire show high agreement about the dimension of top management support on SPC implementation, with an average of 4.26 (see Table 4.4), since the item (Top management demands regular process performance reviews) has the highest mean for this dimension with the mean 4.62.

However, the questionnaire result for this dimension does not support the interviews' results. The researcher explained these issues as follow:

Building on the demographic characteristics, all of the respondents of the target sample belong to a high or middle position level. Mostly, the employees at this level often try to show the best image of their companies and hide any weaknesses points and negative images from others, i.e., their answers reflect the image that they want to show to others, not the actual image. Therefore, most of their responses tend towards (agree - strongly agree).

During the interviews, the researcher noted a possible positive relationship between the respondent being a family member of the company and the subjectivity or bias of their answer. The company's family members try to show the company a perfect picture to preserve its reputation. As for the respondents who are not the company's family members, their answers are more honest and objective than others, and therefore their responses can be more reliable.

Table 4.4 Mean and Standard Deviation for the Top Management Support Dimension

<b>Object</b>	<b>Mean</b>	<b>Std. Deviation</b>
The management is ready to shut down an unstable process for corrective action	4.2973	.74030
Top management understands its role to start implementing SPC	4.2432	.95468
Top management demands regular (e.g., Daily, weekly) process performance reviews.	4.6216	.79412
Top management allocates adequate financial resources to promote SPC	3.8378	1.09325
The management allows for sufficient time to implement SPC	4.3243	.57995
The management supports training an old production employee for a new employee on the requirements to achieve quality control.	4.2432	.89460
<b>Average</b>	<b>4.2612</b>	<b>0.8428</b>

### **Measurement System Readiness**

The purpose of the measurement system is to verify whether the quality parameters are measured accurately to detect errors and apply corrective action to improve the process. Thus, the measurement system includes several significant components that must require attention in the production line, like the employees, machinery, and measuring equipment (S. Lim & Antony, 2019).

The measurement system helps assess the amount of variability through the equipment used to measure quality parameters, isolate the causes of variability in the measurement system, and assess the equipment or instrument (Doganaksoy & Hahn, 2014; Montgomery, 2020). So, the existence of a measurement system is one factor that influences SPC implementation.

- **Qualitative Data Analysis**

As noted by the researcher from interviews analysis, no interviewees have an integrated measurement system. Still, many of them have a data collection system, as a part of the measurement system. As P3, P4, P5, ... and P11 explain about data collected manner in their companies:

*“The samples are taken based on a systematic sampling system, i.e., a specific number of samples taken from each batch to ensure that conform to the determined specifications, the collected data is recorded through excel forms built by the company”* (P3, P8, and P11).

*“The samples are taken, and the data collected recorded by paper forms”* (interviewees 4, 5, 7, and 9)

*“The Samples are taken regularly, and their data recorded through paper forms and then transferred to Excel sheet”* ( P3, P8, and P11).

*“The PSI instructions determine the production specification limits, and any sample outside of these limits will be excluded, and investigate the causes of their non-conformity”* (P3 and P11).

*“to some extent, the large-size companies have a good level readiness for the SPC application; they are nearly 70% ready to implement SPC methodology, without realizing it by these companies”* (P1 and P3).

*“The problem is how well analyze and interpret the collected data. This problem stems from the lack of expertise in the field of data analysis and statistical knowledge”* (P1).

Most participants employ a data collection and have a database, either through paper or Excel forms. But they are not aware of the post-documentation stage of this data. Data is not exploited or analyzed scientifically. The lack of specialists in data analysis methods may explain this situation. The top management does not care about the importance of employing expertise in statistical data analysis or software like (SPSS, Mini tap.. etc.). The Weakness in this aspect has been confirmed by a few interviewees explain:

*"in terms of data analysis, some calculations are made, including average, variation, mean, and standard deviation. Some data are converted into graphics and histograms, but not interpreted and exploited in the correct scientific methods. The histograms and other graphs are used only for the presentation of managerial meetings" (P1 and P11)*

The above comment agrees with (Bjerke & Hersleth, 2001) work. They detect that the data is usually stored and rarely used for quality improvement purposes in the food industry because of the poor understanding of the usage and importance of data.

*"The companies making decisions based on the direct and striking data only, but they do not look beyond this data and making in-depth analysis to quality improvement purposes and gain new ideas outside the box." (P1 and P2)*

- **Quantitative Data Analysis**

The previous comments for this dimension agree with the SPSS analysis regarding data collection and documentation. The item (the measurement data for product specifications is always recorded) has the highest mean at this dimension, 4.48.

Regarding the training of operators in dairy companies, according to the SPSS analysis, the item (Employees are trained to conduct data collection) has the lowest mean of 3.7568 at this dimension (Table 4.5); this result weakens the Palestinian dairy companies' readiness to implement SPC in this aspect of calibrating and training.

The item (Guidelines exist for calibrating the measuring equipment) has a low mean compared to other items in this dimension; it was 3.8919 as Table 4.5. These results are agreed with the interviewees' comment as follow:

*“The calibration process of machines is done periodically, but there are no documented instructions or guides for the calibration process” (P6, P8, and P11).*

The importance of calibration and training process confirmed by (Kovach & Cho, 2011; Srikaeo et al., 2005) explains that to improve the capability for the measurement system; the food companies may require re-calibrating the equipment and increasing the training of operators as corrective actions for an incapable measurement system.

Table 4.5 Mean and Standard Deviation for the Measurement System Readiness Dimension

<b>Object</b>	<b>Mean</b>	<b>Std. Deviation</b>
The measurement system is available	4.3243	.85160
The Measurement data for product specifications are always recorded.	4.4865	.69208
Employees aware and understand the key processes and their critical parameters	4.3784	.63907
Employees are trained to conduct data collection	3.7568	.98334
Guidelines exist for calibrating the measuring equipment	3.8919	1.36999
The company uses the collected measurements to make production decisions	4.1944	.85589

The company use software systems for data analysis, as Mini Tab, SPSS.. etc.	3.9722	1.29804
<b>Average</b>	<b>4.1435</b>	<b>0.9557</b>

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### **Organizational Culture**

SPC experts believe that the organizational culture vitally influences accepting employees the SPC implementation in the food sector (Sarina Abdul Halim Lim & Antony, 2016).

- **Qualitative Data Analysis**

P4 is the manager of one of the oldest dairy factories and the smallest one in terms of production capacity and the number of employees; he stated the following words:

*“The expansion and development in the large-dairy companies are attributed to one main reason, which is the Fund; through financial support from foreign countries and loans from banks” (P4).*

The researcher noted that P4, besides the fund, did not mention or give attention to other vital issues that contribute to company quality improvements, like strategic planning and efficient management for these funds, which indicates the traditional mentality of the manager of this company and why their company remained at the bottom.

A lot of interviewees have confirmed the obstacles of quality management systems adoption; some interviewees stated:

*“The main barriers to implementing quality management systems are the lack of financial resources and inadequate infrastructure and facilities” (P1, P2, P5, P6, and P7).*

*“the poor understanding of the quality management systems application is the main reason for the limited adoption of these systems”* (P1 and P9).

*“The implementation of quality standers is not compulsory from the government; therefore, our company is limited to the minimum requirement of these standers”* (P1 and P2).

In term decisions making process, a lot of interviewees have ensured the importance of a systematic decision-making process; the interviewee's declaration is as follow:

*“The decision-making process builds on data, not sense; the management is used to solve problems at the production line”* (P3, P8, and P11).

*“We delegate employees' decision-making practices through the available data collected for corrective action and improvement purposes”* (P3 and P11).

As confirmed by literature, a data-driven culture is highly necessary for decision-making and performance assessment (Grigg, 1998; Luning & Marcelis, 2009; Lim & Antony, 2016).

- **Quantitative Data Analysis**

The interviewee's analysis agrees with further literature and the quantitative data analysis regarding barriers to quality standers implementation (Table 4.6). The item of (The management supports the adoption of established quality systems (TQM, Six Sigma, Lean, Lean Six Sigma, ISO 9000, ..etc.) have the lower mean at this dimension it was 3.4000, this result agreed with (Trienekens & Zuurbier, 2008). Their results that the developing countries and emerging economies have problems complying with Quality

standards mainly refer to increasing additional costs of accreditation as certification, auditing, and quality assurance, which puts pressure on company profits.

The interview analysis supports questionnaire analysis regarding the importance of systematic decision-making. Table 4.6, the item (Decision-making is based on data) has a higher mean at this dimension, 4.3784. This item is the most essential item to support the organizational culture to SPC implementation, so, it's a good indicator for the readiness of the dairy sector.

Additionally, the items (Employees practice preventive maintenance) and (The brands' names are considered when a company makes machine-buying decisions) have a low means compared to other items at this dimension, it was 3.9706, 3.8649 respectively (Table 4.6). This is not a good indicator for the sample under study in care about preventive maintenance and buying brands machines. Although the importance of these issues is ensured by (Kovach & Cho, 2011; Srikaeo et al., 2005) is proved that the food companies may require preventive maintenance for the equipment/machines and updating the latest model of manufacturing machines.

Table 4.6 Mean and Standard Deviation for the Organizational Culture Dimension

<b>Object</b>	<b>Mean</b>	<b>Std. Deviation</b>
Decision-making is based on data	4.3784	.75834
Problems are addressed using teamwork / cross-functional teams.	4.1892	.84452
Employees practice preventive maintenance	3.9706	1.02942
The tolerance specification data of the company machines systems are set and insured continually	4.0833	.84092
The brands' names are considered when a company makes machine-buying decisions.	3.8649	1.08429

Regular meetings (e.g. monthly) are held to discuss quality issues and problems using data	3.6216	1.27696
The Management emphasizes the accuracy in recording production process data.	4.3243	1.02886
The management supports the adoption of established quality systems (TQM, Six Sigma, Lean, Lean Six Sigma, ISO 9000,.. etc).	3.4000	1.35473
<b>Average</b>	<b>3.9790</b>	<b>1.0272</b>

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### **Urgency to Change**

One factor that emerged in overcoming resistance to change: is a sense of urgency (Kotter, 2008). Underlying this factor is the question: Why do we need SPC in this company? A sense of urgency indicates that top management is highly motivated to improve the status (Lim & Antony, 2019). So, the urgency to change is one of the dimensions influencing SPC implementation.

- **Qualitative Data Analysis**

Resistance to change items revealed the most prominent barrier to successful SPC implementation in the food industry (Lim & Antony, 2016; Lim & Antony, 2019). This study agrees with P3, who states:

*“To implement SPC methodology at all, the company will face many difficulties in terms of organizational change, so it's better to start with a pilot project, provided a team member is knowledgeable and experienced in implementing SPC.”*

In the analysis of the interviews, no company from the target sample is implementing SPC methodology, as evidenced by the declarations of some interviewees about their SPC background.

*"I've never heard of this method"* (P4, P5, P7, P6, P9, and P10).

*"I have a few theoretical backgrounds about SPC methodology, but I have never thought to apply it practically"* (P1, P8, and P11).

Out of all the interviewees, one interviewee (P3) confirmed that he knows a lot about SPC methodology; he stated:

*"I have sufficient knowledge about SPC; I study this methodology as a concept and practice through external workshops and training courses. Continually I try to apply its tools to control the production process and ensure the consistency within the specifications"* (P3).

- **Quantitative Data Analysis**

The above comments were confirmed through questionnaires analysis by the items of (Top management communicates legitimate reasons for adopting SPC) and (An systematic and practical guidelines for SPC implementation are available) from Table 4.7 have a lower means for this dimension, it was 3.9444 and 3.9118. generally, this dimension has a lower mean compared with other sections, simply, this indicates that the SPC culture within Palestinian dairy countries is minor or unrecognized.

The low mean of this dimension explained by (Dora et al., 2013) resulted in the food industry is highly resistant to SPC implementation due to fear and unfamiliarity with statistical techniques because they are rarely required to apply statistical methods in their daily job.

Table 4.7 Mean and Standard Deviation for the Urgency to Change Dimension

<b>Object</b>	<b>Mean</b>	<b>Std. Deviation</b>
the company Understand that SPC can improve process performance continuously	4.0811	.92431
During my tenure at the company, the company developed methods for controlling the quality of products and applied new methods that increased the stability of product specifications.	4.2500	.80623
Top management communicates legitimate reasons for adopting SPC	3.9444	.95452
A systematic and practical guideline for SPC implementation are available	3.9118	1.16431
<b>Average</b>	<b>4.04682</b>	<b>0.9623</b>

### **Employee Involvement**

Grigg & Walls, (2007); Kafetzopoulos & Gotzamani, (2014) are confirms the essential of employee involvement to SPC's successful implementation in food companies; they said it should promote employee involvement and creativity in quality improvement activities.

- **(Qualitative and Quantitative Data Analysis**

The item (external/internal SPC facilitator is hired to aid SPC implementation) has the lower means at this dimension among respondents, it was 3.5833 (as shown in Table 4.8), this result agrees with the previous dimension of urgency to change items 3&4, it was shown that the SPC culture is almost unrecognized.

This result agreed with some interviewees how stated:

*"There is no need for external specialists and experts. The statistical analysis is easy, as statistical programs facilitate the analysis process. The most important is interpreting and exploiting it in decision-making (P3 and P7).*

Some interviewees confirmed a need for trained and skilled employees in the field of statistical analysis. Therefore, the item of (Employees are trained in basic statistics) have a low means compared to other items at this dimension within respondents; it was 3.9429; this result agreed with some interviewees who stated:

*"In terms of employees' statistical background, the employees need training courses to improve their data analysis mindset through adopting the software programs for statistical analysis of collected data, to be used in making decisions" (P1, P8, and P11).*

*"to some extent, a set of the production staff are trained periodically on several issues, including food safety management, risk management .. etc. But, there are no local training programs specialized in quality control within dairy manufacturing. Therefore a knowledge gap in this field exists" (P3 and P11).*

The importance of employee training is confirmed by (Lim & Antony, 2019). They explain that creating an effective training program that emphasizes corporate culture change is essential, and training is a practical approach to developing a sense of responsibility and empowerment.

The item of (Employees' ideas and opinions are appreciated) have high mean, it was 4.0811 as Table 4.8. This agreed with the interview analysis. The interviewees P8, P9, and P11 have confirmed upper management's support, empowerment, and attention towards the employees' opinions, ideas, and suggestions. Some interviewees stated:

*"the senior management at most supports the employees at all level, since, their suggestions and new ideas are put on the table for discussion to study their feasibility, and adopt them if they prove their worth"* (P8, P9, and P11).

Table 4.8 Mean and Standard Deviation for the Employee Involvement Dimension

<b>Criteria</b>	<b>Mean</b>	<b>Std. Deviation</b>
Employees are trained in basic statistics	3.9429	.90563
Employees' ideas and opinions are appreciated	4.0811	.89376
SPC facilitator is hired (external/internal) to aid SPC implementation	3.5833	1.22766
Employees understand the benefits of process improvement to the business and themselves	4.3784	.82836
Employees are involved in CI activities	4.0000	.97183
<b>Average</b>	3.9971	0.9654

#### **4.5.2 Methodological Aspect**

The methodological aspect is the second complementary aspect that is important to the successful implementation of SPC methodology; this aspect addresses the practical procedures and instructions involved production process to successful implementation of SPC. The researcher split this aspect into three dimensions: Process performance, Applied testing parameters, Applied quality control tools as follows.

To qualitative and quantitative data analysis, this aspect answers the first and third research questions (What are the perceived determinants to implement SPC in the Palestinian dairy industry?) through qualitative data analysis, and (How well prepared, regarding methodological requirements, are the Palestinian dairy firms to implement SPC?) through quantitative data analysis. To assessing the readiness of Methodological

aspects within Palestinian dairy companies. The finding of data analysis for this aspect presented as the following manner:

### **Process Performance Measurement**

According to (Lim et al., 2017; Lim & Antony, 2019), the process performance measurement is one of the dimensions influencing SPC implementation.

- **Qualitative Data Analysis**

All interviewees agreed that:

*“The dairy manufacturing sector is one of the most sensitive sectors because of its dependence mainly on the milk product. Therefore, it needs systematic and intensive quality control procedures for all variables and processing parameters to ensure the stability of the production process at all stages to gain products that confirm the specifications. Therefore, the application of SPC is critical in this sector.”*

The above comment agreed with the literature on this topic; since dairy processing is easily polluted and deteriorates rapidly, microorganisms from several sources may contain contaminant products (Papademas & Bintsis, 2010). Thus, the quality control of raw milk sources is necessary for assuring quality control within all dairy production stages (Ding et al., 2019).

In term of customer complaints management, the interviewees confirm the management's attention to customer complaints as follow:

*“There is a special department for customer complaints management; the staff follows up the customers' complaints systematically from the complaint's arrival until to ensuring customer satisfaction”*(P3, P6, and P11).

*"Although there is no customer complaints department or special staff, the top management gives intensive attention to this issue, as it is the one who follows up on customers to ensure they are satisfied"* (P4, P7, P8, and P9).

On the other hand, Through the interviews:

*"the defect and defective products are excluded for destruction or reworking process; however, they are not considered when calculating the cost of quality"* (P4, P5, P6, P7, and P9).

*"the company doesn't measure the waste, scrap, and productivity (yield or throughput) as the performance measurement of the production process"* P4, P5, P6, P7, and P9).

From another hand, most interviewees agreed that waste reduction is the most significant advantage gained from quality control practices.

This, confirmed by (Lim et al., 2017), has resulted in significant differences between SPC and non-SPC companies in terms of waste, product consistency, customer complaints, defect rates, productivity, rework percentages, and quality awareness.

- **Quantitative Data Analysis**

The item (Fresh samples are taken based on a systematic sampling system) has the highest mean at this dimension, 4.5405 (as shown in Table 4.9). This agrees with the dimension of (measurement system), which shows a high mean of the item (Measurement data for product specifications is always recorded, it is again 4.4865 (see Table 4.5) which indicates the existence of sampling and documentation system. This is

a good point to increase the readiness for SPC implementation within companies under study.

Again, the questionnaire results align with the interviewees' analysis of management attention to customer complaints. The items of (The company has a customer complaints system) and (The company follows up the customer complaints to ensure they are satisfied) have high means at this dimension, were was 4.3714 and 4.4865 respectively.

The result of interviews and questionnaires are agreed with the literature in term of managing the customer complaints to achieve customer satisfaction as follow: Companies that have applied SPC have higher process performance criteria in terms of customer satisfaction and customer loyalty (Lim & Antony, 2019).

Table 4.9 Mean and Standard Deviation for the Process performance measurement dimension

<b>Object</b>	<b>Mean</b>	<b>Std. Deviation</b>
The processes cycle time is well-known and imposed	4.0811	.86212
Fresh samples are taken based on a systematic sampling system	4.5405	.64956
The company investigates beyond the inconsistency process to become consistent and under control	4.2973	.74030
The defects percentages are calculated and considered	4.2432	1.03831
The Rework percentages are calculated and considered	4.1111	1.14087
The company addresses the root causes to eliminate or reduce them	4.3514	.85687
The company has a customer complaints system.	4.3714	1.11370
The company follow up the customer complaints to ensure they are satisfied	4.4865	.83738
<b>Average</b>	4.3103	0.9048

### **Applied Testing Parameters (Process Parameters and Measurement Tools)**

- **Qualitative and Quantitative Data Analysis**

Concerning the reliability test for this dimension, the Cronbach's Alpha was (0.523), as Table 3.10 at chapter three, this value is unacceptable due to is lower than 0.70, the researcher guesses that there is a misunderstanding in this dimension among responders refer to poor usage of the testing equipment (measurement tools). This reason is agreed with (Luning & Marcelis, 2009; Van der Spiegel et al., 2003) detects that the main problem in food quality management practices is the lack of proper equipment and the use of faulty measuring equipment. Additionally, the small sample size of the research may create biases and harm the reliability.

As interviews analysis, all interviewees stated that all dairy companies conduct the same production tests by the same measuring tools, such as the test of weight, PH, dry matter, temperature .. etc. as interviewees P1 & P4 clear:

*“These examinations are considered the minimum required for the Palestinian Ministry of Health.”*

Regarding Table 4.10, all 37 respondents answered with “yes” related to weight, PH, and temperature test. But, some additional tests distinguish one company from another, namely the test of product taste, smell, product color. etc. As some of the interviewees declare related to these tests:

*"The smell and taste of the product are measured by human sensory evaluation by the quality auditor at the production lines. His opinion relies on being an expert"* (P4, P5, P6, P7, and P8).

*"More than one person measures the product's taste from several company departments to express their opinion" (P3 and P11 ).*

As interviews analysis, the researcher notes that companies under study do not refer to external parties to measure the taste and smell of products, like consultants or inspectors or consumers.

From another hand, for the dairy products color, all the interviewees confirmed that:

*"For color, it only depends on the measurement by eyes without referring to international or local standards."*

although there are some devices and methods for measuring color around the world, such as the colorimetric and/ or spectrophotometry principles, but, some interviewees commented about this principle:

*"The Color measuring devices are very expensive and their cost is exceeded than their value and benefits" (P3 and P8).*

Table 4.10 The Frequencies of the Applied Measurement Tools Dimension, N=37

Criteria	Frequency (%)	
	Yes	No
A balancing device measures the product weight (mass).	37 (100%)	0 (0%)
The product taste is measured by human sensory evaluation, in which tasting a sample is relayed to inspectors.	36 (97.3%)	1 (2.7%)
The product smell is measured by human sensory evaluation, in which tasting a sample is relayed to inspectors.	34 (91.9%)	3 (8.1%)
The product color is measured by the colorimetric and/ or spectrophotometry principles.	19 (51.4%)	18 (48.6%)
The product PH is measured by PH meter.	37 (100%)	0 (0%)

The product density is measured by the lactometer or hydrometer instrument	36 (97.3%)	1 (2.7%)
The product dry matter is measured by dry matter testing equipment	36 (97.3%)	1 (2.7%)
A special thermometer measures the product temperature.	37 (100%)	0 (0%)
An air leakage test checks the product packaging.	25 (67.6%)	12 (32.4%)
The validity of the product's shelf life is measured by taking follow-up samples.	33 (89.2%)	4 (10.8%)
The validity of production inputs (milk) is checked	37 (100%)	0 (0%)
The viability of production inputs (water) is checked.	36 (97.3%)	1 (2.7%)
Verify the plastic packaging specification certificates from the supplier are checked.	33 (89.2%)	4 (10.8%)

### **Applied Quality Control Tools**

The quality tools (SPC tools) consist of qualitative and quantitative approaches. Problem-solving activities are facilitated by using a quality tools variety to maintain consistency of a process and reduce the variability of production (Lim & Antony, 2019).

- **Qualitative Data Analysis**

From the Interviewee's analysis, the researcher discovers that:

All Interviewees are known and use the “Check sheets” tool for data collection.

(P3 and P8) are known and use the "Process Flowchart” to follow the process steps.

(P3, P8, and P11) are known and use the “Histogram” to explore and picture the process variation.

(P3) is known and uses the Cause-and-Effect Analysis to analyze the process problems.

(P4, P5, P6, P7, and P9) I don't know or use any tools of 7 SPC tools, except the Check sheets

Concerning interview analysis, the tools (Check sheets and Process flowcharting) are the most common among Interviewees.

However, no interviewees companies are using the tools of (Scatter Diagram, Pareto Diagram, and Control Charts).

As interviews analysis, no company uses the control charts tool, although it is the most primary tool of SPC methodology.

The analysis of the interviews agrees with (Madanhire & Mbohwa, 2016) finding out that the most popular tools in the developing countries were the Check Sheets and Flow Charts, respectively, followed by Pareto Analysis as the third. The other five SPC tools did not have a significant application. Thus, the poor application of Histograms, control charts, cause& effect diagrams, and scatter diagrams needs to restructure the companies' policies regarding SPC tools.

During the interviews, it was proven that all companies record production process data through forms either by paper or Excel sheet, but in fact, no company knows the scientific name of this data form, which is “check sheet”.

To some extent, some companies partially applied SPC and may be ready for the implementation process without the company realizing that because there have a misunderstanding of the concept of SPC and cognitive deficiency.

Therefore, no company from the Palestinian dairy sector is systematically implementing all SPC tools. Still, the companies' readiness for SPC implementation varies based on the usage of companies' characteristics and attributes.

- **Quantitative Data Analysis**

There is a moderate agreement between qualitative and quantitative data analysis among interviewees and questionnaire respondents for this dimension.

The flow chart and check sheet tools gain the highest number of frequencies in terms of “Tool theoretical background and Tool practical implementation.” Out of 37 respondents, 27 respondents have a theoretical background about these tools, 20 respondents have Process Flowchart practical implementation, and 23 respondents have check sheet practical implementation (see Table 4.11). To some extent, this result agreed with the interviewees' analysis, who declared that the tools (Check sheets and Process flowcharting) are the most common tools among interviewees.

There is a clear gap of practical implementation in Scatter Diagram, Pareto Diagram, and control chart tools. As Table 4.11, out of 37 respondents, 25 respondents don't have a practical implementation on the Scatter Diagram tool, 26 respondents don't have a practical implementation on the Pareto Diagram tool, and 22 respondents don't have practical implementation of the control chart tool (Table 4.11). To some extent, this result agreed with the interviewee's analysis, who declared that the means (Scatter Diagram, Pareto Diagram, and Control Charts) no Interviewees companies are using them.

At this dimension, the results of interviews are more accurate and reliable than questionnaires; the researcher interprets that, during the interviews, there is the ability to make face-to-face discussions with respondents and investigate SPC tools in more depth, thus obtaining more accurate answers. However, respondents may have misunderstood the SPC tools term while filling out the questionnaire, so their responses

were somewhat random. Also, the small size of the target sample may affect the accuracy of the questionnaire results.

There is a moderately agreed between the results of interviews and questionnaires in terms of applied quality control tools, which may be due to a misunderstanding in SPC tools application among respondents, so their answers were somewhat random.

Table 4.11 The Frequencies of the Applied quality control tools dimension, N=37

Object	Frequency (%)				Missing Data
	Tool theoretical background		Tool practical implementation		
	Yes	No	Yes	No	
The company follows up the process steps by "Process Flowchart"	27 (72.9%)	6 (16.2%)	20 (54.0%)	11 (29.7%)	11 (29.7%)
The company collects data about process performance by "Check sheets"	27 (72.9%)	7 (18.9%)	23 (62.1%)	12 (32.4.6%)	5 (13.5%)
The company explores and pictures the process variation by "Histogram"	18 (48.6%)	14 (37.8%)	13 (35.1%)	20 (54.0%)	9 (24.3%)
The company explores and relationships between variables by "Scatter Diagram"	15 (40.5%)	17 (45.9%)	6 (16.2%)	25 (67.5%)	11 (29.7%)
The company analyzes the process problems by "Cause-and-Effect Analysis"	19 (51.3%)	13 (35.1%)	15 (40.5%)	18 (48.6%)	9 (24.3%)
The company prioritizes the process problems to solve it by "Pareto Diagram"	11 (29.7%)	21 (56.7%)	6 (16.2%)	26 (70.2%)	11 (29.7%)
The company monitors the process variation by "Control Charts"	18 (48.6%)	14 (37.8%)	10 (27.0%)	22 (59.4%)	10 (27.0%)

#### 4.6 ANOVA Analysis (One Way Analysis of Variance) Test of Differences Between Groups

The researcher used the one-way analysis of variance (ANOVA) to determine any differences between the means of more independent variables. So, one-way ANOVA was conducted to understand whether SPC implementation readiness differed based on demographic characteristics for the companies under study (location, ownership, legal form, size, age, accreditations) amongst Palestinian dairy companies. The following results show the important relationships based on SPSS analysis.

Therefore, the one-way ANOVA is conducted to answer the following hypothesis:

**H<sub>0</sub> (null hypothesis):** There is no significant difference between the means of different groups of respondents.

**H<sub>1</sub> (alternative hypothesis):** There is a significant difference between the means of different groups of respondents.

Significance level P-values < 0.05

### Company's Location

The researcher examines a significant difference in readiness to SPC implementation between the company's Location groups, so the One Way ANOVA Test was conducted.

The results show significant differences between the company's location groups in SPC implementation readiness in the dimension of "Employee Involvement" with a P-value = 0.009 (P-values < 0.05).

Therefore, there is evidence to reject the null hypothesis (Table 4.12).

Table 4.12 One-Way ANOVA for the Company's Location

Dimension		Sum of Squares	df	Mean Square	F	Sig.
<b>Top Management Commitment</b>	Between Groups	.004	1	.004		.890
	Within Groups	7.970	35	.228		
	Total	7.974	36			
<b>Measurement System</b>	Between Groups	.056	1	.056	.103	.750
	Within Groups	18.350	34	.540		
	Total	18.406	35			
<b>Organizational Culture</b>	Between Groups	.512	1	.512	.900	.350
	Within Groups	17.070	30	.569		
	Total	17.582	31			
<b>Urgency to Change</b>	Between Groups	.864	1	.864	2.078	.159
	Within Groups	12.890	31	.416		
	Total	13.754	32			
<b>Employee Involvement</b>	Between Groups	3.314	1	3.314	7.678	.009
	Within Groups	14.245	33	.432		
<b>Total</b>		<b>17.559</b>	<b>34</b>			

Dependent Variable: SPC implementation Readiness

### Company's Ownership

The researcher guesses that there is a difference in readiness to SPC implementation between the company's ownership groups, so the One - Way ANOVA test was conducted.

As Table 4.13 shows, there aren't significant differences between the company's ownership groups in SPC implementation. since the p-values are more than the significance level of 0.05, the researcher fails to reject the null hypothesis. This indicates that the independent variable doesn't influence the dependent variables.

Table 4.13 One-Way ANOVA for the Company's Ownership

Dimension		Sum of Squares	df	Mean Square	F	Sig.
<b>Top Management Commitment</b>	Between Groups	.108	1	.108	.480	.493
	Within Groups	7.867	35	.225		
	Total	7.974	36			
<b>Measurement System</b>	Between Groups	.059	1	.059	.109	.744
	Within Groups	18.347	34	.540		
	Total	18.406	35			
<b>Organizational Culture</b>	Between Groups	.047	1	.047	.080	.779
	Within Groups	17.535	30	.584		
	Total	17.582	31			
<b>Urgency to Change</b>	Between Groups	.076	1	.076	.172	.681
	Within Groups	13.678	31	.441		
	Total	13.754	32			
<b>Employee Involvement</b>	Between Groups	.014	1	.014	.027	.871
	Within Groups	17.545	33	.532		
<b>Total</b>		<b>17.559</b>	<b>34</b>			

Dependent Variable: SPC implementation Readiness

### Company's Legal Form

The One-Way ANOVA Test was conducted to examine the difference in readiness to SPC implementation between the company's based Legal Form.

The results showed no significant differences between the company's legal form groups in SPC implementation. since the p-values are more than the significance level of 0.05, the researcher fail to reject the null hypothesis Table (4.14). This indicates that the independent variable doesn't influence the dependent variables.

Table 4.14 One-Way ANOVA for the Company's Legal Form

<b>Dimension</b>		<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>
<b>Top Management Commitment</b>	Between Groups	.029	1	.029	.129	.722
	Within Groups	7.945	35	.227		
	Total	7.974	36			
<b>Measurement System</b>	Between Groups	.253	1	.253	.473	.496
	Within Groups	18.153	34	.534		
	Total	18.406	35			
<b>Organizational Culture</b>	Between Groups	.024	1	.024	.041	.842
	Within Groups	17.558	30	.585		
	Total	17.582	31			
<b>Urgency to Change</b>	Between Groups	.118	1	.118	.269	.608
	Within Groups	13.635	31	.440		
	Total	13.754	32			
<b>Employee Involvement</b>	Between Groups	.003	1	.003	.006	.936
	Within Groups	17.555	33	.532		
<b>Total</b>		<b>17.559</b>	<b>34</b>			

Dependent Variable: SPC implementation Readiness

### **Company's Size**

One Way ANOVA Test was conducted to check the differences in the readiness of Palestinian dairy companies to implement SPC methodology between groups in term of company's size (large and small size) either based on production capacity or a number of employees as indicators. Results show no significant differences between the company's size groups in SPC implementation readiness (Table 4.15).

Since the P-values are more than the significance level (0.05), the researcher fail to reject the null hypothesis that the company's size does not affect SPC implementation readiness. And it concludes that there is no sufficient evidence to say that there is a

statistically significant difference between the mean of SPC implementation readiness of the company's size groups.

However, compared with the researcher's findings during interviews, the interviewee's analysis explores a difference between Palestinian dairy companies in terms of size concerning the readiness of the SPC implementation process. The researcher attributed this incompatibility to the small sample size may impede accurate quantitative data results.

Table 4.15 One-Way ANOVA for the Company's Size

<b>Dimension</b>		<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>
<b>Top Management Commitment</b>	Between Groups	.043	1	.043	.191	.665
	Within Groups	7.931	35	.227		
	Total	7.974	36			
<b>Measurement System</b>	Between Groups	1.965	1	1.965	4.063	.052
	Within Groups	16.441	34	.484		
	Total	18.406	35			
<b>Organizational Culture</b>	Between Groups	.098	1	.098	.168	.685
	Within Groups	17.484	30	.583		
	Total	17.582	31			
<b>Urgency to Change</b>	Between Groups	.094	1	.094	.214	.647
	Within Groups	13.660	31	.441		
	Total	13.754	32			
<b>Employee Involvement</b>	Between Groups	.417	1	.417	.803	.377
	Within Groups	17.142	33	.519		
<b>Total</b>		<b>17.559</b>	<b>34</b>			

Dependent Variable: SPC implementation Readiness

### **Company's Age**

The One-Way ANOVA test was conducted to examine the difference in readiness for SPC implementation between the companies based on their age. Table 4.16 shows that there are significant differences between the company's age groups in SPC implementation readiness in the dimensions of "Measurement System, Organizational

Culture, Urgency to Change, Employee Involvement” with P-values .002, .005, .024, .004, respectively, which are less than the significance level (P-values =.05).

Since some p-values are less than the significance level of 0.05, the researcher rejects the null hypothesis. This indicates that the independent variable influences the dependent variables.

Table 4.16 One-Way ANOVA for the Company’s Age

<b>Dimension</b>		<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>
<b>Top Management Commitment</b>	Between Groups	1.965	8	.246	1.133	.375
	Within Groups	5.634	26	.217		
	Total	7.598	34			
<b>Measurement System</b>	Between Groups	8.530	8	1.066	4.466	.002
	Within Groups	5.968	25	.239		
	Total	14.498	33			
<b>Organizational Culture</b>	Between Groups	9.054	8	1.132	3.929	.005
	Within Groups	6.336	22	.288		
	Total	15.390	30			
<b>Urgency to Change</b>	Between Groups	6.462	8	.808	2.842	.024
	Within Groups	6.536	23	.284		
	Total	12.998	31			
<b>Employee Involvement</b>	Between Groups	9.981	8	1.248	4.056	.004
	Within Groups	7.382	24	.308		
<b>Total</b>		<b>17.362</b>	<b>32</b>			

Dependent Variable: SPC implementation Readiness

### **Company’s Accreditations**

One Way ANOVA test was conducted to check the differences in the readiness of Palestinian dairy companies to implement SPC methodology between groups based on company’s accreditations. Accreditation could be (ISO 45001, ISO 22000, ISO 9001, HACCP, PS, ISO 9001& PS, ISO 22000 & Other, Other, Nothing).

Table 4.17 shows significant differences between the company's accreditations groups in SPC implementation readiness in the dimension of "Urgency to Change" with P-values of .030, which is less than the significance level (P-values =.05).

Since the p-value is less than the significance level of 0.05, the researcher rejects the null hypothesis. This indicates that the independent variable influences the dependent variable.

To some extent, the analysis of the questionnaire agreed with the interviewee's analysis, since the researcher noted during interviews that there are differences between the target sample in terms of the company's accreditations about readiness for the SPC implementation process.

Table 4.17 One-Way ANOVA for the Company's Accreditations

<b>Dimension</b>		<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>
<b>Top Management Commitment</b>	Between Groups	.199	4	.050	.205	.934
	Within Groups	7.775	32	.243		
	Total	7.974	36			
<b>Measurement System</b>	Between Groups	4.072	4	1.018	2.202	.092
	Within Groups	14.334	31	.462		
	Total	18.406	35			
<b>Organizational Culture</b>	Between Groups	4.856	4	1.214	2.576	.060
	Within Groups	12.725	27	.471		
	Total	17.582	31			
<b>Urgency to Change</b>	Between Groups	4.261	4	1.065	3.142	.030
	Within Groups	9.493	28	.339		
	Total	13.754	32			
<b>Employee Involvement</b>	Between Groups	4.520	4	1.130	2.600	.056
	Within Groups	13.039	30	.435		
<b>Total</b>		<b>17.559</b>	<b>34</b>			

Dependent Variable: SPC implementation Readiness

#### 4.7 Regression Analysis

A Stepwise Regression was conducted to provide evidence of rejecting the above three null hypotheses. Table 4.19 shows the regression coefficients and their P-values (Sig.). The result indicates that the significant independent variables (top management commitment, measurement system, organizational culture, urgency to change, and employee involvement) have a P-value of .000, .000, .000, .000, and .012, respectively. Additionally, based on the standardized coefficients, the most significant independent variables are the top management commitment, measurement system, organizational culture, and urgency to change than employee involvement. The results show that the model is fitted at a 95% confidence interval.

Table 4.18 SPC Readiness Regressions Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.838	.619		1.354	.185
<b>Top Management Commitment</b>	.834	.144	.715	5.787	.000

Dependent Variable: Process Performance

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.999	.435		4.592	.000
<b>Measurement System</b>	.571	.102	.708	5.588	.000

Dependent Variable: Process Performance

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.
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	<b>B</b>	<b>Std. Error</b>	<b>Beta</b>		
<b>(Constant)</b>	1.895	.333		5.693	.000
<b>Organizational Culture</b>	.622	.082	.814	7.543	.000

Dependent Variable: Process Performance

<b>Model</b>	<b>Unstandardized Coefficients</b>		<b>Standardized Coefficients</b>	<b>t</b>	<b>Sig.</b>
	<b>B</b>	<b>Std. Error</b>	<b>Beta</b>		
<b>(Constant)</b>	2.172	.486		4.466	.000
<b>Urgency to Change</b>	.546	.115	.668	4.752	.000

Dependent Variable: Process Performance

<b>Model</b>	<b>Unstandardized Coefficients</b>		<b>Standardized Coefficients</b>	<b>t</b>	<b>Sig.</b>
	<b>B</b>	<b>Std. Error</b>	<b>Beta</b>		
<b>(Constant)</b>	2.989	.528		5.657	.000
<b>Employee Involvement</b>	.348	.130	.438	2.672	.012

Dependent Variable: Process Performance

### **Regression Equations**

The level of SPC implementation readiness reflected by process performance dimension, built on the dimensions of top management commitment, measurement system, organizational culture, the urgency to change, and employee involvement, i.e. the researcher based on the process performance dimension as an indicator to measure the level of SPC implementation readiness within Palestinian dairy companies under study.

The Regressions Line that is obtained for predicting the readiness of Palestinian dairy companies to implement SPC methodology is given by:

*The Level of SPC implementation Readiness (Y) = .838 + .834 (X1) + ε*

*The Level of SPC implementation Readiness (Y) = 1.999 + .571(X2) + ε*

*The Level of SPC implementation Readiness (Y) = 1.895 + .622 (X3) + ε*

*The Level of SPC implementation Readiness (Y) = 2.172 + .546 (X4) + ε*

*The Level of SPC implementation Readiness (Y) = 2.989 + .348 (X5) + ε*

The description of regression variables is as follow:

Y = readiness to SPC implementation

X1 = Top Management Commitment

X2 = Measurement System

X3 = Organizational Culture

X4 = Urgency To Change

X5 = Employee Involvement

- (Y) represents the dependent or response variable.
- (X1, X2, X3, X4, and X5) are represent the independent or predictor variables.

### **The Regression Equation Explanation**

- There is a positive relationship between SPC implementation readiness and the company's top management commitment. When increasing the top management commitment by one unit, the SPC implementation readiness will increase by 0.834.
- There is a positive relationship between SPC implementation readiness and the company's measurement system, where when increasing measurement system by one unit, the SPC implementation readiness will increase by 0.571.

- And there is a positive relationship between SPC implementation readiness and the company's organizational culture. When the organizational culture is increased by one unit, the SPC implementation readiness will increase by 0.622.
- There is a positive relationship between SPC implementation readiness and the company's urgency to change. When increasing the urgency to change by one unit, the SPC implementation readiness will increase by .546.
- And there is a positive relationship between SPC implementation readiness and the company's employee involvement. When increasing the employee involvement by one unit, the SPC implementation readiness will increase by .348.

## Chapter 5

### Conclusions and Recommendations

This thesis tackles a vital topic by investigating the prerequisites for adopting SPC among Palestinian dairy producers. Qualitative and quantitative data describe the reality, barriers, and potential areas for improvement. Results shed light on many issues relevant to the institutional body of “The Palestinian Standards Institution” and the management of the dairy companies.

#### 5.1 Qualitative Data Analysis Results

##### **Section One: The Organizational Aspect**

Palestinian dairy companies are ready for the SPC implementation process in term of top management commitment. Since top management among target sample companies supports employee training on quality control methods and demands regular employee performance reviews from employees. On the other hand, the top management must to allocates additional adequate financial resources and allow for sufficient time for SPC implementation and quality control technics in general

Palestinian dairy companies are ready for the SPC implementation process in term of measurement system readiness. Although most respondents have a data collection system that includes a sampling system and database for documented data collection, whether through paper forms or Excel forms, they need to be aware of the importance of in-depth data analysis to improve the decision-making process.

Also, there are apparent misunderstandings in the concept of data analysis by the respondents; they generalize the process of data analysis by the process of converting collected data into graphs like histograms, pie charts, and flowcharts for illustrative and representation purposes in management meetings only.

Dairy companies do not show a sufficient level of readiness for implementing SPC regarding organizational culture readiness. Because the traditional mindset of senior management is not uncommon, it still can affect the ways of thinking and decision-making process. The Palestinian dairy companies have problems complying with quality standards, which refer to a lack of knowledgeable people, financial resources, and inadequate infrastructure and facilities. Substantially, the SPC culture is almost unrecognized. Operationally, the SPC is considered an advanced methodology for this sector.

Palestinian dairy companies do not have a readiness for the SPC implementation process regarding the urgency to change. Since the top management of the target sample doesn't explain the reasons for adopting SPC with employees, and there are no systematic and practical guidelines for SPC implementation. Therefore, the Palestinian dairy companies are highly resistant to SPC implementation due to fear and lack of knowledge of statistical techniques because they are rarely required to apply them in their daily jobs.

Palestinian dairy companies do not have a readiness for the SPC implementation process in terms of employees involvement. Since there are no skilled employees in statistical analysis or hired external/internal SPC facilitators to aid SPC implementation,

although the upper management considers and appreciates the employees' opinions, ideas, and suggestions.

### **Section Two: The Methodological Aspect**

Palestinian dairy companies are ready to implement the SPC methodology in terms of process performance dimension. Since the Palestinian dairy companies have a systematic sampling system, thus the defect and defective products are excluded from the destruction or reworking process. The companies also follow up the customer complaints to ensure that they are satisfied.

According to respondents, they are ready to implement the SPC methodology in the applied testing parameters dimension. The Palestinian dairy companies conduct the same production tests by measuring tools, such as weight, PH, dryness matters, and temperature. But, some additional tests distinguish one company from another, namely the test of product taste, smell, and product color. The companies' awareness of these extra tests has determined the company's interest in obtaining a stable production process.

Finally, concerning the applied quality control tools, to some extent, the Palestinian dairy industry doesn't implement quality control tools. Only the tools (Check sheets and Process flowcharting) are common among the interviewed firms. However, the tools (Scatter Diagram, Pareto Diagram, and Control Charts) are not used or even recognized.

### **Section Three: The Demographic Characteristic (Size and Accreditation)**

There are differences between the Palestinian dairy companies regarding size categories (large and small) regarding adoption of quality control procedures that help ensure its stability and continuity within determined specification limits.

There are differences between the Palestinian dairy companies regarding quality systems accreditation about readiness for SPC implementation. Since, for respondents under study, the marketing goal is the primary motive for adopting established quality systems such as (PS, ISO 9001, and ISO 22000) to gain a good reputation among consumers. Performance enhancement or continuous process improvement comes as a secondary goal. Competition between companies also plays a crucial role in obtaining these certificates. This creates a difference between these companies in their readiness to implement SPC methodology compared to companies that do not have accreditations in quality.

## 5.2 Quantitative Data Analysis Results

### Section One: The Organizational Aspect

- 1) Palestinian dairy companies have the highest degree of top management support toward the SPC methodology implementation process compared to other dimensions in this section.
- 2) Palestinian dairy companies have a moderate level of readiness to adopt an integrated measurement system compared to other dimensions in this section.
- 3) Palestinian dairy companies have a lower readiness level of organizational culture readiness to SPC methodology implementation process than other dimensions in this section.

- 4) Palestinian dairy companies have a low level of urgency to change among employees compared to other dimensions in this section.
- 5) Palestinian dairy companies care about employees' business involvement moderately compared to other dimensions in this section.

### **Section Two: The Methodological Aspect**

- 1) Palestinian dairy companies have a high degree of process performance readiness toward the SPC methodology implementation process compared to other dimensions.
- 2) All respondents have measured the basic tests as weight, PH, and temperature. But, some additional tests distinguish one company from another, namely the test of product taste, smell, and product color. Etc.
- 3) The flow chart and check sheet tools gain the highest frequencies in “Tool theoretical background and practical implementation.” However, there is a clear gap in practical implementation in tools of Scatter Diagram, Pareto Diagram, and control chart,

### **Section Three: The Demographic Characteristic (Size and Accreditation)**

- 1) There are no significant differences in the readiness of Palestinian dairy companies to implement SPC methodology in terms of the company's size variable (large and small size) either based on production capacity or the number of employees as indicators.
- 2) There are significant differences in the readiness of Palestinian dairy companies to implement SPC methodology between groups in terms of company's

accreditations (ISO 45001, ISO 22000, ISO 9001, HACCP, PS, ISO 9001& PS, ISO 22000 & Other, Other, Nothing) about the “Urgency to Change” dimension.

### **5.3 Recommendations**

The related Palestinian ministries must impose quality management standers that manage the quality control practices among Palestinian dairy companies.

Top management's adoption of SPC methodology needs to be recommended by Palestinian dairy companies to achieve a companywide understanding of SPC (benefits and awards) to ensure the production process stability among all stages, thus gaining products that confirm the determined specifications.

The top management of Palestinian dairy companies needs to be employing specialists and expertise in data analysis methods and adopt software programs that facilitate and manage the statistical data analysis process like (SPSS, Mini tap.. etc.) to improve their process performance.

The Palestinian dairy companies need a systematic training program for related employees about statistical thinking, data collection and sampling plans, statistical stability and capability, and effective implementation of quality control tools to improve companywide SPC culture.

The Palestinian dairy sector needs to establish documented instructors for the calibration process of measurement equipment to ensure accurate measures.

The Palestinian dairy sector needs to establish documented instruction for the testing process of quality parameters to detect the amount of variability and out-of-control points, thus applying corrective action to improve the production process.

#### **5.4 Future Researches**

SPC is viewed as a powerful technique through quality control and quality improvement activities. However, the literature suggests that SPC implementation in the food industry is still low compared to other quality control tools and techniques due to high “resistance to change” and “lack of guidance” to implement the method compared to other industries. To facilitate the readiness for SPC implementation in the food industry, particularly the dairy industry, this thesis has proposed a conceptual SPC implementation framework developed from the literature on SPC implementation and the food industry.

This research can be extended in several directions. Considering a larger sample size would be more fruitful in general applicability to the Palestinian dairy industry. Second, do Palestinian dairy companies need to score high on some dimensions for a successful SPC adoption? Moreover, further empirical research should address the relation of readiness dimensions under study. Finally, it is unclear if the dimensions under investigation apply to the individual level of readiness as this research only captured organizational and methodological readiness dimensions. Its implementation entails hierarchical involvement at the corporate, methodological, and personal levels, leading to further investigations.

#### **5.5 Limitations of Research**

In developing countries, quality lags behind developed countries and is less addressed in the literature. Therefore, the scarcity of secondary data in the Palestinian settings constrained the researcher from enriching the discussion. Remarkably, studies that tackle the topic of SPC readiness within the dairy industry are scarce in both developing

and developed countries. So the researcher relied on the articles that address the food industry within developed countries to build the conceptual framework.

The researcher faces various obstacles and limitations that prevent getting valuable data through conducting interviews and questionnaires as survey tools, which may seem in the research. This leads to biased responses, nonresponse, or inaccuracy, affecting the study findings.

### **Qualitative Data Collection Barriers**

Biased responses during interviews were touched when the interviewees are family members of the company and are biased toward showing their companies the best image. This situation constrained the interviewees to talk about their internal performance and weaknesses.

Additionally, given dairy companies' internal policies to maintain the production process's confidentiality and security, access to objective information about the quality control practices was hard for the researcher.

Also, the researcher touched on a significant misunderstanding and lack of Awareness about SPC methodology as a concept among respondents. Although some large-sized companies partially randomly implement SPC without realizing that, this may impede accurate data collection.

### **Quantitative Data Collection Barriers**

The researcher faced several obstacles to identifying the research population. Referring to the relevant Palestinian authorities, sources from (the Palestinian Federation of

Industries, Palestinian Ministry of National Economy, and Palestinian Food Industries Union) are contradictory and are not updated. Later on, the Ministry of Economic list was selected as the most comprehensive list.

Also, the researcher faced several barriers in selecting the research sample. Although the initial list chosen contains 45 dairy companies, 30 companies were excluded for various reasons, including many closed or suspended companies. Others have changed their commercial activity to another activity away from dairy or have duplicate companies under more than one name—companies without service contact numbers, companies under wrong contact numbers, and unanswered contact numbers. Therefore, the researcher investigated only the 15 active companies as a sample.

The researcher suffers from a lack of cooperation by some senior manager companies. Since during the questionnaire distribution process, some of the companies refused to fill the required number of questionnaires that were needed to cover the target sample.

Although most of the target sample are well educated (including 73% university educated and 13.5% postgraduate educated, according to the analysis of the demographic characteristics), the researcher noticed an apparent ignorance and unawareness of the importance of scientific research. Since Out of 53 questionnaires respondents, 16 respondents are answered with “strongly agree” for all questionnaires items, which may indicate to answering without reading the questions. The researcher considers them random filling, so they were excluded for biasing purposes.

Therefore, the small size of the research target sample may create biases and harm reliability and conformity between quantitative and qualitative data analysis results for some readiness dimensions.

The researcher indicates that there is limited information to explain the results from this thesis survey, which highlights the necessity to carry out another in-depth study. The survey supplements the literature supporting the effectiveness of SPC in the food industry and highlights the need for a systematic guideline for SPC implementation in the Palestinian dairy industry covering to increase the adoption of SPC in this sector.

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## Appendixes

### Appendix A: The Dairy Companies Distribution According to Palestinian Ministry of National Economy (MNE)

State of Palestine Ministry of Economy 08/09/2021		دولة فلسطين وزارة الاقتصاد الوطني
<b>النشاط الصناعي: صناعة منتجات الألبان</b>		
العنوان	الهاتف	اسم المصنع
الخليل الرامة	2259612	شركة الجبريني لمنتجات الالبان والمواد الغذائية
بيت كاحل	0599321531	شركة حلب لمنتجات الالبان والمواد الغذائية
الخليل- الشعابة	02-2259612	شركة الجبريني للصناعات الغذائية
ودا الكرم	0568040900	فادي فرج امريش للبوطة
الخليل بيت كاحل	2228618	شركة مصنع البتراء للبوطة وراس العبد
الخليل - الشعابة	022299885	شركة الجبريني لصناعة الاجبان
الخليل - الشعابة	2299885	شركة استثمارات اغروبال
الخليل / المنشر	2252238	شركة الصافي للألبان
الخليل قيزون	2220928	شركة الكرد إخوان للمربطات والمواد الغذائية
الخليل / خلة المغاربة	2229011	شركة الجنيدي لتصنيع الالبان والمواد الغذائية
الخليل	059877226	رمزي عمر محمود الترك
الخليل يطا الكرمل	2270738	البان جمعية نادي شباب الكرمل
14		العدد
<b>النشاط الصناعي: صناعة اللبن الرايب واللبننة</b>		
العنوان	الهاتف	اسم المصنع
الخليل - يطا	2273064	جمعية المنطار التعاونية للثروة الحيوانية
1		العدد
<b>النشاط الصناعي: صناعة منتجات البان اخرى</b>		
العنوان	الهاتف	اسم المصنع
الظاهرية	2259612	شركة المتوسط للمواد الغذائية
راس حسان	0562001242	مصنع شركة كراجة الزراعية التجارية الحديثة
الحواور	0222215961	مصنع شركة كراجة الزراعية التجارية الحديثة
3		العدد
<b>النشاط الصناعي: صناعة الاجبان</b>		
العنوان	الهاتف	اسم المصنع
الشارع الرئيسي	0	مصنع حسن أحمد حسين للأجبان
1		العدد

النشاط الصناعي: صناعة منتجات الألبان		
العنوان	الهاتف	اسم المصنع
شارع عمان	232240	جمعية المشروع الانشائي العربي
نابلس / شارع سفيان	2377677	شركة مصنع بوظة الارز
المنطقة الصناعية	0597478213	مصنع فاروق مهدي شلهوب
نابلس/عسكر	2336761	لجنة زكاة نابلس للحليب المعقم ومنتجات الالبان
null	2377677	شركة مصنع بوظة الارز
5		العدد

النشاط الصناعي: صناعة اللبن الرايب واللبننة		
العنوان	الهاتف	اسم المصنع
عسكر	0599382373	معمل محمود طلال صقر للالبان
1		العدد

النشاط الصناعي: صنع الايس كريم		
العنوان	الهاتف	اسم المصنع
نابلس عمورية	0598202818	ايد محمد عبد الجليل لصناعة البسكوييت
عزموط	0595827496	أيمن محسن عبد اللطيف مياله
2		العدد

النشاط الصناعي: صنع منتجات البان اخرى		
العنوان	الهاتف	اسم المصنع
تل	0599085867	محمود اسعد ربحان لمنتجات الالبان
1		العدد

النشاط الصناعي: صناعة منتجات الألبان		
العنوان	الهاتف	اسم المصنع
قفايلية - مقتل بكر	092940022	شركة البلدي اوفر للانتاج الغذائي والحيواني
1		العدد

النشاط الصناعي: صناعة منتجات البان اخرى		
العنوان	الهاتف	اسم المصنع
صوفين - مرج الزيتونات - بالقرب من مسلخ البلدية القديم	0	مصنع المثلث للالبان
1		العدد

النشاط الصناعي: صناعة منتجات الألبان		
العنوان	الهاتف	اسم المصنع
الشارع الرئيسي	2353168	شركة بيبوس للمنتجات الغذائية
الشارع الرئيسي	02/2441889	شركة الهدمي للصناعات الغذائية
القدس / السواحة الشرقية	6710160	شركة الحمودة للمنتجات الغذائية والزراعية والصناعية والاستثمارية
رام الله / المنطقة الصناعية	2984738	شركة الريان لمنتجات الألبان

شركة بوظة بلدنا	2956721	رام الله / رام الله البلد
شركة الالبان الوطنية	2957310	رام الله/المنطقة الصناعية
شركة البينار للتجارة العامة	2402277	رام الله/ البيرة
شركة مرطبات ركب	2953467	رام الله
العدد	8	
<b>النشاط الصناعي: صناعة منتجات البان اخرى</b>		
اسم المصنع	الهاتف	العنوان
شركة تل العاصور للألبان	0599700861	الشارع الرئيسي
العدد	1	
<b>النشاط الصناعي: صناعة اللبن الرائب واللبننة</b>		
اسم المصنع	الهاتف	العنوان
معمل البان جمعية العقبة الزراعية للثروة الحيوانية	092572201	العقبة
العدد	1	
<b>النشاط الصناعي: صناعة الاليس كريم</b>		
اسم المصنع	الهاتف	العنوان
معمل سفيان ابو عرة للبوطة والمنتجات	092573789	مركز شرطة عقابا السابق
معمل سفيان ابو عرة للبوطة والمنتجات	092573456	مركز الشطة سابقا
العدد	2	
<b>النشاط الصناعي: صناعة منتجات الألبان</b>		
اسم المصنع	الهاتف	العنوان
شركة الحميدي للألبان والمواد الغذائية	092689615	الاسكان الفلسطيني
بوظة عصر الفضاء	09267082	طولكرم
الجمعية التعاونية لتنمية الثروة الحيوانية	09/2672526	ارتاح
البن شركة قيسي اخوان للصناعة والتجارة	2670894	طولكرم / شوفة
العدد	4	
<b>النشاط الصناعي: صناعة اللبن الرائب واللبننة</b>		
اسم المصنع	الهاتف	العنوان
شركة الطيف للألبان والمواد الغذائية	2683319	كفر زيباد
شركة مزارع الشمال للألبان	0595281076	كفر صور
العدد	2	
العدد الكلي	45	

Source: Palestinian Ministry of National Economy (MNE)

## Appendix B: Questionnaire Dimensions and Items Draw on the Following Studies.

### Questionnaire's Section 2: The Readiness of Palestinian Dairy Companies to Implement SPC

Dimension	Source
<b>Top Management Support</b>	(Lim & Antony, 2016)
<p>The management is ready to shut down an unstable process for corrective action</p> <p>Top management understands its role to start implementing SPC</p> <p>Top management demands regular (e.g., Daily, weekly) process performance reviews</p>	(Lim & Antony, 2016)
<p>Top management allocates adequate financial resources to promote SPC (CI) activates</p> <p>The management allows for sufficient time to implement SPC (CI)</p>	(Sorianoa et al., 2017)
<b>Measurement System Readiness</b>	(Lim & Antony, 2016)
<p>The measurement system is available</p> <p>Employees aware and understand the key processes and their critical parameters</p> <p>Employees are trained to conduct data collection</p> <p>Guidelines exist for calibrating the measuring equipment</p>	(Lim & Antony, 2016)
<p>The company use software systems for data analysis as Mini Tab, SPSS,.. etc.</p>	(Rungasamy et al., 2002)
<b>Organizational Culture Readiness</b>	(Lim & Antony, 2016)
<p>Decision-making is based on data</p> <p>Problems are addressed using teamwork / cross-functional teams.</p> <p>Employees practice preventive maintenance</p> <p>The tolerance specification data of processes is set and insured when designing/ redesigning the systems of company machines.</p> <p>The brand, high-tech, and efficiency are considered when a company makes machine-baying decisions.</p> <p>Regular meetings (e.g., monthly) are held to discuss quality issues and</p>	(Lim & Antony, 2016)

problems using data	
The management supports the adoption of established quality initiatives (TQM, Six Sigma, Lean, Lean Six Sigma, ISO 9000,.. etc.)	(Lim & Antony, 2013)
<b>Urgency To Change</b>	(Lim & Antony, 2016)
<p>Top management communicates legitimate reasons for adopting SPC</p> <p>Regular meetings (e.g., monthly) are held to discuss quality issues and problems using data</p> <p>Aware that the company will achieve a fully controlled process when implementing SPC; it will not just eliminate the assignable causes to improve the quality of process based on customer demand</p> <p>Understand that SPC can improve process performance continuously?</p>	(Lim & Antony, 2016)
systematic and practical guidelines for SPC implementation are available	(Lim et al., 2017)
<b>Employee Involvement</b>	(Lim & Antony, 2016)
<p>Employees are trained in basic statistics</p> <p>Employees' ideas and opinions are appreciated</p> <p>SPC facilitator is hired (external/internal) to aid SPC adoption</p> <p>Employees understand the benefits of process improvement to the business and themselves</p> <p>Employees are involved in continuance improvement CI activities</p>	(Lim & Antony, 2016)

The Sources of the Thesis Questionnaire Dimensions and Items

Questionnaire's Section 3: the Reality of SPC Implementation Among Palestinian Dairy companies

Dimension	Source
<b>Process Performance</b>	(Lim et al., 2017) (Lim & Antony, 2019)
<p>The Process cycle time of processes is well-known and imposed</p> <p>Fresh samples are taken based on a systematic sampling system</p> <p>The company investigates beyond the inconsistency process to become consistent and under control</p> <p>The defects percentages are calculated and considered</p> <p>The Rework percentages are calculated and considered</p> <p>The assignable causes are identified when the process is out of control</p> <p>the company addresses the root causes until eliminate or reduce them</p> <p>The company follow up the customer complaints to ensure they are satisfied</p>	(Lim et al., 2017) (Lim & Antony, 2019)
<b>Applied Testing Parameters</b>	
<p>The product taste is measured by human sensory evaluation, in which tasting a sample is relayed to inspectors</p>	(Gupta et al., 2010) (PSI, 2016) (PSI, 2017) (PSI, 2020)
<p>The product color is measured by the colorimetric and/ or spectrophotometry principles</p> <p>The product PH is measured by PH meter</p> <p>The product weight (mass) is measured by a special scale or balance device</p> <p>The product smell is measured by human sensory evaluation, in which tasting a sample is relayed to inspectors</p> <p>The product density is measured by the lactometer or hydrometer instrument</p> <p>The product dry matter is measured by dry matter testing equipment</p>	(PSI, 2016) (PSI, 2017) (PSI, 2020)

<p>The product temperature is measured by a special thermometer</p> <p>The product closure is checked by an air leakage test</p> <p>The validity of the product shelf life is measured by taking a follow-up sample.</p>	
<p><b>Applied Quality Control (7 Quality Tools)</b></p>	
<p>The company follow up the process steps by "Process Flowchart"</p> <p>The company collect data about process performance by "Check sheets"</p> <p>The company explore and pictures the process variation by "Histogram/stem and leaf plot"</p> <p>The company explore and relationships between variables by " Scatter Diagram"</p> <p>The company analysis the process problems by "Cause-and-Effect Analysis"</p> <p>The company priorities the process problems to solve it by "Pareto Diagram"</p> <p>The company monitor the process variation by "Control Charts"</p>	<p>(Oakland &amp; Oakland, 2018)</p>

## Appendix C: Thesis Questionnaire - Arabic Version

الجامعة العربية الأمريكية  
ARAB AMERICAN UNIVERSITY



كلية الدراسات العليا – برنامج ماجستير إدارة الجودة

جاهزية مصانع الألبان في فلسطين لتطبيق منهجية ضبط العمليات الإحصائية SPC

تحية طيبة،

تعتبر منهجية "ضبط العمليات الإحصائية" من الموضوعات المهمة جدا في القطاع الصناعي على وجه التحديد، لما لها من دور مهم وبارز في الحصول على منتج يرضي المستهلك كونه يحقق المواصفات والمقاييس الموضوعه له.

يتلخص مفهوم منهجية "ضبط العمليات الإحصائية SPC" في مراقبة وضبط سير العملية الإنتاجية في المراحل المختلفة للتأكد من ثباتها واستمراريتها ضمن حدود مواصفات المنتج المعتمدة في الشركة، وذلك من خلال مجموعة من الأدوات التي تهدف الى: تتبع العملية الانتاجية، قياس ثبات المواصفة خلال الإنتاج، اكتشاف المنتجات غير المطابقة للمواصفات، تحديد أسباب الانحراف في العملية الإنتاجية عن المواصفة لاتخاذ القرار الذي يؤمن ضبط الجودة.

تهدف الاستبانة الى قياس مدى جاهزية مصانع الالبان في فلسطين على تبني "منهجية ضبط العمليات الإحصائية SPC" لتحليلها وتقديم توصيات قد تساهم في تحسين أداء العمليات الإنتاجية من خلال تسليط الضوء على نقاط القصور والعوامل المؤثرة في مدى تطبيق المنهجية الإحصائية.

نقدر مساهمتكم في تحقيق هدف الدراسة البحثي ونشكر تعاونكم معنا في تعبئة هذه الاستبانة (يحتاج الى أقل من 10 دقائق من وقتكم)، مع العلم ان هذه البيانات سوف تستخدم لأغراض البحث العلمي فقط ولن يتم ذكر اسم الشركة او اسم معبئ الاستبانة في البحث.

مع جزيل الشكر

للاستفسار: الباحثة: شفاء حامد قواسمة [shifaaqawasmeh@gmail.com](mailto:shifaaqawasmeh@gmail.com)

## القسم الاول: الخصائص الديمغرافية (DC) Demographic Characteristics (DC)

بيانات  
الشركة:

- DC1. المقر الرئيسي للشركة: .....
- DC2. ملكية الشركة:  عائلية  غير عائلية
- DC3. طبيعة عمل الشركة:  ربحية  غير ربحية
- DC4. حجم الانتاج اليومي (الطاقة الانتاجية) تقريبا: ..... لتر حليب/ يوم
- DC5. عدد موظفي الشركة: .....
- DC6. عمر الشركة في سوق صناعة الألبان (سنة التأسيس): .....
- DC7. شهادات الجودة الحاصلة عليها:
- HACCP  ISO 45001  ISO 22001  ISO 9001   
PS

بيانات معبي  
الاستبانة:

- DI8. المسمى الوظيفي: .....
- DI9. عدد سنوات الخبرة:  اقل من 5 سن  اكثر من 5 سنوات
- DI10. العمر:  30 سنة أو أقل  أكثر من 30 سنة
- DI11. الجنس:  ذكر  انثى
- DC12. المؤهل العلمي:  تعليم مدرسي  تعليم جامعي  دراسات عليا
- DC13. طبيعة الوظيفة:  فني (الانتاج)  اداري

### للتوضيح:

مرفق ملخص عن سبع ادوات تستخدم في منهجية التحكم في العمليات الاحصائية (أدوات الجودة السبعة)

القسم الثاني: جاهزية مصانع الالبان في فلسطين على تبني "منهجية ضبط العمليات الاحصائية"  
The readiness of Palestinian dairy companies to implement SPC

حسب مقياس من 1 إلى 5 (تدل الاجابة 1 على معارض بشدة وتدل الاجابة 5 على موافق بشدة)، أرجو الإجابة على كل سؤال حسب ما تراه موجوداً في الشركة.

درجة الموافقة					البعد الاول	الرمز
5	4	3	2	1	دعم/ التزام الادارة العليا Top Management Commitment	
					في حال وجود خلل (عدم مطابقة للمواصفة) في العملية الانتاجية فان الادارة تقرر ايقاف العملية الإنتاجية.	TM1
					تدرك الإدارة العليا دورها الداعم لتطبيق منهجية الرقابة الإحصائية على العمليات	TM2
					تؤكد الإدارة العليا على تقارير دورية عن سير أداء العمليات الإنتاجية.	TM3
					تخصص الإدارة العليا موارد مالية لتعزيز تطبيق الرقابة الإحصائية على العمليات الإنتاجية مثل تكلفة التدريب أو تكلفة توفير أدوات القياس.	TM4
					تعطي الإدارة العليا وقتاً كافياً لتنفيذ مهام التحكم وضبط الجودة.	TM5
					تدعم الإدارة تدريب موظف انتاج قديم لموظف جديد على متطلبات وسبل تحقيق التحكم بالجودة.	TM6

درجة الموافقة					البعد الثاني	الرمز
5	4	3	2	1	نظام القياس Measurement System	
					يتوفر نظام خاص لقياس مواصفات المنتج وفق المتطلبات الموضوعية	MS1
					يتم تسجيل بيانات القياس لمواصفات المنتج بشكل دائم.	MS2
					يدرك موظفي الانتاج العمليات الرئيسية للإنتاج وعوامل المعالجة الخاصة بها	MS3
					يتم تدريب الموظفين على نظام جمع البيانات الخاص بالإنتاج	MS4
					يتوفر دليل خاص لفحص ومعايرة معدات القياس	MS5
					تستخدم الشركة القياسات التي تم جمعها في عمليات صنع قرارات متعلقة بالإنتاج	MS6
					تستخدم الشركة برامج خاصة لتحليل البيانات التي يتم جمعها، مثل SPSS Mini Tab, Excel,	MS7

درجة الموافقة					البعد الثالث	الرمز
5	4	3	2	1	الثقافة التنظيمية Organizational Culture	

					يتم اتخاذ القرارات في الشركة بناء على البيانات المتوفرة	OC1
					يتم العمل على تحليل ومواجهة المشاكل في الشركة بروح الفريق	OC2
					تؤكد الإدارة على ضرورة ممارسة فنيي الإنتاج للصيانة الوقائية	OC3
					تتم عملية معايرة الات الإنتاج بشكل منتظم (في إطار خطة معرفة سابقاً)	OC4
					تدعم الشركة شراء آلات تحمل علامات تجارية بهدف تحسين الجودة	OC5
					يتم عقد اجتماعات دورية تضم موظفي الإنتاج (مثلا شهرية) لمناقشة قضايا جودة الإنتاج والمشاكل التي تواجه العمليات الإنتاجية	OC6
					تؤكد الإدارة على الدقة في تسجيل بيانات العملية الإنتاجية.	OC7
					تدعم الشركة استخدام أنظمة الجودة مثل إدارة الجودة الشاملة، 6 سيجما... الخ.	OC8

درجة الموافقة					الرمز	البعد الرابع الترغيب في التغيير Urgency to Change
5	4	3	2	1		
					UC1	تدرك الشركة أهمية دور تطبيق الرقابة الإحصائية في تحقيق التحسين المستمر لأداء العمليات الإنتاجية.
					UC2	خلال فترة عملي في الشركة، قامت الشركة بتطوير طرق التحكم بجودة المنتجات وتطبيق طرق جديدة ساهمت في زيادة ثبات مواصفة المنتجات.
					UC3	تعمل الإدارة العليا على توضيح أسباب اعتماد منهجية الرقابة الإحصائية على العمليات الإنتاجية.
					UC4	يتوفر دليل لتطبيق منهجية وأدوات الرقابة الإحصائية على العمليات

درجة الموافقة					الرمز	البعد الخامس إشراك الموظفين Employee Involvement
5	4	3	2	1		
					EI1	يتم تدريب الموظفين على أساسيات العمليات الإحصائية مثل تعريف العينة
					EI2	يتم سماع آراء الموظفين وأفكارهم من قبل الشركة
					EI3	يتم الاستعانة بخبراء خارجيين أو داخليين في منهجية الرقابة الإحصائية على العمليات للمساعدة في تطبيقها
					EI4	يدرك الموظفون ان تطوير العمليات الإنتاجية يعود بالفائدة للشركة عموماً وبالتالي لهم بشكل خاص
					EI5	يشارك الموظفون في أنشطة التحسين المستمر، مثل المشاركة في المقترحات والتجارب الجديدة

القسم الثالث: واقع تطبيق إجراءات "منهجية ضبط العمليات الإحصائية" في مصانع الالبان في فلسطين

### The reality of SPC implementation among Palestinian dairy companies

حسب مقياس من 1 إلى 5 (تدل الاجابة 1 على معارض بشدة وتدل الاجابة 5 على موافق بشدة)، أرجو الإجابة على كل سؤال حسب ما تراه مطبقاً في الشركة.

درجة الموافقة					الرمز	البعد الأول أداء العمليات Process Performance
5	4	3	2	1		
					PP1	الوقت الفعلي الذي يتم استهلاكه لإنتاج المنتج لكل عملية معروف وملزم لفني الانتاج
					PP2	يتم أخذ عينات خلال العملية الانتاجية بطرق منهجية ومخطط لها مسبقاً لأغراض الفحص والتحقق
					PP3	تقوم الشركة بدراسة أسباب الخلل/الانحرافات في العمليات الإنتاجية وتحويلها إلى عمليات متسقة ومسيطر عليها
					PP4	يتم حساب كمية المنتجات التالفة وأخذها بعين الاعتبار في عمليات صنع القرار
					PP5	يتم حساب كمية العمل المعاد من الإنتاج وأخذها بعين الاعتبار في صنع القرار
					PP6	يتم تحديد الأسباب في حال حدوث عطل في العمليات الانتاجية
					PP7	لدى الشركة نظام لمتابعة شكاوى الزبائن.
					PP8	تقوم الشركة بمتابعة شكاوى الزبائن لحين التأكد من أنه تم حلها

أرجو الإجابة على كل سؤال بنعم أو لا حسب ما تراه مطبقاً في الشركة.

يتم القياس		الرمز	البعد الثاني عوامل الاختبار المطبقة Applied Testing Parameters
لا	نعم		
		TP1	يتم قياس وزن المنتج باستخدام مقياس خاص أو ميزان مخصص طرق اخرى (حددها) .....
		TP2	يتم تقييم مذاق المنتج من خلال التقييم الحسي البشري ولأكثر من شخص من ذوي الخبرة طرق اخرى (حددها) .....
		TP3	يتم تقييم رائحة المنتج من خلال التقييم الحسي البشري ولأكثر من شخص من ذوي الخبرة طرق اخرى (حددها) .....
		TP4	يتم تقييم لون المنتج باستخدام مبدأ القياس اللوني (أو الطيف الضوئي) طرق اخرى (حددها) .....
		TP5	يتم قياس درجة الحموضة المنتج باستخدام مقياس الرقم الهيدروجيني طرق اخرى (حددها) .....
يتم القياس		الرمز	تابع .... البعد الثاني عوامل الاختبار المطبقة Applied Testing Parameters
لا	نعم		
		TP6	يتم قياس كثافة المنتج بواسطة مقياس اللاكترومتر أو الهيدروميترات طرق اخرى (حددها) .....
		TP7	يتم قياس نسبة المواد الصلبة في المنتج باستخدام معدات قياس المواد الجافة طرق اخرى (حددها) .....
		TP8	يتم قياس درجة حرارة المنتج باستخدام الترمومترات

		طرق اخرى (حدها) .....	
	TP9	يتم قياس احكام اغلاق المنتج باستخدام معدات اختبار تسرب الهواء طرق اخرى (حدها) .....	
	TP10	يتم قياس العمر الافتراضي للمنتج (صلاحية المنتج) من خلال اخذ عينات متابعة طرق اخرى (حدها) .....	
	TP11	يتم فحص صلاحية مدخلات الإنتاج (الحليب)	
	TP12	يتم فحص صلاحية مدخلات الإنتاج (الماء)	
	TP13	يتم التأكد من شهادات مواصفة العبوات البلاستيكية من المورد.	

أرجو الإجابة على كل سؤال بنعم أو لا حسب ما تراه مطبقاً في الشركة (الرجاء الاطلاع على الملحق).

هل تستخدمها		هل تعرفها		الرمز	البيد الثالث تطبيق ادوات التحكم بجودة العمليات الإنتاجية Applied quality control tools
لا	نعم	لا	نعم		
				QT1	تعمل الشركة بمتابعة تسلسل مراحل العمليات الانتاجية باستخدام خارطة تدفق العمل <b>Flowchart</b>
				QT2	تقوم الشركة بجمع بيانات عن أداء العمليات باستخدام قوائم الاختبار <b>Check Sheet</b>
				QT3	تقوم الشركة بدراسة التباين في العمليات الانتاجية باستخدام المدرج التكراري <b>Histogram</b>
				QT4	تقوم الشركة بدراسة العلاقة بين المتغيرات الانتاجية باستخدام مخطط التبعثر <b>Scatter Diagram</b>
				QT5	تعمل الشركة على تحليل مشاكل العمليات الإنتاجية باستخدام مخطط السبب والنتيجة <b>Cause and Effect Diagram</b>
				QT6	تعمل الشركة على ترتيب المشاكل حسب الأوليات لحلها باستخدام مخطط باريتو <b>Pareto Diagram</b>
				QT7	تعمل الشركة على مراقبة استقرار العمليات الانتاجية Stability باستخدام خرائط المراقبة <b>Control Chart</b>

## الملحق: ادوات الجودة

### قوائم الاختبار

#### Tools for Generating Ideas

(a) *Check Sheet*: An organized method of recording data

Defect	Hour							
	1	2	3	4	5	6	7	8
A	///	/		/	/	/	///	/
B	//	/	/	/			//	///
C	/	//					//	///

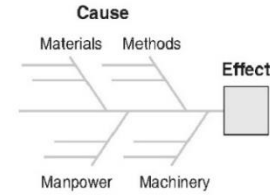
### مخطط التبعثر

(b) *Scatter Diagram*: A graph of the value of one variable vs. another variable



### مخطط السبب والنتيجة

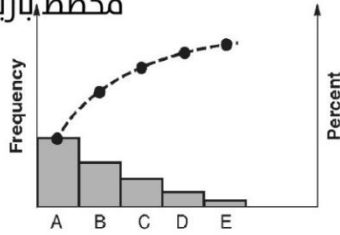
(c) *Cause-and-Effect Diagram*: A tool that identifies process elements (causes) that may affect an outcome



#### Tools for Organizing the Data

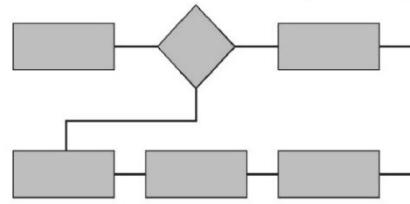
(d) *Pareto Chart*: A graph that identifies and plots problems or defects in descending order of frequency

### مخطط باريتو



(e) *Flowchart (Process Diagram)*: A chart that describes the steps in a process

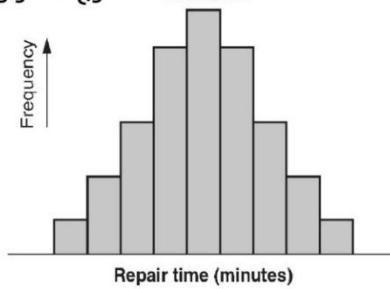
### خارطة تدفق العمل



#### Tools for Identifying Problems

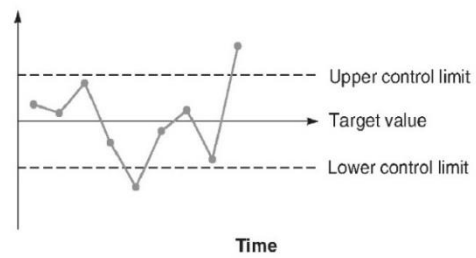
(f) *Histogram*: A distribution that shows the frequency of occurrences of a variable

### المدرج التكراري



(g) *Statistical Process Control Chart*: A chart with time on the horizontal axis for plotting values of a statistic

### خرائط التحكم الاحصائي



Source: Heizer, J., Render, B., Munson, C., & Sachan, A. (2017). Operations management: sustainability and supply chain management, 12/e.

## Appendix C: Thesis Questionnaire - English Version

الجامعة العربية الأمريكية  
ARAB AMERICAN UNIVERSITY



Faculty of Graduate Studies - Quality Management Program

### The Readiness of the Palestinian Dairy Industry towards Implementing Statistical Process Control

*Dear sirs / ..... after compliment*

The “Statistical Process Control SPC” methodology is critical in the industrial sector because of its prominent role in obtaining a product that satisfies the consumer as it fulfills the specifications and standards set.

The concept of the SPC methodology is summarized in monitoring and controlling the progress of the production process in the different stages to ensure its stability and keep on within approved specifications limits that approved of the in the company, through a set of tools that aim to: follow the production process, measure the stability of the approved specification during the production process, discover Non-conforming products, identifying the reasons for variation within the production process to make a decision that secures quality control.

The questionnaire aims to measure the readiness of Palestinian dairy companies to implement the SPC Methodology to make recommendations that may improve the performance of production processes by highlighting the shortcomings and factors affecting the extent of the application of the statistical methodology.

This questionnaire will take less than 10 minutes of your time, knowing that this data will be used for scientific research purposes only, and the name of the company or the name of the questionnaire respondent will not be anonymous.

**Thank you for your Cooperation**

**Researcher: Shifaa Hamed  
Qawasmeh**



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**Section two: The readiness of Palestinian dairy companies to implement SPC**

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Degree of 1 indicates strongly dis agree, and degree 5 indicates strongly agree. Please answer each question according to what you see in the company.

code	First Dimension <b>Top Management Commitment</b>	degree of approval				
		1	2	3	4	5
TM1	The management is ready to shut down an unstable process for corrective action					
TM2	Top management understands its role to start implementing SPC					
TM3	Top management demands regular (e.g., Daily, weekly) process performance reviews.					
TM4	Top management allocates adequate financial resources to promote SPC					
TM5	The management allows for sufficient time to implement SPC					
TM6	The management supports the training of an old production employee for a new employee on the requirements to achieve quality control.					

code	second Dimension <b>Measurement System</b>	degree of approval				
		1	2	3	4	5
MS1	The measurement system is available					
MS2	Measurement data for product specifications is always recorded.					
MS3	Employees aware and understand the key processes and their critical parameters					
MS4	Employees are trained to conduct data collection					
MS5	Guidelines exist for calibrating the measuring equipment					
MS6	The company uses the collected measurements to make production decisions					
MS7	The company use software systems for data analysis as Mini Tab, SPSS,.. etc.					

code	Third Dimension <b>Organizational Culture</b>	degree of approval				
		1	2	3	4	5
OC1	Decision-making is based on data					
OC2	Problems are addressed using teamwork / cross-functional teams.					
OC3	Employees practice preventive maintenance					
OC4	The tolerance specification data of the company machines systems is set and insured continually					
OC5	The brands name are considered when a company makes machine-baying decisions.					
OC6	Regular meetings (e.g. monthly) are held to discuss quality issues and problems using data					
OC7	The Management emphasizes the accuracy in recording production process data.					
OC8	The management supports the adoption of established quality systems (TQM, Six Sigma, Lean, Lean Six Sigma, ISO 9000,.. etc).					

code	Fourth Dimension <b>Urgency to Change</b>	degree of approval				
		1	2	3	4	5
UC1	the company Understand that SPC can improve process performance continuously					
UC2	During my tenure at the company, the company developed methods for controlling the quality of products and applied new methods that contributed to increasing the stability of product specifications.					
UC3	Top management communicates legitimate reasons for adopting SPC					
UC4	An systematic and practical guidelines for SPC implementation are available					

code	fifth Dimension <b>Employee Involvement</b>	degree of approval				
		1	2	3	4	5
EI1	Employees are trained in basic statistics					
EI2	Employees' ideas and opinions are appreciated					
EI3	SPC facilitator is hired (external/internal) to aid SPC implementation					
EI4	Employees understand the benefits of process improvement to the business and themselves					
EI5	Employees are involved in CI activities					

---

**Section three:** The reality of SPC implementation among Palestinian dairy companies

---

Degree 1 indicates strongly disagree, and degree 5 means strongly agree. Please answer each question according to what you see in the company.

code	First Dimension Process Performance	degree of approval				
		1	2	3	4	5
PP1	The processes cycle time is well-known and imposed					
PP2	Fresh samples are taken based on a systematic sampling system					
PP3	The company investigates beyond the inconsistency process to become consistent and under control					
PP4	The defects percentages are calculated and considered					
PP5	The Rework percentages are calculated and considered					
PP6	the company addresses the root causes until eliminate or reduce them					
PP7	The company has a customer complaints system.					
PP8	The company follow up the customer complaints to ensure they are satisfied					

Please answer each question with yes or no according to what you see applied in the company.

code	Second Dimension Applied Testing Parameters	is measured?	
		Yes	No
TP1	The product weight (mass) is measure by a special scale or balance device. Other tools.....		
TP2	The product taste is measure by human sensory evaluation, in which tasting a sample is relayed to inspectors. Other tools.....		
TP3	The product smell is measure by human sensory evaluation, in which tasting a sample is relayed to inspectors. Other tools.....		
TP4	The product color is measure by the colorimetric and/ or spectrophotometry principles. Other tools.....		
TP5	The product PH is measure by PH meter.		

	Other tools.....		
TP6	The product density is measure by the lactometer or hydrometer instrument Other tools.....		
TP7	The product dry matter is measure by dry matter testing equipment Other tools.....		
TP8	The product temperature is measure by a special thermometer . Other tools.....		
TP9	The product closure is checked by an air leakage test . Other tools.....		
TP10	The validity of the product shelf life is measure by taking follow-up samples. Other tools.....		
TP11	The validity of production inputs (milk) is checked		
TP12	The viability of production inputs (water) is checked.		
TP13	Verify the plastic packaging specification certificates from the supplier is checked.		

**Please answer each question according to what you see applied in the company.(Please see the Appendix)**

code	Third Dimension Applied quality control tools	do you know it?		do you use it?	
		Yes	No	Yes	No
QT1	The company follow up the process steps by "Process Flowchart"				
QT2	The company collect data about process performance by "Check sheets"				
QT3	The company explore and pictures the process variation by "Histogram."				
QT4	The company explore and relationships between variables by "Scatter Diagram."				
QT5	The company analysis the process problems by "Cause-and-Effect Analysis"				
QT6	The company priorities the process problems to solve it by "Pareto Diagram."				
QT7	The company monitor the process variation by "Control Charts"				

## الملحق: ادوات الجودة

### قوائم الاختبار

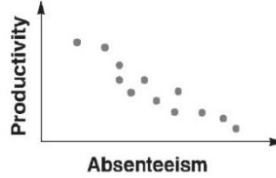
#### Tools for Generating Ideas

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B	//	/	/	/			//	///
C	/	//					//	////

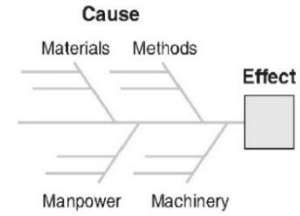
### مخطط التبعثر

(b) *Scatter Diagram*: A graph of the value of one variable vs. another variable



### مخطط السبب والنتيجة

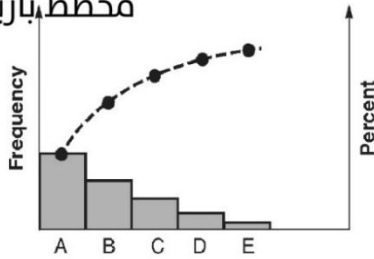
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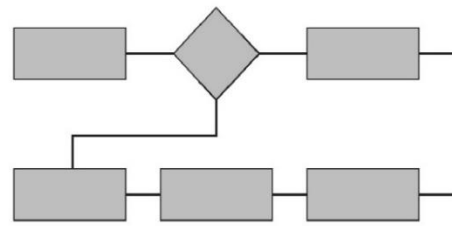
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### مخطط باريتو



(e) *Flowchart (Process Diagram)*: A chart that describes the steps in a process

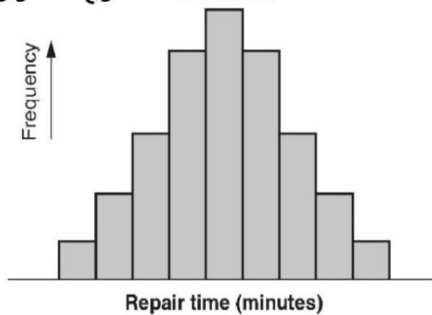
### خارطة تدفق العمل



#### Tools for Identifying Problems

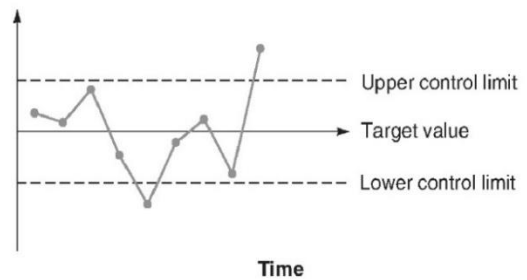
(f) *Histogram*: A distribution that shows the frequency of occurrences of a variable

### المدرج التكراري Distribution



(g) *Statistical Process Control Chart*: A chart with time on the horizontal axis for plotting values of a statistic

### خرائط التحكم الاحصائي



**Source:** Heizer, J., Render, B., Munson, C., & Sachan, A. (2017). *Operations management: sustainability and supply chain management*, 12/e.

## Appendix E: The Interviews Questions

<p><b>Part One</b></p> <p><b>Background Questions</b></p>
<ol style="list-style-type: none"> <li>1. What are your position and responsibility areas in the Company?</li> <li>2. How long have you worked in your current position?</li> <li>3. Have you ever heard about statistical process control SPC? a) Yes    b) No</li> <li>4. What is your previous experience with statistical process control? And Have you ever applied this methodology?</li> </ol>

<p><b>Part Two</b></p> <p><b>Organizational Aspect</b></p>
<ol style="list-style-type: none"> <li>1. Regarding time, effort, and disruption to the company, was quality control practices cost-effective? Why or why not?</li> <li>2. Does the top management provide a supportive climate to improve the quality management practices?</li> <li>3. How is the company working on developing the quality department and adopting new methodologies to improve the control of the production process?</li> <li>4. What is the company's background on quality management systems, and how can we benefit from them and their role in developing production processes management such as PS, ISO 9001 ...etc?</li> <li>5. What practice actions do you expect the companies to use statistical process control?</li> <li>6. Does the company have a data collection system, how implement it? How is this data used after it is collected? Are the managers making decisions based on?</li> <li>7. Does the company use software systems for data documentation and analysis purposes?</li> <li>8. Does the company have an awareness of the importance of hiring specialists Staff in the field of quality control and statistical data analysis?</li> <li>9. What Challenges facing your company hindering and applying statistical process control?</li> <li>10. How is the company developing the capabilities and awareness of employees; through training courses and workshops related to product quality control?</li> </ol>

**Methodological Aspect**

11. What are the measurement tools/ testing devices that the company has/does not have? Please explain why?
12. What are the process parameters that the company considers/ does not consider, and why not?
13. Have you ever heard about or applied the seven quality tools (Flowcharting, Check sheets, Histogram, Scatter Diagram, Cause-and-Effect Analysis, Pareto Diagram, Control Charts) for data collection, data analysis, explore process variation/problems purposes?
14. Does the management give attention to the customers' complaints?
15. What actions/ procedures does the company take to defect the defective products?
16. Does the company depend on/ refer to external parties to measure the taste and smell of products?

## الملخص

تهدف الدراسة الى قياس مدى جاهزية مصانع الالبان في فلسطين على تبني منهجية ضبط العمليات الاحصائية SPC لتحليلها وتقديم توصيات قد تساهم في تحسين أداء العمليات الإنتاجية من خلال تسليط الضوء على نقاط القصور والعوامل المؤثرة في مدى تطبيق المنهجية الإحصائية. وذلك من خلال الكشف عن العوامل المؤثرة على تبني منهجية SPC في قطاع صناعة الألبان الفلسطينية، بالإضافة الى تقييم مستوى جاهزية القطاع لتطبيق منهجية SPC فيما يتعلق بالمتطلبات التنظيمية والمتطلبات المنهجية، أخيراً، فحص ما إذا كانت هناك اختلافات بين شركات الألبان من حيث حجمها أو حصولها تبني على خصائص مصانع الألبان فيما يتعلق بمستوى الجاهزية لتطبيق SPC.

تندرج هذه الدراسة تحت الدراسات المقطعية الوصفية، حيث اعتمدت منهج البحث المختلط (النوعي والكمي) لغرض جمع البيانات؛ تكون مجتمع الدراسة من جميع شركات الألبان الفلسطينية المدرجة في وزارة الاقتصاد الوطني الفلسطيني (MNE) والبالغ عددهم 15 شركة. كذلك تم الاعتماد على طريقة أخذ العينات الملائمة لاختبار عينة البحث والتي بلغت 10 شركات. تم إجراء مقابلات منتظمة وشبه منتظمة مع 11 موظف من ذوي العلاقة بممارسات ادارة الجودة في الشركات بهدف جمع البيانات النوعية. في حين 37 استبياناً تم استردادهم وغربلتهم من جميع الشركات العشر بهدف جمع البيانات الكمية. تم تحليل البيانات الكمية من خلال استخدام مجموعة من الاختبارات الاحصائية مثل Means and Frequencies, One-Way Anova Test, and Regression Analysis، بينما تم تحليل البيانات النوعية باستخدام اسلوب التحليل الموضوعي.

وقد اظهرت نتائج الدراسة عدة امور فيما يتعلق بالبيانات النوعية، منها ان شركات الالبان الفلسطينية لديهم الجاهزية لتطبيق منهجية SPC من حيث عدة ابعاد تتمثل في التزام الإدارة العليا، وجود نظام القياس، أداء العمليات، وتطبيق عوامل الاختبار. ومن جهة اخرى، ان هذه الشركات ليس لديها الجاهزية الكافية لتطبيق منهجية SPC من حيث عدة ابعاد اخرى تتمثل في الثقافة التنظيمية، الرغبة في التغيير، اشراك الموظفين، وتطبيق أدوات التحكم في الجودة السبعة.

كذلك اظهرت نتائج البيانات النوعية ان هناك اختلافات بين شركات الألبان الفلسطينية من حيث الحجم ومن حيث حصولها على اعتمادات فيما يتعلق بمستوى الجاهزية لتنفيذ SPC.

بينما بالرجوع الى تحليل البيانات الكمية، فقد توصلت نتائج الدراسة الى أن شركات الالبان الفلسطينية لديهم الجاهزية لتطبيق منهجية SPC بدرجة عالية من حيث التزام الإدارة العليا. في حين ان هذه الشركات لديهم الجاهزية لتطبيق منهجية SPC بدرجة متوسطة من حيث وجود نظام قياس واشراك الموظفين. كما أن هذه الشركات لديهم الجاهزية لتطبيق هذه منهجية من حيث الثقافة التنظيمية والرغبة في التغيير بدرجة منخفضة.

اظهرت نتائج البيانات الكمية ان هناك فروقات ذات دلالة إحصائية بين شركات الألبان الفلسطينية من حيث حصولهم على اعتمادات فيما يتعلق بمستوى الجاهزية لتنفيذ SPC. بينما لا توجد فروقات ذات دلالة إحصائية بين الشركات بناءً على الحجم فيما يتعلق بمستوى الجاهزية لتنفيذ SPC، أي أن حجم الشركة لا يؤثر على جاهزيتها لتطبيق منهجية SPC.

و قد اوصى الباحث بأهمية دور الادارة العليا لشركات الالبان في فلسطين في نشر ثقافة الضبط الاحصائي للعمليات الانتاجية SPC من خلال استقطاب و توظيف المتخصصين في اساليب تحليل البيانات. بالإضافة إلى ضرورة تشكيل برامج تدريبية ممنهجة حول التفكير الإحصائي، خطط واساليب جمع البيانات وأخذ العينات، الثبات الإحصائي، والتطبيق الفعال لأدوات التحكم في الجودة.