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Faculty of Graduate Studies

Towards Enhancement of Lean Practices in the West Bank Construction Industry

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Dedication

- To the martyrs' souls, who offered themselves for the liberation of Palestine.
- To Palestinian prisoners behind the darkness of occupation jails.
- To my loving parents who have supported me all the way
- To my wife and children whose constant dedication and love enlightened me.
- To all of my family, friends and colleagues who stood beside me with great commitment.

I dedicate my research, hoping that I made all of them proud.

Eng. Wathiq Mohammed Abu Obaid

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الإقرار

أنا الموقع أدناه ، مقدم الرسالة التي تحمل العنوان :

Towards Enhancement of Lean Practices in the West Bank Construction Industry

أقر بان ما شملت عليه هذه الرسالة إنما هو نتاج جهدي الخاص، بإستثناء ما تمت الإشارة اليه حيثما ورد، و أن هذه الرسالة كاملة، أو أي جزء منها لم يقدم من قبل لنيل أي درجة أو لقب علمي أو بحثي لدى مؤسسة تعليمية أو بحثية أخرى.

Declaration

The work provided in this thesis unless otherwise referenced, is the researcher's own work , and has not been submitted elsewhere for any other degree or qualification .

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Date : التاريخ : ٢٦/٥/٢٠١٦م

LIST OF ABBREVIATIONS

AT	Attitudes
BPR	Business Process Reengineering
CC	Coordination & communications
CE	Concurrent Engineering
CO	Communications
CPI	Cost Performance Index
CPM	Critical Path Method
CRM	Customer Relation Management
CT	Cycle Time
DETR	Department of the Environment, Transport and the Regions.
EAA	Employee Affective Attitude
GDP	Gross Domestic Product
HRM	Human Resource Management
IB	Individual Behavior
JIT	Just-In-Time
KPIs	Key Performance Indictors
LCI	Lean Construction Institute
LC-KPIs	Lean Construction Key Performance Indicators
LPS	Last Planner System
MC	Management Commitment
MMC	Modern Methods of Construction
NPD	New Product Development
OC	Organizational Culture
PC	Production Control
PCBS	Palestinian Central Bureau of Statistics
PCU	Palestinian Contractors Union
PDCA	(Plan, Do, Check, and Act)
PFI	Private Finance Initiatives
PPC	Percent Plan Complete
R & D	Research and Development
SCM	Supply Chain Management
SE	Skills and Experiences
SPI	Schedule Performance Index

SPSS	Statistical Package for the Social Sciences
SR	Sigma Rating
TH	Throughput Rate
TPM	Total Productive Maintenance
TPS	Toyota Production System
TQC	Total Quality Control
TQM	Total quality management
TR	Training
TW	Team Work
VBM	Value Based Management
VI	The Value Index
WI	Waste Index
WIP	Work-in-Process
WS	Work Structure (Last planner)
WWP	Weekly Work Plan
BPM	Building Project Management
PPMS	Project Performance Monitoring System

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Abstract

In Palestine, the construction sector is one of the key economic sectors, which still suffers from numbers of problems related to time, cost and quality performance. To overcome these problems this sector needs to adopt new trends of management, which is lean construction.

The main objective of this study is to investigate factors that support the successful implementation of lean related to management and planning systems, human factors, organizational factors and contractual factors. In addition to, identify lean key performance indicators that measure this successful implementation, and finally linking them with a framework to help the construction companies to adopt lean in the construction process.

This research relied principally on analytical and descriptive approaches. The first approach is by reviewing of literatures. The second approach is a questionnaire, which targeted the construction companies in West Bank and is applied on a sample of 153 companies.

The results showed positive effects of adopting lean practices such as (wastes identification, value stream mapping, JIT, Pull approach etc.) and successful lean implementation in addition to management commitment and excellence leadership. In addition, the results showed many factors support successful lean implementation related to human, organizational and contractual issues. In this study, the lean successful implantation can be

measured through the improvement on the lean Key performance indicators. Finally, all these relations are linked with a framework that helps the contractors to adopt lean practices.

The study recommended that the contractors should keep continuous development and learning from the previous projects that they completed to assess the strength and weakness points related to the success factors in order to improve them and this successful should be controlled by the improvement in lean KPIs. Clients are recommended to start injecting mandatory clause in the contract that supports lean construction.

Chapter one
Introduction

1.1 Overview

In this chapter, the problem statement, the research objectives, research questions and the research hypotheses are presented. In addition, the thesis structure is explored at the end of this chapter**.**

1.2 Background

The construction industry in Palestine has been growing at a steady growth rate in recent years. The Palestinian National Bureau of Statistics (PCBS) (2013) indicated that the construction sector in Palestine had contributed about 14.1% to the Palestinian Gross Domestic Product (GDP) (PCBS, 2013).

Abu Shaban (2008) identified that the construction industry will continue to play a significant role in the Palestinian economy. However, this sector is still perceived as a complex sector in nature, and faces many problems related to low productivity, low quality products, low profit margins and poor working conditions on site (Abu Shaban ,2008). Hence, the construction industry needs new trends of management to become more competitive to change its image positively**.**

In modern societies, "Change" is the word that best characterizes its nature and this word (change) became the challenge that managers face in managing their firms. In the fact of rapid technological progress, global

communication and intensified competition, the traditional management trends and methods can no longer reach the same competitive results or improving in the company's performance (Kotter ,2007).The success of companies and managers depends on their ability to react, operate and adapt to change (Kotter ,2007). Some researchers argued that the firm's capability to adjust to the new conditions quickly is a competitive advantage and successful restructuring of change processes requires powerful methods and tools (Mertins and Jochem, 2001).

In construction industry, looking for new ways of reducing cost in the construction process and increase the quality of the products give the company this competitive advantage. Lean construction as a new management trend and is considered a potential approach for improving construction firm’s performance (LCI, 2012). According to Lean Construction Institute (2012), lean construction is a production management-based project delivery system emphasizing the reliable and speedy delivery of value. Lean construction adopts the concepts of lean thinking and lean principles drawn from production management (originally developed at Toyota production system in the 1950s) to create a new way to manage construction projects (Womack and Jones ,2003). In lean construction, the main goal is to build the project while maximizing value, minimizing waste, and pursuing perfection. In construction, the waste is primarily defined in seven categories: defects (errors), delays, over-processing, over-production, excess inventory, unnecessary transport

and conveyance of materials and equipment, and unnecessary motions and movement of people (Ohno, 1988 a).

Successful Lean construction implementation could bring value to the organizational processes and contribute for achieving an operational excellence. To achieve lean adoption it is crucial to answer this question, what are the factors that support the successful lean implementation in order to have the expected profit from this adoption? These factors consider outline and challenge that face the companies when they need to change their business model towards implementing a new management system. Different organizational factors such as human resource practices, management style, organizational strategic vision, organizational culture, external partnerships, have importance in the implementation process and they should be taken in consideration (Kovacheva, 2010). The main objective of this study is to explore these factors, that supports successful lean implementation and to link them in a framework to help the Palestinian construction sector to adopt this new management style.

1.3 Problem Statement

Reducing waste in process, time, costs and other integrated entities and maximizing the value of the project are considered crucial strategies to be implemented in construction projects. In Palestine the construction sector suffers from many wastes such as wastes in materials, building areas, laborers, machines movement , delay in decision making etc. and this showed that the traditional trend of management is still insufficient to

highlight all wastes in the construction process (Issam Al-Khatib et al ,2011) .

In this research, a new trend of management, which is lean construction, is studied to investigate the awareness of lean principles and tools among the Palestinian contractors. Then, determine the degree to which these principles were planted among their culture. Investigating this conformance of lean construction among the contractor can be done by investigating factors that support these principles and tools, which form a platform for the successful implementation of this new trend of management. This conformance should be examined by determining the degree of contractor's perceptions among the key performance indicators that measures the successful lean implementation. As the results of this investigation, the factors that contribute to strength this adaptation were highlighted besides, the key performance indicators that may measure this successful adoption. Moreover, these factors will be linked in a framework that may consider a platform for enhancing lean in Palestinian construction industry, which are effective to help the contractors to add value to the project, and minimizing the wastes to develop their competitive profile.

1.4 Significance of the Research

The relevance of this research work is of significant importance to the Palestinian construction sector. It represents comprehensive study about enhancing lean in the Palestinian construction sector. The study main goal is to develop a model that suggests a detailed perspective of the factors that

support successful lean implementation to the contractors who consider implementing lean as possible direction towards achieving improvement for their companies' performance. Therefore, this research could help the Palestinian construction sector by suggesting some changing or improving in their management practices and improving in their organizational and human resources that can be taken toward lean construction adoption.

1.5 Research Objectives

The aim of this research is to investigate and enhance the awareness of lean construction concept among the Palestinian contractors and how these principles can be incorporated in the construction process. Research objectives are to :

1. Investigate the key performance indicators that measure the successful implementation of lean among the contractors.
2. Investigate the key factors supporting the principles and the successful implementation of lean construction tools/techniques among the Palestinian contractors.
3. Develop a framework that helps the contractor to adopt lean in their organization by identifying the factors that should be improved or enhanced in the organization.

1.6 Research Questions

In this research, the following research questions, which have been designed to achieve the research objectives, will be answered:-

1- What is the level of agreement in the lean performance indictors among the contractors?

2- What are the factors that support successful lean implementation relative to management and planning systems?

3- What are the human factors that support successful lean implementation?

4- What are the factors that support successful lean implementation relative to organizational issues?

1.7 Research Hypotheses

Hypotheses were formulated during the literature review to further investigate the factors that support successful lean implementation in construction sectors in the West Bank. For this investigation, the following hypothesis will be tested to enhance the search results:

- **H1**: There is a significant relationship between adopting lean principles in the production control and successful implementation for lean.

- **H2**: There is a significant relationship between adopting last planner in project management and successful implementation of lean practices.
- **H3**: There is a significant relationship between management commitment and successful lean implementation.
- **H4:** There is a significant relationship between positive attitudes of the employees and successful lean implementation.

- **H5**: There is a significant relationship between skills and expertise of the employees and successful lean implementation.
- **H6**: There is a significant relationship between good vertical and horizontal communications and successful lean implementation.
- **H7**: There is a significant relationship between working as team and successful lean implementation.
- **H8**: There is a significant relationship between the organizational culture and successful lean implementation.
- **H9:** There is a significant relationship between training and knowledge in lean practices and the successful lean implementation.
- **H10**: There is a significant relationship between the coordination and the communication in the organization and successful lean implementation.
- **H11:** There is a significant relationship between adopting innovations and successful lean implementation.
- **H12:** There is a significant relationship between respondents towards the role of contract in organizing all the relations between the factors that supports successful lean implementation.

1.8 Thesis Structure

This thesis consists of six chapters:

- Chapter one is an introductory chapter: includes the background on the research subject, problem statement, research objectives, research questions, research hypotheses, and thesis structure.

- Chapter two is a literature review of lean construction: At the first of this chapter, the importance and the characteristics of the construction in addition to the problems that face this sector were identified. After that, the key performance indicators that measure the performance of the construction project have been determined. In the next sections of this chapter, the differences between lean management were mentioned in addition to, traditional management, and the lean performance indicators. After that the previous studies related the models that support lean implementation were reviewed and finally the factors that supports lean had been identified.
- Chapter three: this chapter discusses the differences between manufacturing and construction industries. Then, the researcher identifies the seven categories of wastes and the main causes of these wastes. After that, he discusses lean and lean construction as principles and tools.
- Chapter four: this chapter clarifies the research methodology, research design, instrumentation, procedure, data processing, research population and research sample. In addition, this chapter discusses research tool, reliability and validity. Furthermore, it addresses the ethical considerations of the research and research procedure.
- Chapter five: discusses data analysis, statistical methods, answering research questions, testing research hypotheses and proposing the conceptual Framework.
- Chapter six: this chapter is about research conclusions and recommendations and explores the thesis contributions.

Chapter Two

Literature Review

2.1 Overview

Within all world industries, construction industry plays a major role in world's business environment (Mehany .et al, 2015). In Palestine, the performance of Palestinian economy report 2013 that is published by the Palestinian Central Bureau of statistics (PCBS) in March 2014 has shown that the construction sector contribution is about 14.1% of the GDP (Gross Domestic Product) (PCBS, 2013), compared to 9% contribution in 2011 (PCBS.2011) . This rate of contribution in Palestinian GDP shows the importance of this sector in Palestinian economy.

Construction industry contains many parties such as owners, contractors, consultants, stakeholders, shareholders, regulators and others so it is considered a complex industry in its nature (Abu Shaban, 2008). In addition to that, the environment of the construction, get complex rapidly and continuously, because of the increasing need for innovative requirements, the needs for more awareness in the environmental issues, the limited resources, and high competition in construction business. For all of these, the contractors in this sector have to be capable of keeping a continuous improvement of their performance (Aakanksha , 2015).

However, the construction industry plays an essential role in the Palestinian economy and because of its complexity and the special political situation, this sector faces many problems relating to cost, time and quality

performance, which makes adopting new trends for management, a necessity to overcome some of these problems. In construction industry, there are many problems related to the performance appearing into many topics some of these topic are cost, time, quality, client satisfaction; productivity and safety. For example, there is a delay about 110 days in construction of fourteen dwelling units at Rafah. This delay is due to the construction company suffered from poor management that caused a poor performance (UNRWA, 2000). The realistic reasons for this delay referred to closures, amendment of drawings and amendment of the design. Nevertheless, the main causes of this delay are related to other different reasons affecting construction projects performance itself. Some of these causes are poor management and leadership; inappropriate participants; poor relations and coordination between parties; absence of motivation, control, monitor or decision making systems; inadequate infrastructure, political problems; cultural problems and economic conditions (UNRWA, 2000).

2.2 Construction Industry

Karim and Marosszeky (1999) studied the performance of the construction industry and put its key performance indicators (KPIs). These KPIs include factors such as cost, time, quality, owner satisfaction; owner changes, business performance and safety issues. Department of the Environment, Transport and the Regions (DETR) (2000) defined the KPIs throughout all of the stages of the project. The five key stages of the construction project are:

1- Owner commitment to invest: this stage is determined as the point, at which the client decides to invest in a project, sets out the requirements in business terms, and lets the project team to proceed with the conceptual design.

2- Owner commitment to construct: this point is determined, at which the client authorizes the project team to start the construction of the project.

3- Available for use: this point is determined, at which the project is available for use. This may be considered as the completion of the project.

4- End of defect liability period: this point is determined at the period that the contractor is obliged to rectify defects is ended (often 12 months from point C).

5- End of lifetime of project: the point is determined, at which the period over which the project is employed in its original or near original purpose ends. This is a theoretical point over which concepts such as full life costs can be applied.

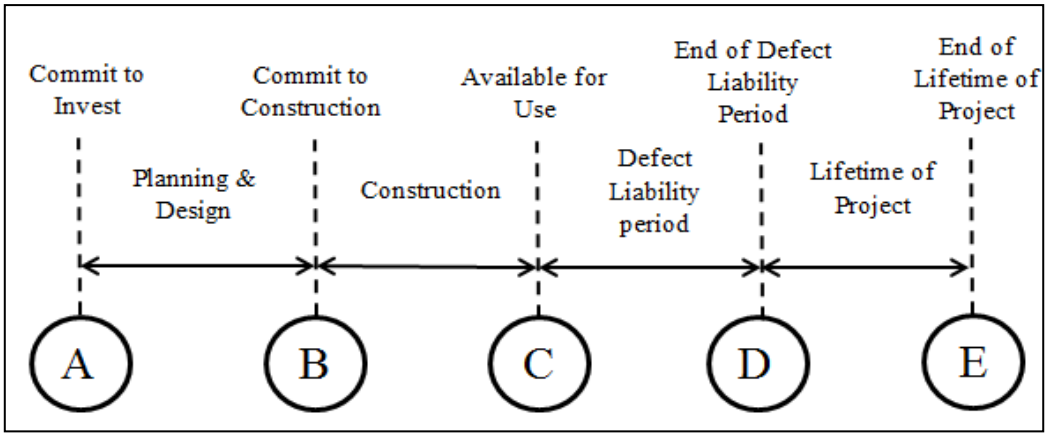

Figure (2:1): KPIs throughout the lifetime of a project (DETR, 2000)

As shown above the performance of the project should be improved throughout the entire project life cycle to improve the value of the project as shown Figure (2:1).

2.3 Problems of Performance in Construction Industry

Many studies have shown that there are many problems affecting the construction performance causing the failure of the project. For example in developing economies, these problems can be classified into three categories: the first are problems due to the shortages or inadequacies in the infrastructure (mainly in the supply of resources). The second is problems caused by clients and consultants, and finally problems caused by contractor incompetence/inadequacies.

In construction industry, the performance problems and the causes of these problems are identified. Okuwoga (1998) found that the performance problem is related to poor budgetary and time control. On other hands, Long et al., (2004) found that performance problems in large construction projects are due to many reasons such as: incompetent designer, incompetent contractors, poor estimation, social and technological issues, and improper techniques and tools. Navon (2005) stated the performance problem could be divided into two groups: the first group is unrealistic planning and the second group is causes from the actual construction (in many cases the causes for deviation originate from both sources). Samson and Lema (2002) found that the traditional performance measurement systems have problems because of large and complex amount of

information with absence of approaches to assist decision maker understand, organize and use such information to manage organizational performance. Navon (2005) remarked that traditional project performance control is usually generic (e.g., cost control techniques) and these types of management depend on manual data collection, which means that it is done at low frequency (normally once a month). Moreover, this manual data collection gives low quality data. Kim et al. (2008) stated that international construction projects performance is affected by more complex and dynamic factors, than domestic projects. Frequently these types of projects are exposed to external uncertainties such as political, economic, social, and cultural risks, as well as internal risks within the project that make the management of these projects more complicated and need new management practices

All these studies show that the traditional means of construction management do not solve all the problems of the construction and this industry still needs a new style of management to help in increasing the value of the project.

2.4 Construction Management and Performance

There is a strong relation between project management and project performance. Construction industry management is considered as one of the most important factors affecting the performance of works. Brown and Adams (2000) found that the effect of the Building Project Management (BPM) on time, cost and quality outputs for 15 cases in the UK fails in

controlling the performance as it was expected from relation to the three predominant performance evaluation criteria; time, cost and quality. In order to improve the construction performance the researchers studied the factors that affect this improvement. Wegelius -Lehtonen (2001) studied both firms' top management and operational managers for continuous feedback on operational activities. Ng et al., (2002) stated that documenting and archiving performance data could be useful for future reference, such as for settling disputes on claims, and in maintenance and repair works. Cheung et al., (2004) studied the project performance related to project managers and they found that developing a Web-based construction Project Performance Monitoring System (PPMS) could assist project managers in monitoring and assessing project performance.

The previous studies indicated that, the traditional construction management became insufficient to meet the dynamic changes of the construction industry. Minimizing all forms of wastes and maximizing the value added become the radical challenge for all stakeholders in construction industry. Therefore, the researchers begin to improve the construction management by studying new factors that may affect improving the construction management or adopting new trends of management to solve problems and increase the value of the project. One of the new trends of management is Lean Construction Management “which emerged from the principles of lean manufacturing".

2.5 Key performance Indicators of Construction Projects

In construction industry, the clients want their projects delivered: (on time, within budget, free from defects, efficiently, right first time, safely) by profitable companies. To achieve this goal it is important to identify the performance of the construction process, so that the KPIs were established for the evaluation of this performance (Abu Shaban ,2008). In addition to that, KPIs can be used for benchmarking purposes, and will be a key component of any organization move towards achieving best practice. Chan and Kumaraswamy (2002) identified that project performance measurement includes time, cost, safety, quality and client satisfaction. On another hand Ng et al. (2002) defined the performance measurement as monitoring and controlling of projects according to regular basis related to time, cost and quality. Kuprenas (2003) stated that the project performance measurement should means an improvement of cost, schedule, and quality for both the design and construction stages. According to the DETR (2000), KPIs framework consists of seven main groups: time, cost, quality, client satisfaction, client changes, business Performance, health and safety.

As mentioned above the regular clients in construction industry expect continuous improvement from their construction team to achieve year-on-year reductions in project costs and time so that the performance of projects should be controlled according to defined measure, which are KPIs. In traditional project management, the three main key performance indicators for the construction projects are cost performance, time performance, and quality performance.

2.6 Lean Construction Concepts and Tools

Lean construction is adopted from the Japanese manufacturing principles and this concept is adopted in different industries in addition to the construction sectors (Bertelsen ,2004). The principles of lean construction had been arisen from the concepts of lean production that developed by Toyota company in Japan in the early 1960,s under the name of production engineering (Cullen et al., 2005).

Ohno (1988b) developed a simple set of objectives in order to design the production system. In this system, a car that satisfied the requirements of a specific customer had been produced, and delivered it instantly. This type of production systems maintains no inventories or intermediate stores, which eliminates the wastes related to inventory (Lim, 2008). Therefore, the lean production methods have been applied in the Japanese car industry as a key to success. According to Murman et al. (2002), lean production or manufacturing concepts share certain principles. These principles include waste minimization, responsiveness to change, just in time, effective relationships within the value stream, continuous improvement, and quality from the beginning. These concepts are continuously evolving but the basic outline is clear. By reviewing many studies the researchers agreed on five main principles for lean principles which are (Value, Value Stream, Flow, Pull and Perfection) Womack and Jones (1996). In construction, Koskela and Howell (2002) have introduced industry lean as a new management approach. Senaratne and Wijesiri (2008) stated that if a company successfully implements the concept of lean construction, it would be able

to gain significant cost advantage by eliminating cost-consuming flow activities and become a cost leader. Furthermore, Johansen and Walter (2007) identified that construction industries all over the world such as Australia, Brazil, Ecuador, Denmark, Finland, Singapore, Peru, UK, USA and Venezuela have implemented the lean concepts within the industry and have reaped its benefits. Moreover Salem et al. (2005) remarked that the LC approach is different from the normal practices. In addition to that, Jorgensen and Emmitt (2008) said common elements in definition of lean that are expressly shown focus on specific aspects, which are proven capable of bringing benefits.

Chapter three in this thesis discusses lean and lean construction principles and tools, and it discusses the benefits gained from adopting lean principle in the construction process.

2.7 Lean Construction Key Performance Indicators (KPIs)

By reviewing studies, there are two types of performance in the construction process and each type has its indictors these two types are operational performance indicators and organizational performance indicators

2.7.1 Operational Performance Indictors

The success of lean implementation is typically measured by operational performance. The term of internal process and operational performance is used interchangeably in some studies. In the construction process, the

operational performance reflects the internal performance in terms of cost and waste reduction, product quality improvement, flexibility, delivery performance and productivity improvement (Jeyaraman and Teo, 2010). Al-Aomar (2012) remarked that the success of lean implementation directly benefits to operational performance where he identified lean construction key performance indicators (LC-KPIs). These indicators are expressed in terms of five important aspects of the construction project. These KPIs include Waste and Value indicators, in addition to the typical (Quality, Speed, and Cost) project management measures. These aspects are shown in Figure 2.2.

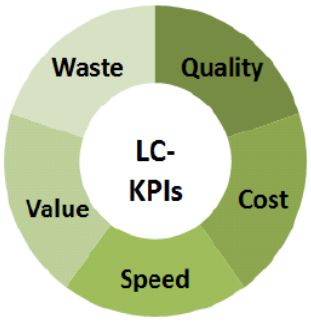

Figure (2:2) : lean performance KPIs

Al-Aomar (2012) described the five LC-KPIs as the following:

- Sigma Rating (SR): is defined as the quality of work completed internally or through the subcontractors. This quality of work should be reviewed at the end of each look-ahead period. The obtained SR value is compared to a certain company standard or benchmark value of Sigma rating to decide if any improvement is needed. Simply to measure the quality of any project it is necessary to have any measure or standards that the completed work should be compared to

- The project cost effectiveness and speed are key aspects in lean construction. These two aspects are measured by calculating cost performance index (CPI) and Schedule Performance Index (SPI) and they should be measured at the end of look-ahead period (Kuprenas, 2003).

- The waste and value indices are important to measure the impact of adopting lean techniques in the construction process. In construction industry lean should translate on site in order to minimize the wastes such as fewer defects and, less material waste, low inventory levels, and less conveyance and movement of labor and material.

- Thomas. (2002) defined the Waste Index (WI) as the difference between the amount of procured and used material and this index can be used to indicate waste in material and working hours. Thus, low values of this index indicate more frequent JIT and low inventory levels.
- The value Index (VI) compares the duration of the effective work (conversion time) to the total duration of the look-ahead period. This index focuses on increasing the amount of time spent in performing benefit activities (conversion activities) and minimizing the non-added value activities (delays, interruptions, and the time spent in unnecessary conveyance and movement of material and labor). The reviewing of this index periodically checks the amount of work spent in value-adding activities during the look-ahead period, see Table (2:1) that show the related studies supports these KPIs.

Table (2:1): lean KPIs related studies

KPIs / Source	Cost	Time	Quality	Waste	Value
Okuwoga (1998)	√	√			
Dissanayaka And Kumaraswamy (1999)	√	√		√	
Reichelt Lyneis (1999)	√	√	√	√	
Karim and Marosszeky (1999)	√	√			
DETR (2000)	√	√	√		√
Samson and Lema (2002)	√	√	√	√	√
Cheung et al. (2004)	√	√	√	√	√
Iyer et al. (2005)	√	√	√	√	√
Aakanksha Ingle, (2015)				√	√

2.7.2 Organizational Performance indicators

Another measure of lean implementation is organizational performance. Jeyaraman and Teo (2010) found that an excellent and smooth carry out of lean implementation would benefit the organizational performance. Organizational performance reflects financial aspects that include revenue growth, net profits, profit to revenue ratio and return on assets, and non-financial aspects, such as investments in research and development, capacity to develop a competitive profile, market development, new products development and market orientation.

2.8 Existing Researches in Lean Construction

From the previous discussion it appears that, it is important for all stakeholders to incorporate lean principles and concepts in the construction process. Most of these studies have shown how these principles benefit the

project performance and help in solving problems related to cost, time, and quality.

As a result of reviewing many studies related to how the researchers examined the principles of lean in construction. Koskela (1992) expressed many benefits when implementing LC in the construction project and it shows great benefits in reducing the construction cost using precise material and fewer wastes. In addition to having proper strategic planning, the construction period will be shortened. In recent years, several research papers have been highlighted how the lean principles as a new trend of construction management can be adopted in this industry. Egan (1998) proposed the United Kingdom construction industry to improve its capability and efficiency using lean. He found that LC is a way forward to minimize wastes of materials, time and effort, which maximizes the total value. Ballard (2000) mentioned that several construction companies are starting to implement lean construction. Additionally, Alarcon et al. (2006) studied how adopting lean principles in construction process can reduce the waste associated to activities that add no value to the project.

Minkarah et al. (2006) examined applying of six lean construction elements (last planner , increased visualization, huddle meeting, first-run studies, five S's and fail safe for quality) on a general contractors in Ohio and assessing the improvement in the project performance. Johansen et al. (2007) studied the current understanding of lean principles and perception to lean and trend in lean development among the German construction industry. In their study, they gathered and measured the extent to which

principles that might be considered “lean” have spread through the German construction industry and they found that convention thinking still governs the German construction industry and the integration of lean related to project process has not been taken place. In addition, they adopted the conceptual framework of lean construction that examines lean principles on (management, planning, control, behavior, supply, insulation, design, collaboration, procurement). In their study, they suggested that there is little awareness of lean in the German construction industry and the lean concepts are occasionally applied within the industry. Therefore, the level of how lean concepts penetrate the construction industry is rather low.

Marhani et al. (2012) discussed how can LC be highlighted in the implementation of construction project in Malaysia and they studied how can these principles enhance the sustainable construction. Andersen et al. (2012) investigated lean construction practices at St .Olav’s hospital implementation in phase 2, and compared it with the phase one. Based on the results of this implementation, they are keeping the building time in phase two and compare with phase one despite increasing in complexity. In addition to that, 3.4% cost reduction per m2, improved build quality and improved the value of the project. Yasemin et al. (2013) examined the lean construction conformance among construction contractor in Turkey and highlighted the competitive strength and weakness of Turkish contractors for lean construction.

In USA, there are several construction companies starting to implement lean construction with nebulous hopes of obtaining better results from their

current projects. Kim and Park (2006) studied the factors that support successful lean implementation in USA construction companies and identified lean implementation benefits and barriers. This study examines the mutual relationships of lean planning systems, organization structure, attitudes of project participants and company strategy that played major influences on successful lean implementation.

From the previous reviews, it shows that the adopting of Lean in Construction Industry is under study of many researchers in the world. The researchers still examine how the traditional trend of construction management can be improved by adopting some of lean principles. This can be examined by applying some of lean construction tools on a case study project and monitor the improvement in the project performance. Another trend of researches is investigating how lean principles are planted in the contractor culture to form a platform for adopting this new trend of management.

In Palestine, very few studies have been done in this area. One of these studies is done in Gaza strip by (El-Kourd ,2009). This study has been applied on a contracting company in construction that constructs a project located in GAZA strip. The main objective of this study was to apply the principles of lean in a construction project in Gaza Strip. The researcher found that the value added time increased, the use of lean tools decreases the cycle time and the value added can be enhanced by using some of lean tools. Abu Ismaiel (2013) investigated the applicability of Lean Construction in Gaza Strip; the results revealed that there are many

challenges and barriers to integrate lean construction with its full techniques in Gaza. The intensive training is needed for construction contractors to be able to use lean construction tools.

In conclusion, it appears that lean construction is a new trend of construction management and it needs more and more study from the researchers. To enhance the lean principles and tools among the Palestinians contractors, it is necessary to study how these principles are planted in their culture and examine the degree to which they are satisfied to adopt a new trend of management.

2.8.1 Conceptual Framework of Lean Construction

For applying Lean in construction process, the researches illustrated that there must be an integration between areas in the construction with lean construction. Johansen and Walter (2007) provided a conceptual framework of lean construction that identified the areas that must integrated with L.C to have successful lean implementation as shown in Figure 2.3.

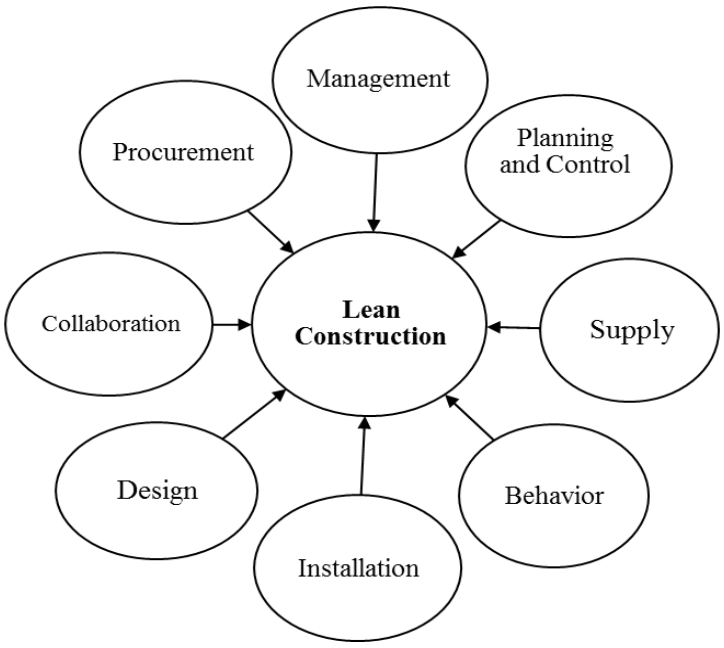

Figure (2:3): Lean construction conceptual framework (Johansen and Walter, 2007).

2.8.1.1 Procurement Area

The procurement in the organization adopting lean should facilitate the progress of design and construction. The procurement department should adopt new strategies such as integrating the design and build management contracting, private finance initiatives and collaborating.

2.8.1.2 Management Area

In lean construction management there are principles that should be involved in management practices in order to have successful lean implementation .Some of these principles are , supply chain management; concurrent engineering and TQM , benchmarking , visualization and standardization .

2.8.1.3 Planning and Control Area

In construction, planning and controlling are combined, because accurate planning leads to an effective control of the process. In lean construction, there are practices that have been adopted in the project planning and controlling in order to reduce the variability and uncertainty in construction. Some of these practices are work structuring, pull scheduling, look ahead planning and weekly work planning that are considered effective in production control.

2.8.1.4 Collaboration Area

Collaboration considered one of lean features that must be considered in lean construction. Collaboration should cover many aspects such as long-term contractual agreements with sub-contractors, suppliers, consultants and clients. Some techniques such as cross-functional teams and the employment of document management systems may facilitate this collaboration.

2.8.1.5 Behavior Area

The transformation from traditional construction management practices to lean construction practices requires participation and loyalty from all hierarchical levels, as well as the ability to analyze the structure and culture of the organization. This change needs a ‘long-term vision 'in addition to commitment to change among the organizational hierarchical levels.

2.8.1.6 Design Area

Lean design is applying lean approaches to construction design. Lean techniques were employed to help preventing the value loss by diminishing inconsistent decision-making and to stimulate flow and this may be achieved by enhancing coordination and information procedures.

2.8.1.7 Supply Area

In lean construction, the supply principles have been outlined in principles that facilitate the delivery of materials of the desired quality at the appropriate time, and to the right amount. In order to achieve this principle lean construction advanced applying special techniques of lean supply as JIT and Kanban.

2.8.1.8 Installation Area

The installation process in lean construction has been recognized as following flow principles. These principles should apply to the movement of work crews and materials. In lean construction, there are tools that support applying the flow principles in order to eliminate the wastes in the process flow. First, run studies and pre-fabrication strategies have been considered as minimizing uncertainty in production processes.

2.8.2 Framework for Successful Lean Implementation

Kim and Park (2006) assessed the effectively adaption of lean construction in the U.S. construction industry. This study investigates the implementation of specific lean tools on real construction sites and assesses

how the mutual relationships of the planning systems in the organization, organization culture, attitude and contract achieved the effectively and highly successful implementation of lean construction. See Figure (2:4)

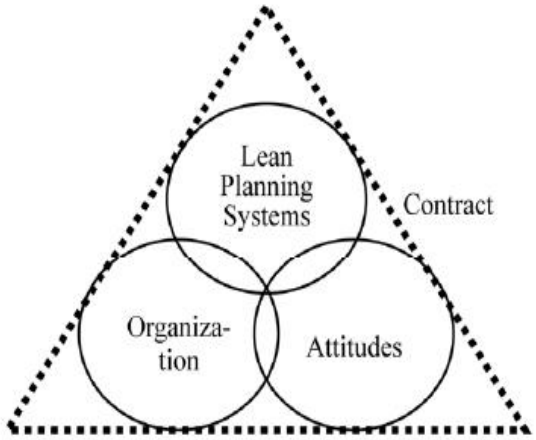

Figure (2:4): Relations for successful lean implementation (Kim and Park, 2006)

Kim and Park (2006) identified the essential foundations for lean construction and the factors that support this foundation

2.8.2.1 Essential Foundation of Lean Construction

1- Production Control

Production control consists of workflow control and production unit control. The traditional construction industry seems to prefer speed of the flow rather than reliability of workflow. This type of flow causes disruption for the entire project. In the contrast lean thinking, believes in the reliability of the flow that is reducing the workflow variability in order to improve the total system performance. Reducing the workflow variability and increasing its reliability makes the project outcomes more predictable, simplify coordination, and reveal new opportunities for improvement. For

that, the strategy of lean construction in a project is reducing variability and increasing the percent plan completes (PPC) (LCI, 2002). Last Planner system, which comes along with the concept “Should-Can-Will-Did.”, Will be the practice that improves the PPC through establishing a detailed planning method through the project. Figure (2:5) describes the last planner tools (Ballard & Howell, 1997).

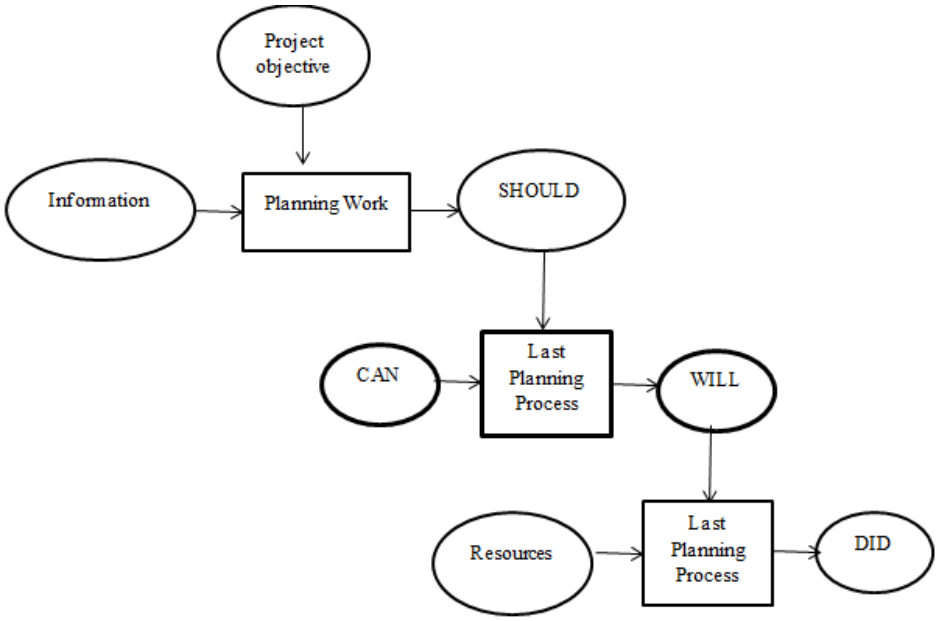

Figure (2:5): Last planner systems (Ballard & Howell, 1997)

2- Work Structuring

Lean Work Structuring is a process design, which expects iteration between “What” is to be built, and “How” to build it. In the process design, changing is the results of “What” while not considering “How.” (Kim and Park, 2006).

3- Production System

LCI (2002) suggested guidelines for self-management. These guideline need changing or improving for some aspects in the production control, such as variability in the production process, the mentality of the activity/contract, the process control, lack of knowledge, little learning and push systems. Lean construction management aims to increase the throughput rate (TH) to match the demand rate and reduce cycle time, work-in-process, and minimizes the resources required,

4- Human Resource Management

Managing people successfully has been a major challenge. It is important to have smaller but highly motivated and highly-productive workforce. Moreover, human resource management (HRM) has come to occupy a more essential role in the employment relationship (Kim and Park, 2006)

2.8.2.2 Factors Supporting Successful Lean Construction Implementation

Kim and Park (2006) identified four themes that form the foundation of successful lean implementation. In their research and in order to support these foundations .They studied the factors that support these foundations which are planning systems, organizational factors, attitudes of individuals and contract. They found that the mutually and effectively combined of these factors support the successful lean implementation.

1- Project Planning System

Kim and Park (2006) assessed some lean practices in construction companies in U.S.A and identified the degree to which these practices are implemented and the benefits gained from them. In the research the researchers studied applying Master Scheduling, look planning, Weekly Work Plan (WWP), percent planned complete (PPC) and Just in time (JIT) in the construction projects and they considered these practices supports successful lean planning implementation. The results in this research show that the master scheduling is a fundamental scheduling most projects In addition to that look ahead planning, WWP, PPC and weekly lean meeting had been implemented in all projects sites and these practices support successful lean implementation.

2- Organization

Kim and Park (2006) assessed the effects of the organizational factors that support successful lean implementation and they studied these factors from the following sub factors.

- **Organizational Support**

In the construction companies, it is observed that involvement of the owner is important for successful lean implementation and the company's support is needed to reinforcement lean implementation. It is found that the upper level management in the most companies was enthusiastic to apply lean

construction to new projects but little support was found for introducing this change in management (Kim and Park, 2006).

- **Communication and Coordination**

Under lean construction, all project participants showed a higher developing of coordination, cooperation and communication. This communication and coordination among project participants showed improvement compared to projects not employing lean construction. This research shows that all foremen in the projects agreed that the best benefit of lean construction was improvements of the working relationships among the trades in addition to that the communications among subcontractors was dramatically increased on lean construction . The researchers identified that the general contractor had good communications and mutual coordination with sub-contractors they could successfully implement lean (Kim and Park, 2006).

- **Training**

Construction training that focused on the lean principles, tools can improve productivity, and performance, has a great influence on adopting and implementing lean in construction companies. This study while assessing this factor in U.S companies .The researchers found that most owner and general contractor project team members were aware of lean theoretically, but the subcontractors were rarely aware of lean and both needs training in lean practices (Kim and Park, 2006).

3- Attitude

Project participant's attitude toward lean construction is a sensitive factor for successful lean implementation. It is found that involvement and commitment of the employee among lean is an essential factor for successful lean implementation. In addition to that, enthusiasm, open-mindedness and motivation among general contractors and subcontractors also have positive effects for successful lean implementation.

4- Contractual Restraints

The enthusiasm and involvement of project participants to implement lean construction should be empowered by contractual relationships. So contractual agreements to use lean among the owner, the general contractor, and the subcontractors is essential to support this implementation. The contract required all participants to try to use the lean ideas and system.

2.9 Factors Supporting Successful Lean Implementation

Based on the work of Liker (2004), Shah and Ward (2003) and Shingo (1992), a conceptual framework for lean thinking had been developed. In this framework, all the enablers of lean thinking and the relationships between them were put together. These enablers include the principles, practices and processes needed for adoption of lean thinking within the whole organization.

Lean thinking is as an integrated management approach", that its impact will cover the whole organization including its stakeholders – suppliers and other business partners, customers, etc.

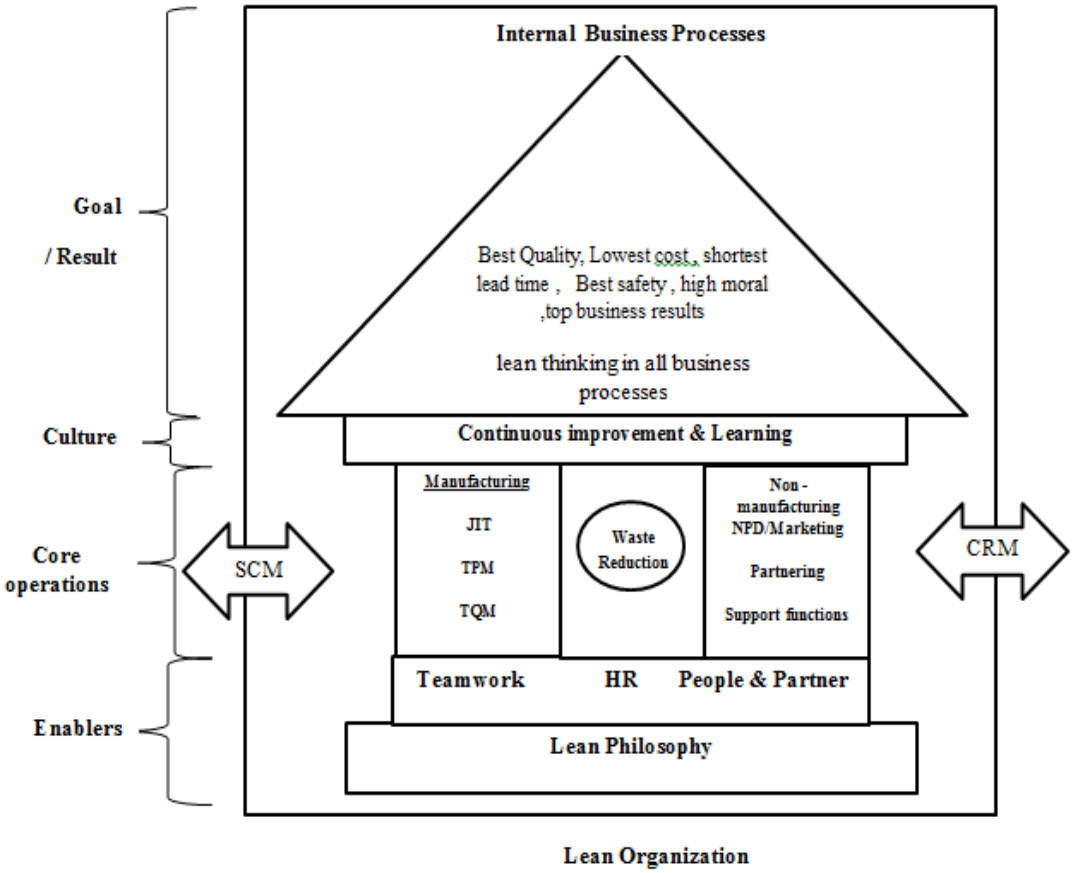

Figure (2:6): Conceptual framework for studying lean thinking (Liker ,2004)

The Womack and Jones (2003) defined two terms in his framework for lean implementation: the first one is lean organization that is reached when the organization implements the lean practices only at the inside structures. The second term is "Lean enterprise"; this is reached when the organization applied lean at the all value –adding activities within the organization as well as between the organization and its contractors. In this research, the authors suggested house that keeps together all the necessary parts of the

lean enterprise as shown in Figure 2.6. In this house, each of these elements is important to be present, so that full benefits could be received for the company adopter.

In this house, the base consists of the enablers of successful lean implementation. First of these enablers is lean philosophy, this philosophy refers to the appropriate leadership style and commitment of all management levels until the top management. This philosophy should depend on the perfection in meeting customer requirements and continuous improvement, learning and waste reduction.

The second layer of the house is human resource management (HRM). In this layer, the employee empowerment, involvement, teamwork and sharing the value of lean principles are considered key success factors for lean implantation. The third layer illustrates the supporting activities that the company needs to improve its core processes with the focus on “waste reduction”. The left side of this layer shows some of the best practices such as just in time (JIT), total productive maintenance (TPM), and total quality management (TQM), which contribute for waste reduction. On the other side of this layer, there are areas that are non-manufacturing and supporting functions that should be influenced and improved. These practices include marketing, new product development (NPD), collaborating with suppliers and customers.

The lean house ceiling consists of lean culture that supports the roof of the house, which consists of lean goals and results. Lean culture deals with the

problem solving in the process of learning going on the way of continuous improvement. Culture is both a result and enabler for sustainable and successful lean operations (Liker,2004). Finally, on the top of this house there are goals and results reached by implementing Lean. These results are related to best quality, lowest cost, shortest lead-time, high employee morale, safety working issues, top business results. These results give the company high performance and competitive advantage (Womack et. al., 1994).

For studying lean in any industry, the lean house is considered a guide for the employees through the organizational change towards the values of lean thinking.

2.10 Factors Supporting Lean Construction

As reviewing in literatures there are many studies that summarized factors influence implementation of lean construction and considered as challenges that should be taken and overcome. The following are some studies that considered some factors for successful lean implementation.

Motwani (2003) concluded that changing the process needs the following success factors: 1) Managers should define and communicate the vision of change , 2) enhancing the willingness to learn, 3) Culture of organization should be ready for change , 4) Good network relationships in the organization, 5) Knowledge sharing, 6) Management practices should be changed .

Salem et al. (2005) found that top management commitment is the most important factor in successful implementation of lean construction tools.

Pavez and Alarcon (2006) summarized the factors that influence the implementation of lean construction and considered, as challenge factors. These factors are: 1) Time, 2) Training, 3) Organization, 4) Parallel implementation with other improvement programs, 5) Problematic projects. Kim and Park (2006) showed that without a mandatory clause in the contract, there is no means to enforce all trades to get involved in lean implementation. Pavez and Alarcon (2006) believed in the four key elements that support lean implementation which are: 1) the firm should adopt lean vision 2) having good technical capacity, 3) Management capacity and 4) Social competence.

Hook and Stehn (2008) concluded adopting the lean construction can be achieved through the following drivers 1) continuous maintenance of the equipment , 2) Work standardization ; 3) visual information ; 4) enhancing team work, 5) multifunctional workers,6) the quality leadership, 7) Just in time (JIT) tool ; 8) continuous improvement, 9) error proofing, 10) defect and waste reduction .

Kovacheva (2010) in her study summarized the factors which are most important for the Lean implementation:1) Management commitment in the implementation process and communicating the vision of the improvement program, 2) Necessary changes in the organizational culture,3) Employee’s

involvement, 4) Network relationships, 5) Holistic strategy for integrating the system, and 6) Willingness to learn.

2.11 Key Success Factors in the Research and the Research Framework Variables

In this research and as results of reviewing many studies related to the factors that support successful lean construction implementation and the lean key performance indicators in order to build the framework of this research the following variables were identified.

2.11.1 Key Performance Indictors in the Proposed Framework

From the previous studies and as shown in section 2:8 in this chapter the following performance dictators were adopted to present the perception of the contractors towards successful lean implementation. The proposed KPIs were supported by literature studies .These KPIs are operational performance indicators (Cost , time , quality , waste and value) , and the organizational indicators (revenue , net profits and developing competitive profile) and these variables are considered dependent.

2.11.2 The Successful Lean Implementation Factors in the Proposed Framework

In this section, the factors suggested to support lean construction implementation were identified related to literature reviews and these variables are considered independent variables .

1- Management and Planning Systems

- **Production Control**

In all production, systems there are two aspects that are considered the core of the new lean philosophy these two aspects are conversion and flow. In production process, all activities expend cost and consume time but only conversions activities add value to the materials or information being transformed into a product (Luis Alarcon, 1994). In lean philosophy the improvement of non-value adding flow activities (inspection, waiting moving), should primarily be focused on reducing or eliminating them whereas conversion activities should be made more efficient (Koskela ,1992). Figure (2:7) explains the different levels of the new production philosophy that depends on adopting the new lean principles and tools in the production process to achieve the core concepts of improving the value of the products and reduce the waste(Koskela ,1992).

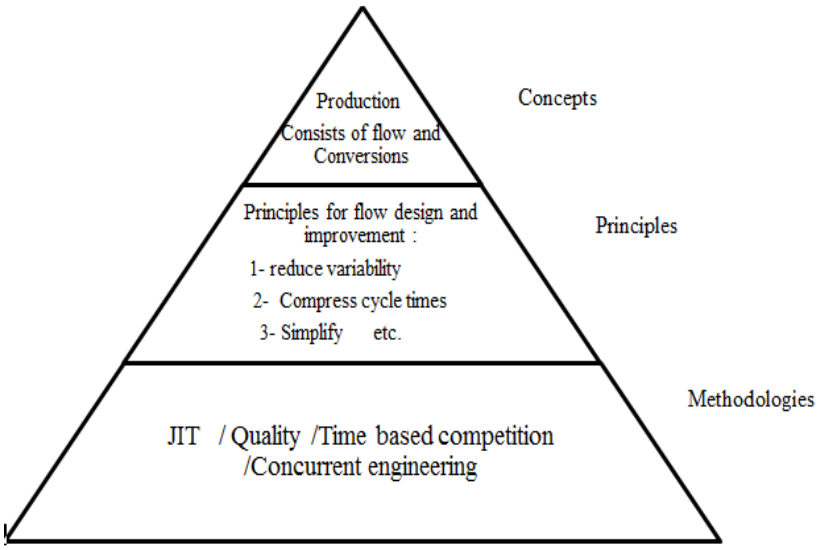

Figure (2:7): Levels of the new production philosophy (Koskela ,1992)

In lean production philosophy and for achieving an improvement of the whole process both aspects of the process, which is conversion and flow, should be considered. In contrast, the traditional managerial principles have considered only conversion or all activities have been treated as though they were value. So conversions activities in traditional managerial principles flow processes have not been controlled or improved this has led to complex , uncertain , confused flow process , expansion non value – adding activities and reduction of output value. In lean philosophy, Information flows are thus the basic unit of analysis, which are characterized by time, cost and value. In different subfields of lean philosophy a number of heuristic principles for flow process design, control and improvement have evolved. There is ample evidence that through these principles the efficiency of flow processes cab be considerably and rapidly improved (Koskela, 1992). Ohno (1988a) defined the five lean principles (Value , Value stream mapping , Flow , Pull, perfection) that considered the base principles of the new production philosophy and the researchers built on these principles and defined many principles that support the core principles of lean . Koskela (1992) summarized some these principles in the following principles :-

1. Reducing the non-add value activities (also called waste)
2. Improving the value depending on satisfying the customer requirements.
3. Minimizing the process and flow variability.

4. Eliminating any wastes to reduce the cycle time.

5. Simplifying the process by minimizing steps, parts and linkages in the process.

6. Increasing the output flexibility of the process.

7. Increasing the process transparency

8. Control should be on the complete process

9. Continuous improvement of the process

10. Create the balance in the improvement between flow and conversion processes.

11.Benchmark

For attaining lean principles and according to Koskela (1992) there are many methodologies and tools that help to achieve lean principles in the production process and these tools have been originated around the basic principles, some of these tools are:

-Just in time (JIT)

- Total quality management (TQM)

- Time based competition

- Concurrent engineering (or reengineering)

-Value base management

-Visual management

-Total productive maintenance (TPM)

-Employee involvement

To examine the contractor's agreements of adopting lean principle in the construction process control, and how these principles can affect the improvements of both the operational and organizational. The following items will be examined (identifying wastes, value stream mapping, pull approach, just in time, total quality management and continuous improvement). All these items were supported in the literature.

- **Work Structure and Last Planner**

Ballard and Howell (1997) identified that design and construction of a project require planning and control done by different people, at different places within the organization, and at different times during the life of a project. In order to achieve planning and controlling Ballarad (2000) defined the Last Planner as a mechanism for transforming what SHOULD be done into what CAN be done. In this system, the firms can build their inventory of ready work, from the information that comes from Weekly Work Plans. The weekly work plans should depend on the Last Planners (foremen, squad bosses) commitment to what they actually WILL do. According to Ballarad (2000) Percent, Plan Complete (PPC) is an important measure for the production control and it is defined as the number of planned activities completed divided by the total number of

planned activities, expressed as a percentage. In addition to that, Koskela (1992) showed that PPC measures the extent to which the front line supervisor's commitment (WILL) was realized.

After calculating PPC and determining the variance if it is exists the planner should analyses the non-conformances in the process then determine the root causes, so that improvement can be made in future performance. Moreover, Kovachva (2010) thinks that measuring performance at the Last Planner level does not mean making changes at that level but PPC analysis can become a powerful focal point for breakthrough initiatives.

In studying the effect of last planer system on the improvement of the construction project the following sub factors will be examined (dividing the project in activities on a schedule having the critical path , adjusting the variance in the plan , weekly work plan and having PPC chart) all of these sub factors were supported in the literature .

- **Management Commitment**

An excellence leadership and management is considered one of the most essential factors that leads to successful lean implementation (Achanga et al., 2006). In the organization, the continuous support and commitment from top management, appears to be one of the crucial factors for adopting new initiatives in the organization that will be weakened without this commitment (Pande et al., 2000). Some companies that have been implemented lean were not successful due to poor management supports

(Jeyaraman and Teo, 2010). By consolidating many studies the researchers considered , leadership and management as the most essential prerequisites in successfully adopting new improvement initiatives (Antony and Banuelas, 2001; Coronado and Antony, 2002; Henderson and Evans, 2000). In this research and in order to understand the effect of management on successful lean implementation there are sub factors that categorized including management commitment, management engagement and an excellence leadership and all these sub factors are supported in literature.

2- Human Factors

- **Attitudes of the Individuals**

According to Fazio et.al (1978)," Employee affective attitude (EAA) is defined as views, outlook, and beliefs of employees towards their job". The EAA of the employee's is shaped according to their experience and attitudes regarding companies' culture (Fazio et al., 1978). Moreover, the employees develop their attitudes depending on their working environment and working methods (Monge et al., 2008). The EAA of the employees could be measure through these factors job satisfaction, job stress and commitment (Rodwell et al., 1998). These factors were measured for Australian companies and it is found that these factors are significant for EAAs' effectiveness and play a critical role in the organization's success and its development. For example, job satisfaction has important effects on

the employees' performance like well-defined work, freedom in performing task, better quality of the work, and goal clarity .

(Hackman et al., 1980). In construction industry and according to Kraus (1995) and Rodwell et.al (1998) all these factors play an important role in the success of a construction project.

As a result of reviewing literature and according to Coffey (2000) human resources in the organization plays a major role in lean implementation and its success. He said that “implementation of lean construction is in its infant stage, so that lean construction yet depends upon the potential and abilities of employees in order to successfully perform many of its functions and achieve its potential.” For successful lean implementation there are several elements that should be involved in project participants’ attitudes. Some of these elements are, involvement of employee’s in participating in decision-making concerning their own work, commitment that could be achieved by involvement, motivation, enthusiasm to employ lean, open-mindedness and having a positive vision to accept the change.

In this research, the attitude of the employee and its effects will be examined through these sub factors, job satisfaction, job stress, commitment, involvement and open mindedness and all of these items were supported in literature.

- **Skills and Expertise**

In the organization, the employees play important roles in delivering the value of the project and this value should be determined according to customer's requirements. So that the highly-skilled labors of the organization are important to improve this value and ensure company's growth and success (Jeyaraman and Teo, 2010). Lean construction management is a new management trend that aims to improve the value of the project, so it is necessary for the company to pay more attention on skills and training for employee in order to achieve the goal of lean implementation. With this regards there are dimensions related to the skills and training that should be taken into consideration such as, employee sufficiency, employee training, and employee learning.

In this research, the skills and expertise will be examined through the importance of the training courses in lean practices, hiring employees have experience in lean and the skilled labors in lean practices and all these factors were supported in literature.

- **Team Works**

In the organization cross-functional teamwork of all employees are important for improving their performance. In order to improve teamwork in the organization it is important to pay attention to communication both in terms of vertical and horizontal communication. Jeyaraman and Teo (2010) considered that the horizontal communication and vertical communication link to teamwork. The horizontal communication was

referred to an informal, social, and economic communication among proximate colleagues, whereas the vertical communication was defined as communication with management sharing the strategic information (Postmes et.al, 2001). Another factor that affects working the employees as team is the individual behavior (IB). According to Lingard et.al (2007) individual behavior IB in the construction industry is related to work-life balance of a construction worker, which maintains organizational effectiveness and occupational health. In order to optimize the performance of the employee and improving the IB, there are factors that should be taken to consideration, some of these factors are an affective workers commitment, job performance, and job satisfaction (Leung et.al, 2008).

Park et.al (2008) surveyed thirty seven workers to analyze the job satisfaction of workers working in a team. They concluded that workers have high job satisfaction working in a team regardless of the task complexity. This study leads to the fact that the teamwork enhances job satisfaction affecting the IB positively and may enhance the acceptance of lean practices.

From the previous study, it concludes that working as team in the construction industry increases the effectiveness of the employees and increases the job acceptance. Moreover, team work enhances the job satisfaction about the work, which affects the individual behaviors that leads to positive work environment and may support lean culture in the organization .In this research, for examining the effect of team work, these

items will be examined, participation of individual in the responsibility, communications and enhancing team work in the job environment.

- **Communications**

Communication is considered another crucial factor of lean implementation. Antony and Banuelas (2001) emphasized that efficient and frequent communications provide employees a guideline and maintain the momentum in implementing lean towards continuous improvement efforts. Implementing lean requires the effective top down communication in order to provide employee with clear objectives and consistent mission statements (LluÍs Cuatrecasas ArbÓs ,2002). In addition to that, successful lean implementation required cross-functional teamwork of all employees in the organization. Jeyaraman and Teo (2010) considered brainstorming and frequent communication important elements of successful implementation.

In this research, communications will be examined through the following items: good vertical and horizontal communication, cross functional team works and good communication systems and all these factors are supported in the literatures.

3- Organizational Factors

- **Organization Culture**

Organizational culture is defined as the belief, values, and practices shared by the employees of organization towards achieving organizational

(effectiveness Blunt ,1991). Changing in organizational culture is the major transformation in beliefs, values, and working practices of employees, therefore it serves to be the main focus of organization and is considered as a barrier to improve organizational effectiveness (Boan, 2006).

Denison et al. (1995) identified adaptability, mission, involvement, and consistency as four essential traits of organizational culture. Further, they concluded that an employee who is adaptive to changing nature of work, familiar with the mission of organization, involved and consistent with his/her work has better satisfaction and performance.

Organizational culture varies with the different organization and depends on the attitude, beliefs, values, and practices being followed within a particular organization. To support this fact, Chatman et.al (2001) did the comparative study of organizational culture for four industries and found the culture to be different in every industry. Sengupta et al (2005) analyzed the influence of organizational culture over the working behaviors of the managers of the firms and he found that there are direct correlation between organizational belief and the working behavior of the individual

Kim and Park (2006) studied the effects of four major elements on organizational culture that affect lean construction implementation ,these factors are, organizational support, training (knowledge), coordination, and communication between the owner and general contractor, owner and subcontractors, and the general contractor and subcontractors. They found that for successful lean implementation, changing organizational culture

should be performed through different ways including strategic change and process changing to reach the lean culture in the organization .Furthermore, Anchanga et al. (2006) stated that the creation of supportive organizational culture is an essential platform for the implementation of lean concept.

Bhasin (2011) mentioned that collaboration is required in order to achieve and sustain the success of lean implementation. Kim and Park (2006) considered organizational culture as a critical success factor for lean adoption and it is important to consider essential aspects of cultural factors including openness, collaboration, receptivity, and data sharing.

According to Krafcik (1988), the human recourse department in the organization, adopting lean culture should be different from the conventional hierarchical command-and-control structures. Lean HR policies and practices should reinforce employee empowerment, so that employees from shop floor to management are encouraged to engage in continuous improvement activities aimed at eliminating waste (suggestion schemes, quality circles).

In this research, the organizational culture and its effects on adopting lean will be examined through the openness, collaboration receptivity, the comprehensive strategy and culture change.

- **Training and Knowledge**

Proper training is necessary in motivating the workers to accept the change. The concept of Lean may be new to many of the workers and they may be

resistant to the change due to the fear of the unknown. Training acts as a way of educating them on how to go about making the changes and how to maintain it Murthy (2007). According to Murthy (2007), training could be done such that the workers gain hands on experience on Lean implementation and should be able to effectively communicate with the training leader about any doubts, or opinions, or suggestions.

Financial capacity of the organization is a critical success factor in Implementing the lean, because it needs some significant investment of company in developing resources, training materials, and statistical software licensing purchase, seeking consultation advice Anchanga et al (2006).

Kim and Park (2006) find that construction training that focuses on the lean tools may improve productivity and performance, and he found that the training also should focus on lean concepts and principles also they found that most owner and general contractor project team members were aware of lean, but that subcontractors were rarely aware of lean.

In the research the effect of training and expertise on lean implementation will be examined through these sub factors, providing training course, company capability to invest in training and the training should cover both the general and sub-contractors.

- **Coordination and Communication**

In the organization, it is vital to remember that communication goes both ways and it is important to create an environment that makes workers feel confident in giving their feedback. While implementing lean practices in the organization the senior management should explain to the workers that their input is vital in making the lean implementation success. In addition, the senior management team should not just collect this information but also use it. When the workers see that their suggestions are being used or taken into consideration they may be more willing to take part and contribute in the change.

According to Banuelas (2001) the effective communication is a prerequisite to successful change, helping to shape the mindsets and behaviors of everyone involved, but it must be a two-way dialogue, not a one-way broadcast. In any organization there may always be some (if not all) workers who have the most challenge in accepting the lean implementation. One way of avoiding workers resistance to change is by involving them in the entire processes of lean implementation from beginning to end. For improving lean adoption, coordination and communication are considered crucial factors according to Antony and Banuelas (2001).They emphasized that efficient and frequent communications provide employees a guideline and maintain the momentum that helps them for adopting lean. Moreover implementing lean requires the effective top down communication in order to provide employee with clear objectives and consistent mission statements (LluÍs Cuatrecasas ArbÓs, 2002).

Kim and Park (2006) found that an open communication environment between the general contractor and subcontractor are vital for successful lean implementation. If general contractors had good communication and mutual coordination with the subcontractors, they could successfully implement lean construction.

In this research, the coordination and communication will be examined through these items: creation of supportive culture, openness, collaboration and open communications.

- **Research and Development (R & D)**

Construction is a unique environment and by definition is creative industry .This creativity is regarded as crucial to the future of the industry. In construction industry, no single project is the same as another and that diversity breeds innovation and innovative problem solving at the practical level (Jamie Dale, CIOB, 2007).

According to Jamie Dale, CIOB (2007), who represents in his study that carried out the construction company in UK, 99.7% of respondents felt that R & D was important or very important to their company and 100% also felt that innovation was important or very important to the future of construction. Jamie Dale, CIOB (2007) defined innovation as the successful introduction of new technologies or procedures into industry. R&D will be defined as the process that is undertaken to introduce innovation into industry. Innovation is not to be confused with R & D with which it is often linked. Innovation is a product of R & D.

Ozorhon et al. (2009) list some measures that defined the impacts of innovation on construction industry. The following impacts are found to agree with lean construction principles: -

- Revenue growth due to new products or services
- Short and long-term profitability
- Increase in organizational effectiveness
- Improvement of service/product quality/processes
- Improvement of organizational structure

Adopting innovation in construction can be presented in adopting modern methods of construction (MMC) that is renewable, sustainable, recyclable, non-toxic, and waste-efficient. These methods are agreed with the principles of lean and suitability.

From the previous studies, it is concluded that R&D and adopting innovation are critical factors for successful lean implementation .In this study this factor will be examined through these sub factors: the existence of R&D units, adopting innovative method in performing activates and adopting new construction technology.

4- Contractual Factors

Contractual factors in the construction process have to be initially oriented to create strong involvement of the owner, general contractor and subcontractors, and to define roles and responsibilities of project

participants. Miles and Ballard (1997) indicate that “contracts are one dimension of organizational relationships,” and “cooperation must be based upon realistic appreciation and recognition of the self-interests of the participants in a project.” The contracts must support these self-interests and provide a framework for the overall best success of the project. Contracts can create better coordination and help keep a promise among project participants, and should support effective implementation of lean systems. Kim & Park (2006) identified that the enthusiasm and involvement of project participants to implement lean construction should be empowered by contractual relationships. In their study, they observed that all participants try to use the lean ideas and systems should be powered by the contractual agreements among the owner, the general contractor, and the subcontractors.

Timothy et al (2012) compared between the lean construction agreement and one of the traditional construction agreement in USA, which is design built agreement. Design-built is a project delivery method in which a single entity, the design-builder, is responsible for both the design and construction services necessary for completion of a building project (Songer, 1996). In this study, they found that there are different topics that should be included in the contract support lean implantation as shown in Figure (2:8).

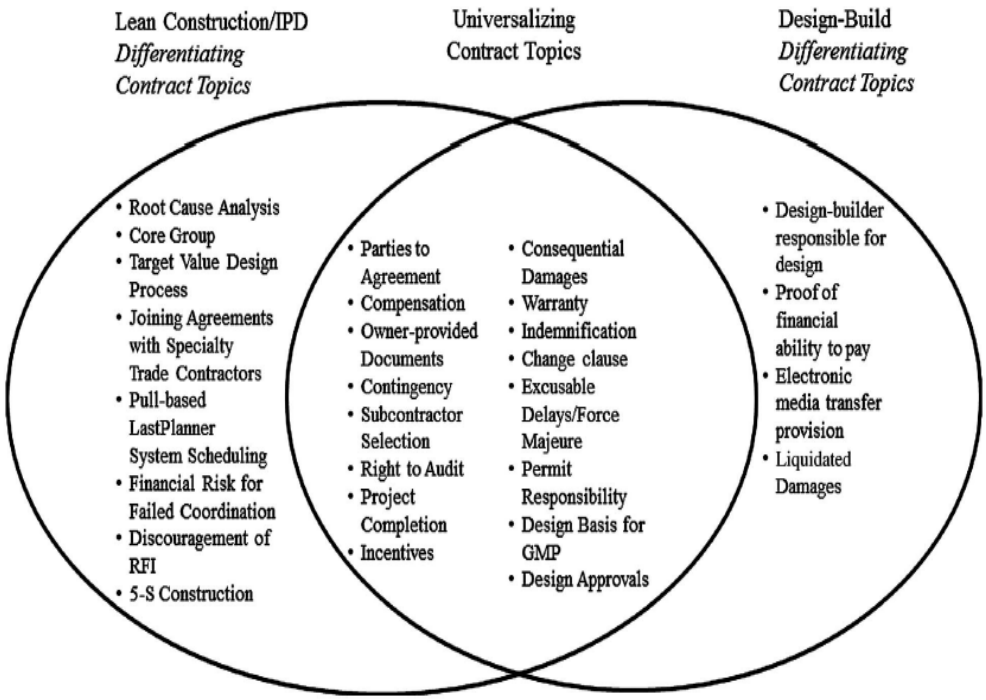

Figure (2:8): Comparative between lean construction contract and design build contract (Timothy et al ,2012)

2.11.3 The Research Factors Determination

In order to examine the factors that support successful lean implementation in the construction industry and in order to form a framework that supports this successful implementation and from the previous studies the following factors were determined as Table (2:2)

Table (2:2): The proposed framework variables

Dependent Variables (KPIs)	**KPI (successful lean implementation)** - Operational KPI (Cost, time, quality, wastes and value) - Organizational KPI (net profit, revenue growth and competitive profile)
Independent variables (Factors for successful lean implementation)	**Management and planning systems** - Production control - Work structure and last planner - Management commitment **Human Factors** - Attitude of the individuals - Skills and experiences - Team works - Communication **Organizational factors** - Organizational culture - Training - Coordination and communications - R&D

2.12 Summary

From the previous studies, it appeared that the construction industry is an essential sector in Palestine and this sector is complex in nature. This sector faces many problems related to cost, time, and quality and the traditional trend of management still insufficient to deal with these problems, so it is essential to think about new management practices. One of the new trends is lean construction (LC) that appeared in the world of construction industry as new management trend. To adopt this management in the Palestinian construction industry, it is necessary to start by studying the factors that support this new philosophy and build a framework for lean construction successful implementations. Finally, at the end of this chapter the KPIs for the proposed model of this research and the factors that will be examined related to planning and controlling, human factor, organizational factor s and contractual factor have been determined. More details about lean and lean construction principles and tools will be discussed in Chapter Three.

Chapter Three

Lean Construction

3.1 Introduction

In this research, a new trend of management, which is lean thinking, would be examined as principles and tools to help the construction industry to overcome some performance problems related to cost, time and quality. This chapter reviews many studies related to lean manufacturing principles and tools, and how these principles were used to contribute in solving many construction industry problems in the world.

3.2 Construction Industry Versus Manufacturing Industry

According to Koskela and Howell (2002), there are four different features between construction and manufacturing. The finished product in manufacturing moved as one unit to customers while in construction, the finished product is large that cannot be transported as a whole. The three other features are-

- **Production is on-site:** in construction industry, the installation and erection are the activities that most increase the value of the product so it is important to meet high quality standards. But in manufacturing, the product moved, and shipped after assembly so this type of production is fixed-position manufacturing (Schemenner, 1993).

- **Standardization of the product:** In manufacturing industry, it is easy to standardize the product because of the specialized equipment that

helps to standardize the product which leads to limit the level of retailers' customization. In construction, customers play a key role throughout the project cycle. In the design phase, the designer defines the client needs through the bid package .After that the clients can modify their needs by addenda (before bids are opened) or change orders (once the bid is closed).

- **Complexity:** In manufacturing, the flow of the process can be reliable because of specialized facilities with suitable technology. In manufacturing, it is easy to select the suppliers early in the design phase so it could be easy to manage many components from different subassemblies. On the other hand , the construction activities are highly complicated and interrelated so construction projects are considered as complex, unique and dynamic (Bertelsen, 2004).

As shown above and because of the differences in the nature of each industry, it is found that the uncertainty in manufacturing can be reduced by increasing control on the process while in construction projects the uncertainty exists throughout the project.

3.3 Construction Process verses Manufacturing Process

As shown above ,there are different characteristics between construction industry and manufacturing industry depending on the nature of each industry. These characteristics make the processes of these two industries differ too. Table 3.1 shows the main differences in both industries.

Table (3:1): Construction process Verses manufacturing process

Feature	Manufacturing	Construction,	Source
The lifecycle of a product.	Long enough to develop related research and training	It is relatively small, to develop research and training.	- (Banik ,1999) - (Minkarah et al ,2006)
Investment in innovation and technology	Highly investment in innovation.	Lack of investment innovation and technology	- (Banik ,1999) - (Minkarah et al ,2006)
Decision making	It is concerned with optimization between trade-off future growth and machine depreciation.	It depends on purchasing of the resources or it could be rented/leased for the project at appropriate time-value. In the most cases, contractors look for minimizing ownership and the operation costs .	-(Banik ,1999) -(Minkarah et al ,2006)
The supply chain	It is defined from the beginning of the component .	It is flexible and depends on the resources of each specific project. The supply chain is main contractor-client based. In the intermediate, there are the subcontractors. In the supply chain both the subcontractors and the general contractor demands should be cooperated and based on transparency.	-(Matthews et al, 2000) -(Minkarah et al ,2006)
The workforce	The workforces have higher security and get a stable wages. Also ,the employees gain experience in performing specific tasks.	The wages of the workforces depend on skill, and experience.	-(Minkarah et al ,2006)

Job security	The job security is high Because of the skills are valuable and it is highly regarded, and well compensated.	Job security is low	-(Minkarah et al ,2006)
Quality	It is related to process control. The common tasks are monitoring and defect prevention, so the rework is avoided.	Quality in construction related to product conformance. Quality is determined by the degree to which the product conformed the project specifications and standards. So, rework is a common practice .	-(Arditi& Gunaydin ,1997) -(Minkarah et al ,2006)
Supply	Supplying is an order-driven activity .It is determined through the product design, and changes are limited.	Supply in construction is schedule driven because the process span is longer and the sequence of tasks can be modified, if required.	-(Minkarah et al ,2006)

3.4 Construction Waste

Wastes in construction industry are the subject of several studies around the world in recent years (Formoso et al., 1999). There are number of definitions available. Alarcon (1994); Koskela (1992) and Love et al. (1997) agreed among defining the wastes as those activities that do not add value or progress to the final product and they produce costs, direct or indirect, take time, resources and require storage. From a lean point of view, waste is defined as anything that does not add value to the final products such as houses, buildings, structures and they include direct and indirect waste (Ikuma et al., 2012). Understanding the wastes and their

causes in addition to the value of the final product based on customer satisfactions are essential for applying the lean philosophy to construction (Jørgensen et al., 2008).

The two types of waste are direct and indirect waste. The direct waste consists of a loss of materials, this loss is due to damaging or losing in the materials and they should be removed from site Formoso et al. (1999); Shen et al. (2005) also defined direct waste as the loss of materials due to damage and this damage could not be repaired or used. On the other hand, indirect waste is any monetary loss, but it is not due to physically lost in materials. For example, increasing the slab thickness larger that the designed (Formoso et al., 1999). Generally, indirect waste occurs when there is an excess use of quantities that is allowable under the design (Shen et al., 2005).

In construction, the non-value-added activities take time, resources or space but do not add value to the process (Koskela et al., 1992). Graham and Smithers (1996) believed that construction wastes could occur during different project phases: the design phase, procurement phase, material handling and operation phase. Figure (3:1) shows examples of the seven wastes in construction.

Figure (3:1) : Seven waste in construction

In Palestine, the construction wastes become one of the most concerning subjects of the researchers. Enshassi et al., (2006) and Said (2006) studied the construction wastes resource in Palestine and classified them according to the seven wastes. As shown above and according to Enshassi et al., (2006) and Said (2006) there are several wastes in the Palestinian construction industry that need new trends of management that helps in minimizing the wastes and increase the value of the project.

Lean construction as new management practices used to maximize value and reduce waste. These aims are achieved by applying specific lean techniques in an innovative project delivery approach. Some of these techniques are supply chain management and Just-In-Time that helps in improving the production process and minimize the waste.

3.5 Lean Thinking

Lean thinking is a new management trend for managing an organization to improve the productivity, efficiency and quality of its products or services. This concept was studied by many researchers (Abu Ismaiel, 2013; Alarcon et al., 2006; Antonio, 2002; Ballard, 2000; Bertelsen, 2004; Johansen & Walter, 2007). After World War II, the Toyota Production System (TPS) was adopted in Japan. This system based on a scenario of fluctuating demand. Ohno (1988) developed the model that was infinitely superior to the mass production system, and this model is considered as the spark of arising lean management ideology Antonio (2002). Koskela (1992) introduced that lean ideas developed by Ohio based on the adoption of production of new strategies in the production systems are identified according to the demand of the downstream production chain.

These new strategies should be part of a production planning that ensured the planned pace was maintained throughout the production process. After that and over the latter half of the last century ,the Japanese and American management specialists developed the lean ideas and employed the lean

practices in both the aerospace industry (Boeing) and in the auto sector (Toyota).

3.6 Lean Construction

Lean thinking is adopted in many sectors such as manufacturing, health care and construction and showed a radical improvement in their performances. Their evolvement and change and this is related to the characteristics of the industry. Nevertheless, when lean construction is compared with lean manufacturing literature the manufacturing field is found to be more developed than construction (Jorgensen et al., 2008).

Around 1992 the adoption of lean construction started by the creation of the International Group of Lean Construction. And over the past decade, the firms all over the world have been looking for increasing their competitive advantage through the application of lean concepts and practices (Arbulu et al., 2006). Today, in the Arabic world the concern towards the adoption of lean practices is found in many manufacturing industries such as military ,clothing industry as in Iraq(Sameh ,2008). In addition to that, there are many researches, and studies that recommended applying lean at the construction projects in the Arab countries (Sameh, 2008).

Lean construction has many definitions indicating the positive evolution of lean methodology as well as its diversity. The following definitions stated the best description of the methodology and application of lean construction: Lukowski (2010) defined lean construction as “it is the

practical application of lean manufacturing principles, or lean thinking, to the building environment". Marhani et al. (2012) stated that "Lean construction is a concurrent and continuous improvement to the construction project by reducing waste of resources and at the same time able to increase productivity and secure a better health and safety environment in order to fulfil the client requirements as well as contributing towards sustainable and greener environment. "

The Lean Construction institute (2012) defined lean construction as a new way of production management that leads to project delivery by adopting new practices in design and building. Lean manufacturing improves the process of design, supply and assembly of the product that leads to minimize the waste and maximize the value of the final product. Lean construction extends from these concepts and built specific techniques, and applies them in a new project delivery process.

3.6.1 Lean Construction Principles

From the literature research, in order to implement the LC, Koskela (1992) identified principles for implementing LC to the total flow process and its sub process. Some of these principles are, minimizing or eliminating the non-value-adding activities, maximizing the value of the output that satisfied customer needs, variability flow reduction, cycle time reduction, minimizing the number of steps in the process, process transparency, controlling the complete process, and continuous improvement of the process.

On the other hand, Womack and Jones (1996) identified five principles of lean construction, these principles are: 1) identify the value from customer perspective 2) determine the value stream for the process 3) modifying the flow to be more valuable 4) pull approach 5) pursue perfection for continuous improvement. Another researchers such as, Lim (2008) and Bashir et al. (2011) have the same point of view with Womack and Jones about the five lean principles but Lean Enterprise Institute, (2009) used different keywords: identify the value, map the value stream, create flow, establish pull and seek perfection as shown in Figure (3:3).

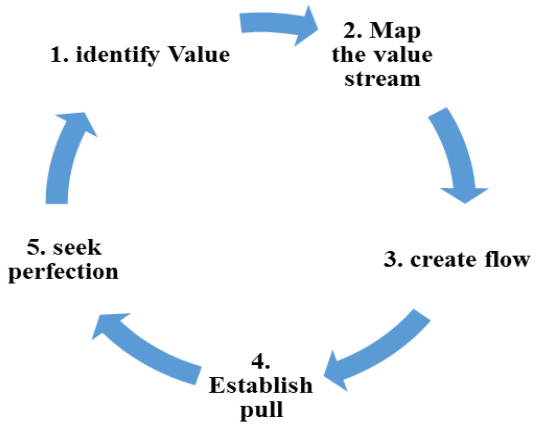

Figure (3:2): Lean construction Principles

Cain (2004) described six principles of construction best practice on LC. These principles are to satisfy the end customer requirements, minimizing the cost to reach the optimum cost of ownership, elimination the waste in the use of labor and materials, specialist suppliers involvement and integration , the effective coordination and clarity of responsibility, and establishment of performance measurement tools to control the

improvement achievements. On the other hand, Salem and Zimmer (2005) suggested the five lean principles applicable in the construction industry which focus on customer needs, people's culture, workplaces standardization, waste elimination and continuous improvement by focusing on built-in quality Table (3:2) summarize the lean construction principles.

Table (3:2) Lean Construction Principles

Source	LC Principles
Womack and Jones (1996), Lim (2008) Bashir et al.(2011)	1. Determine the value 2. determine the value stream map 3. Flow 4. Pull approach 5. Pursue perfection (continuous improvement)
Lean Enterprise Institute (2009)	1. Value (form customer perspective) 2. Map the value stream of the process flow 3. Create flow 4. adopting pull approach in the process 5. Seek perfection (continuous improvement)
Cain (2004)	1. Satisfying the end customer 2. Minimizing the cost to benefit the customer 3. Suppliers involvements and integration. 4. Effective coordination and clarity of responsibility of the employees 5. Establish performance measures to control the improvement achievements
Salem and Zimmer (2005	1. Focusing on customer requirements 2. The culture of the employees 3. Standardize the work place 4. Eliminate the wastes in the process 5. Build continuous improvements

From the above studies, it indicated that Womack and Jones (1996); Lim (2008); Lean Enterprise Institute (2009) and Bashir et al. (2011) are agreed on the five principles of LC. It also shows that lean construction principles can be applied in an effective way, if these principles focus on improving the whole process of a project and concerning in increasing the

transparency of the project flow. Table (3:3) identifies how lean principles have been conceptualized in construction according to (Björnfot, 2006).

Table (3:3) The conceptualization of the lean in construction (Björnfot ,2006)

No	Lean principle	Conceptualization in construction
1	Value	• In construction, the value should be defined from the customer perspective and this value should be defined to delivery team to determine how this value can be specified by product.
2	Value stream	• In construction, it means that all activities and resources required for construction should be determined. Then, the key component suppliers should be defined.
3	Flow	• The flow of the process should be determine a) identifying the none-value added activities b) Eliminate or minimize the wastes in the process c) Identifying KPIs. d) Measure performance.
4	Pull	• In pull, approach the production systems should be flexible and adaptable to future customer change • Perform the work at the last responsible time.
5	Perfection	In construction perfection means a) The transparency of the production system to all involved stakeholders. b) Conscious improving effort for customer's value. d) Conscious effort at improving the execution of work.

3.6.2 Benefits of Adopting Lean Practices in Construction

Applying lean practices in construction provides key benefits to the construction process. Arbulu et al. (2006) identified these benefits and impacts on the construction process as follows:

1. Lean construction increases the value of the project and minimizes the wastes of time and resources.

2. It provide the contractors with practices that improve the process of the project overall its stages

3. Improving the productivity in the process by improving the planning.

4. It keeps the process fixable to adopt any change from the client.

5. It improves the quality and safety of the project in addition to reducing the cost.

6. It keeps the products or services to be delivered on time and within budget.

7. Improving the reliability, accountability, certainty, and honesty into the project environment.

8. Keeping continuous improvement in project through lessons learned from previous projects.

3.6.3 Criteria of Conversion Lean Production to Lean Construction

Koskela (1992) applied lean principles in the construction process with eleven criteria, which are shown below:

3.6.3.1 Reducing the non-value Added Activities

In some studies, the researchers found that the non-value-added activities govern most processes; only 3% to 20 % of steps in the flow add value Ciampa et al. (1991). So reducing the non-value-added activities in the process is a fundamental guideline in lean construction.

According to Koskela (1992) and Ramdane M. El-Kourd (2009), there are three main reasons for the presence of non-value-added activities:

1) **Management of the construction process:** in the traditional project management dividing the task into two subtasks performed by two different specialists' leads to increasing of the non-value-added activities in the flow (such as: inspecting, waiting etc.).

2) **Ignorance:** this type of non-added value activities exists in the administration of construction project, and reducing them require a project manager with a wide experience in dealing with the use of lean tools.

3) **The nature of production itself**: In the production, process there are many wastes that appear such as work-in-process, defects, and accidents i.e. the (Seven wastes during construction) and these waste should be minimized.

3.6.3.2 Increase Output Value through Systematic Consideration of Customer

In lean construction, the value is generated through fulfilling customer requirements. In the production process, each activity has two types of customers, the first one is the next activity and the second is the end user of the product. In construction process, there must be a systematic identifications of the customer in each step (Koskela ,1992). For example, the investment firms are considered as clients to the consultant firms, so the consultant firm should give the design of the project according to client's

specifications and standards in addition to that, the consultant office should provide the owner with a reasonable cost estimate and duration of project. In this case, the owner is considered also a customer to the construction firms, and s/he aims to get the project according to the specification of bidding and within time and cost. (Ramdane M. El-Kourd, 2009).

3.6.3.3 Reducing the Variability in the Process

Sullivan (1984) says that" reduction of variability within processes must be considered an intrinsic goal" .So it is important to identify the variation in the process and working on minimizing or eliminating them. Minkarah et al., (2006) identified two types of variability that must be taken in consideration:

1- **Flow Variability**

Flow variability in the process is addressed by production leveling, which is minimizing the batch size with optimizing the sequence of products in order to control the impact of fluctuating demand (Minkarah et al. ,2006). In lean construction it is essential to improve the flow variability because the late completion of one activity can affect the overall completion time of a project. The lean construction practices dealing with this type of variability are “Last planner”. Last planner is a lean practice that helps to implement the plans on time(Ballard ,2000). This process starts by having a detailed plan for the project that helps in determining the hand offs between trades for each stage in the project (Ballard & Howell ,2003). Depending on the detailed plan, the planner could prepare a “look ahead”

plan which is a schedule that provides the activities to be completed during the coming weeks and the backlog of ready work. Improving the process could be achieved by determining the root cause of the variance and developing an action plan to prevent future recurrences of the problem.

2- Process Variability

Process variability is the actions that should be performed to eliminate the defects at the source in order to prevent the flow of these defects through the process. In construction process, it is difficult to determine any defects before installation, so in construction the quality has traditionally been focused on conformance to specifications or standards. Lean construction concentrates efforts on defect prevention. Some LC practices such as failsafe actions that could be applied on a site to ensure first-time quality for all the assignments (Tommelein, 1999).

3.6.3.4 Reducing the Cycle Time

The cycle time is the time needed for implementing the process traverse the construction flow, this time includes processing time, inspection time, waiting time and moving time and this time is considered as a metric of flow (Koskela ,1992). Krupka (1992) considered time as the most important measure than cost and quality because improving in time can leads to improve the both.

In lean construction ,one of the main aims is compressing the cycle time, this compress can be achieved by reducing or eliminating the time of

inspection, waiting time and moving time (Schmenner ,1988) and (Hopp et al ,1990). Some of practices that may use for the cycle time reduction are JIT, smooth moving of the process, reducing variability , performing activities in parallel manner and eliminating non-value added activities (Plossl ,1991), and (Stalk & Hout ,1990) as shown in Figure (3:3) .

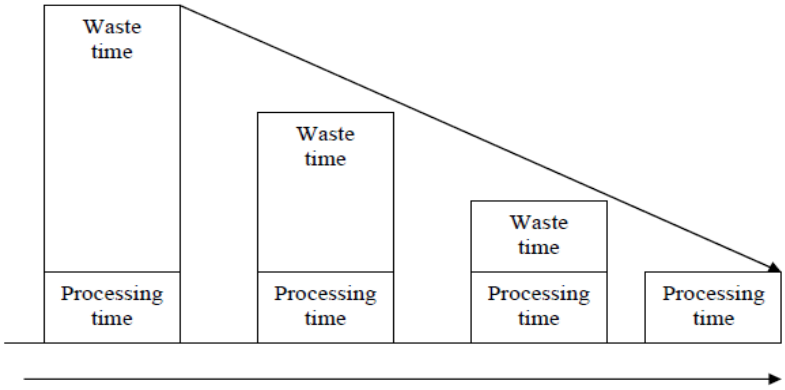

Figure (3:3): Reduction of cycle time (Stalk & Hout ,1990)

3.6.3.5 Minimizing the Number of Parts and Steps (Simplifying)

In production process complexity is related to increasing the number of steps that may increases the non-value-added activities(Ramdane M. El-Kourd ,2009). Simplifying the production process leads to reducing the cost, increasing the reliability of the process and increasing the ability of the human to deal with the process (Child et al. ,1991). In addition to that simplifying the products can be achieved by reducing the number of parts in a product, and minimizing the number of steps in a material or information flow. In order to simplify the process there are many practical approaches include: consolidating activities, product's part reductions, standardization of parts, materials, tools, etc.

3.6.3.6 Increase Output Flexibility

Increasing the output flexibility in the organization leads to increase the simplification and this become one of the main organization's goals (Stalk and Hout ,1990). In order to increase the flexibility of the process, there are some of the key elements that should be connected with modularized product design; some of these elements are cycle time compression and transparency.

Stalk and Hout (1990), Child et al. (1991): mentioned practical approaches to increased flexibility including:

- Minimizing batch sizes to match demand as possible.
- The setups time should be reduced.
- Increasing customization.
- Having workforce with multi-skilled.

3.6.3.7 Increase Process Transparency

Transparency of the production processes means separating the network of information and the hierarchical structure in order to have clear information (Greif ,1991). The main goal in this concept is to build the self-control; this can be occurred by letting the production process flow be visible to all workers from start to finish (Stalk & Hout ,1989). Moreover increasing visualization helps in identifying the work flow and creates the employee's awareness among the action plans on a job site. Moser and dos Santos

(2003) suggested some practices that may be useful these practices are 5-S method (Sort, Standardize, Shine, straighten, and Sustain), appropriate layout and signage for the project flow and utilizing visual controls.

3.6.3.8 Controlling Should be on the Complete Process

In the construction process, there are two types of flow: first, the flow through the different hierarchical levels in the organization and the second is the flow crosses through an organizational border. Focusing control on the complete process needs that the employees in the all-hierarchical levels should share the responsibility for the efficiency and effectiveness and they should have self-responsibility to control their processes (Rummler et al. ,1990). On the other hand, inter-organizational flows can be achieved by long-term co-operation with suppliers. Focusing on these two flows leads to optimizing the total process flow (Stewart et al., 1992).

3.6.3.9 Build Continuous Improvement into the Process

In the construction process, waste reduction and increasing the value must be carried out continuously. West (1998) identified the PDCA _plan, do, check, and act_ cycle. It is considered as a tool to achieve continuous improvement in the organization. In this cycle, Plan means studying and analyzing the steps to how eliminate the waste, Do means testing new ideas, Check means checking what happened in actual and Act means the teams should meet, and communicate the improved method.

3.6.3.10 Balance between Flow and Conversion Improvements

Products activities improvement should take in consideration both types of activities, conversions and flows .The most challenge in the organization is to keep these two types of activities in balance. In production process there are different aspects for flow and conversion activities that lead to different potential for improvement. This goes as a rule:

- Increasing the complexity of the production process, may increase the impact of flow improvement.
- Having better flows in the production process required less conversion capacity.
- Improving the control on the flows leads to having easier implementation of new conversion technology.
- Adopting new conversion technology may reduce the variability in the process, and improve the flow.

As seen above both flow and conversion activities are correlated and any improvement in one aspect may affect the other one. For that Blaxill et al. (1991) argue that to achieve improvement to any process you should improve the existing flow process before invest in new conversion technology. This means that you should perfect the existing processes to their full potential before you think in designing new ones. After improving the existing process to its full potential, you can invest in new conversion technology that will improve the flow activities.

3.3.6.11 Benchmark

Benchmarking is a useful stimulus to achieve improvement through radical reconfiguration of processes. Camp et al., (1989) defined the basic steps of benchmarking these steps include , assisting the existing process then determine the strengths and weaknesses of sub processes, Identifying the competitors of the same industry then finding, understanding , comparing the best practices of these competitors and adopting, modifying and incorporating these best practices in the sub processes.

3.7 Lean Construction Tools

At each stage of project life cycle, there is a key driver/tool to achieve lean construction concept. Many researchers investigated applying some lean tools and practices on construction projects and identified the results. Johansen and Walter (2007) applied some of lean practices on construction project and investigated the results some of these practices are (Benchmarking, Total Quality Management (TQM), Visual Management, Standardization of Management, Last Planner System (LPS), Look Ahead Planning, Weekly Work Planning, Just In Time, Document Management Systems, and other integrated tools and approaches).

Researchers such as Thomassen et al. (2003) and Salem et al.(2005) studied the effectiveness of some lean construction tools i.e.(last planner, increased visualization, daily huddle meetings, the 5s process, and

fail safe for quality). All These tools in construction aim to eliminate waste and increase profit in these projects.

Table (3:4) below summarizes some of these tools and the key factors that support implementing

Table (3:4) Lean construction tool

Lean practices	Essential Factors	Source
Just-In-Time (JIT)	• This term liked with three concepts first optimizes inventories the second is construction levelling and the third is decreasing the setup activities. • JIT linked to the waste reduction and Continuous improvement in processes.	- Salem et al (2006) - Koskela (1992)
Total quality Management (TQM)	• TQM is an integrated management system that includes thinking and actions in order to encourage the organization to focus on quality. • TQM makes continues improving on quality of goods and services to achieve customer expectation.	- Small et al.(2011) - George& Jones (2008) - Summers (2005)
Business Process Reengineering (BPR)	• This concept improves the organization's performance by starting from the beginning in designing or redesigning the foundation of that leads to improve the quality and reduce the cost.	- Small et al.(2011) - George&Jones (2008)
Last Planner System (LPS)	• This concepts aims to improve the productivity and reducing the wastes in the production process by mutual planning that leads to increase the reliability of commitments of team members.	- Salem et al. (2005)
Teamwork	• Teamwork is a skilled peoples who are committed to a common purpose and mutually accountable for its achievement	- Excellence (2004)
Value Based Management (VBM)	• It is an approach that indicates the product value is the value for customers while	- Bertelsen (2004)

	process value is the value for the workers and project participants.	
OHSAS 18001	• Steps and practises adopted to improve existing features of the work environment, in order to improve the safety and elimination in frequency of undesired incidents	- Mohd Yunus (2006)
5S and Visual Management	• Sort – keep only what we need. • Set –keeping materials, tools and equipment in the safest and best place. • Shine –keeping the workplace clean and clear. • Standardise – there must be an agreement between the team and the standards of the work environment. These standards should be photographed and display it is clear to everyone on how the work place should look. • Sustain – keeping the first 4Ss in place.	- Steve Knapp& Debbie Hunt(2012)

Chapter Four

Research design and methodology

4.1 Introduction

This chapter covers the research design and methodology that is followed in this research. This includes an explanation of the purpose of the study, the population of the study and sample size, instrumentation, data collection and analysis have been identified. In addition to that, it discusses how the data was analysed; furthermore, validity and reliability of the data will be discussed. Finally, it discusses the ethical considerations of the research

4.2 Research Design

Research design is defined as “a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings” Burns and Grove (2003). Parahoo (1997) described a research design as “a plan that describes how, when and where data are to be collected and analyzed”. Polit et al (2001) defined a research design as “the researcher’s overall for answering the research question or testing the research hypothesis”.

4.2.1 Research Purpose

According to Patton (1990), the purposes of the research activity could be described into four main purposes. These are the exploratory, the

descriptive, the explanatory and perspective. Jackson (1994) said that in the research the purpose(s) should be named by linking the research questions to the research objectives

- **Exploratory**

Exploratory research could be performed through conducting structured or semi structured interviews on focus group, this interviews prepared by experts and a search of the relevant literature (Saundres, 2000).

- **Descriptive**

Robson (2002) descriptive research design: used to obtain information on the current status for a certain phenomenon, and to study the relationships between variables.

- **Explanatory**

Miles, et al. (1994) stated that the purpose of explanatory research is studying the relationship between different variables and the elements of the research problem.

- **Prescriptive**

Hair (1992) stated that the purpose of the prescriptive research is identifying proposed solutions to investigative research problem.

4.2.2 Research Approach

The research approach selection should be in accordance with the important decisions needed to be made. The research approach will not influence the research design, but it will give the researcher the opportunity to consider how each of the various approaches may contribute to the research design. It may also limit the study, allowing satisfaction of the articulated objectives and design to an approach which best satisfies the research‘s requirements (Creswell, 2003). The research approach embraces the quantitative versus the qualitative and the deductive versus the inductive. Each set of approaches is commonly perceived of as referring to polar opposites (Hair, 1992).

- **The Deductive versus the Inductive Approach**

Deductive approach depends on testing of theories. The researcher in this approach sets theories and conceptual principles then s/he formulated the hypothesis on their basis, after that the researcher follows the statistical methods to test the proposed hypotheses and describes the results. On the other hand, the inductive approaches depend on collecting empirical data and then formulating concepts and theories depending on the collected data (Marcoulides ,1998).

- **The Qualitative versus the Quantitative Approach**

The quantitative approach for data analysis generally appears in the physical sciences, this tool is used to guarantee as much as possible of

objectivity, ability to generalize and reliability of the research Creswell (2003). On the other hands, qualitative tools are used to analyze the reasons for particular phenomenon but quantitative tools analyze the phenomenon itself, independent of human perceptions of reasons why (Creswell ,2003). According to Creswell (2003), qualitative methods include questionnaires, which considered as leading tools in addition to the interviews, observations and focus groups.

4.2.3 Research Strategy

Robson (2002) stated that in order to answer the research questions there are three research strategies, or plans. These strategies are the experimental, the survey and the case study. In any study, the researcher may select one, or even all three of these strategies that depend on the nature of the study.

This study focuses on the agreements of the contractors among the factors that support successful lean implementation. The research approach to answer the research questions is exploratory-descriptive, explanatory and correlative. In this study, the researcher adopted three plan phases: the first phase is an exploratory research used though literature reviewing for previous studies, article, journal, papers, books conferences and internet. The second phase is an explanatory descriptive analytical approach by using quantitative survey which tries to assess the agreements of the contractors among the successful lean performance indicators that present in the proposed model and their agreements among the factors that support

successful lean implementation. The third phase is testing the research hypotheses and building the model.

The data of the research were analyzed descriptively and statistically by using Statistical Package for the Social Sciences (SPSS). A number of analytical and descriptive statistical techniques were used to arrive at the results. These include t. test, One way nova test (ANOVA). Frequencies and percentages were also used. The correlative approach which is used in this study is the most logical approach to describe the current situation and answer pertinent questions on the successful lean implementation and their relationship to the study variables.

4.3 Settings and Participants

- **Population of the study:**

Parahoo (1997) defined population as "the total number of units from which data can be collected"; This population may be number of individuals, artifacts, events or organizations. Burns and Grove (2003) described the research population as the all units that meet the criteria for inclusion in study.

In this research, the questionnaire was designed to measure the perception of the contactors among the key performance indicators of successful lean implementation and the factors that support successful lean implementation in the construction industry in the West Bank. According to Palestinian Contractors Union (PUC), it is allowed for the contracting companies to

have several categorizations in different specializations. In this research, it was decided to consider each firm once according to its highest classification then we decide to make a comprehensive sample.

In 2011, the number of the contractors in the West Bank increased to reach 422; in these companies the mainly three categories 1st, 2nd and 3th (A, B, C) consist of 253 companies. Other classified contractors will be consulted with inferior priority. PCU classifies the contracting companies according to the capital of the company, staff, company's experience, projects performed, and other issues (Najmi, 2011).

In this research, the three main categories (A, B, C) were chosen; because 95% of the total projects values in the West Bank were executed by these three degrees as it is registered according to PCU (PCU records 2011) as shown in Figure (4:1). Therefore, it is intended to focus on the contractors of these three degrees because they implement the highest present of project.

The researcher will measure the perception about implementing the lean practices in construction projects in West Bank from the contracting companies 'perspective regardless of its location; Figure (4:2) shows the percentage of the executed projects according to the classification degree. Aldo, Figure (4:3) shows the distribution of the contracting companies throughout the West Bank according to its location.

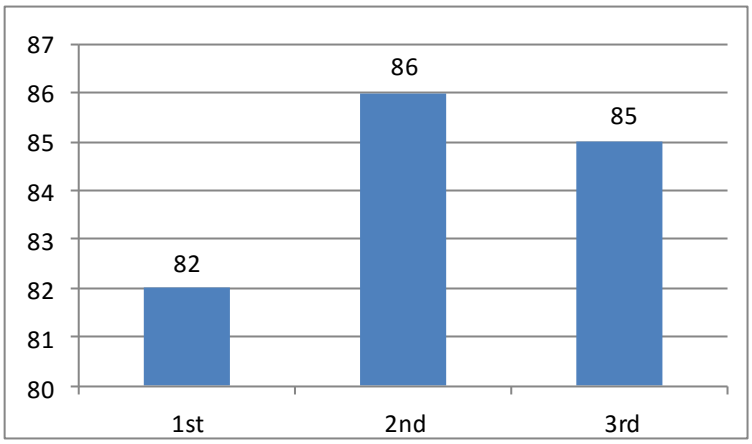

Figure (4:1): The number of the Classified Contracting companies in West Bank (Najmi ,2011)

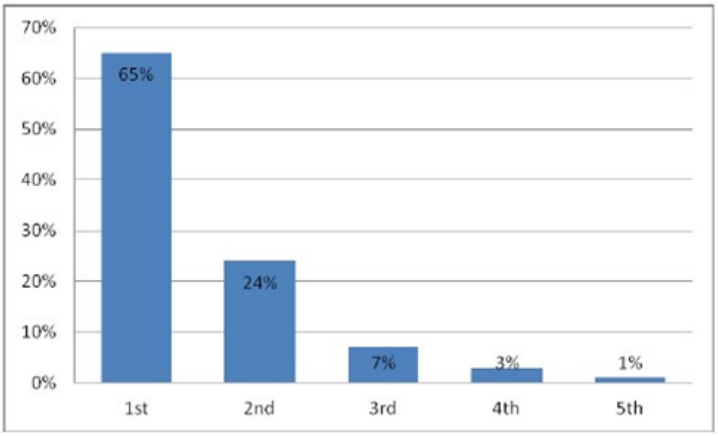

Figure (4:2) : percentage of the executed projects according to the classification degree for the registered classified contracting companies in West Bank (PCU, 2003)

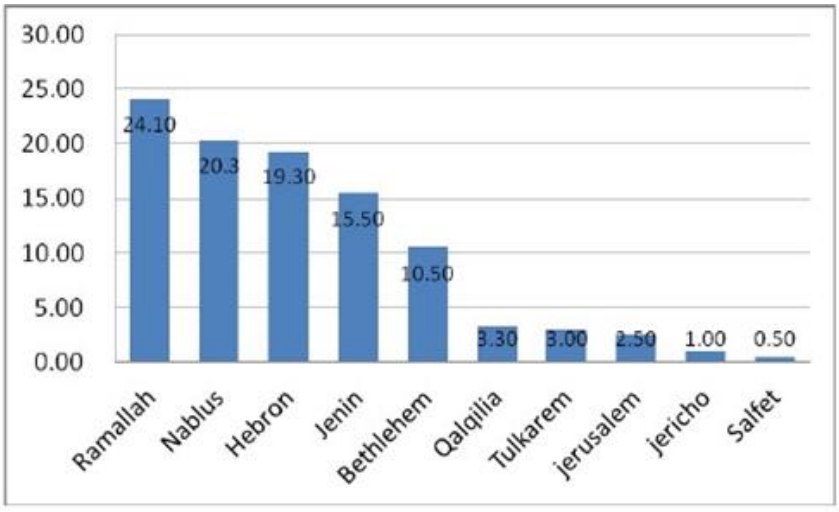

Figure (4:3) : percentage of classified contractors with respect to the Location in West Bank (PCU, 2003)

In this study, the target population will be all contractors working in Palestinian construction industry in the West Bank under the classification of A,B ,C So ,the whole population consists of (253) contractors working in Palestinian construction industry in the West Bank.

- **The Sample of the Study**

Sample size for the questionnaire was calculated based on the size of the sample on the web calculator Systems (1982) with 95% confidence level and confidence interval 5. The required sample size is 153, but it is collected 126 as 83% level of respondents. 126 questionnaires constitute 50% of the population of contractors working in Palestinian construction industry in the West Bank and according to Weiten (1989), more than 20% is a good representative sample for research purposes.

4.4 Instrumentation

There are many tools that could be used in order to accomplish data collection of research study. This study was based on a structured Likert type questionnaire for contractors working in construction industry in order to measure their perception towards the successful lean implementation and the factors that support lean in the construction industry.

4.4.1 Questionnaire Design and Content

In this research, the questionnaire is adopted as a tool for collecting the data because it’s the best way to gather numerical data and the most appropriate tool for this research in order to confirm the research

hypothesis. In addition to that, questionnaire is considered as the simplest and most rapid tool for collecting data in a reasonable time with a reasonable effort. In this research, two versions of the questionnaire have been designed. The first version is in English and the second in Arabic, to ensure getting highest response rate.

The questionnaire has been prepared in three steps based on data collection from literature review. The first step is identifying the main research objectives (mentioned in Chapter 1), and the second step is to identify proper variables that should be studied and analyzed carefully to achieve the objectives. After setting these variables, the third step is to develop questionnaire items to assess each variable.

The questionnaire consists of four sections in addition to a brief description about the study to let the contractors be aware about this study and have an accurate filling of the questionnaire. The four sections of the questionnaire were consists as follows:

1 - The first part has the demographic characteristics of the Contractors such as: company's location, company experience, capital of the company, average size of projects the company, number of employees working in the company, average number of contract employees working in the company, Contractor's classification under PCUs category

2- The second part includes the perception of the contractors towards the Lean Construction Key Performance Indicators (KPI), which consists of (8 items). These items examined the successful lean implementation by

improving both the operational performance and organizational performance. Operational performance KPIs are examined through the five sub factors. These sub factors are (waste, value, time, cost and quality) based on data from literature review in Chapter Three. On the other hand, organizational performance is examined through three items (net profits, developing competitive profiles and revenue growth).

3- The third part includes the success factors for successful lean implementation which consists of (32 items). These factors are classified into three main factors. The first factor is management and planning, this factor has three main sub factors which are: production control which is examined through six items, work structure (last planner) which is examined through four items and management commitment which is examined through three items and all of these questions and items are based on literature review in Chapter Three. The second factor is human factor, this factor has three sub factors which are, attitudes, which is examined through five items, the other sub factors, are skills and experiences, team work and communications each of them is examined through three items. The third factors are the organizational factor. This factor has four sub factors which are, organizational culture, training, coordination and communication and R&D each of them is examined through three items.

4- The fourth part includes three closed questions (yes or no) about the contract and if it should domain the all factors to have successful lean implementation.

During the preparation of this questionnaire, it was taken into account that the questions cover all aspects of the literature review, and meet all the variables affecting the research objectives, and was also taken into account that most of the questions are clear for ease of answering and analysis.

4.4.2 Scale of Measurement for Measurement

In this research, the Likert type questionnaire is used and the contractors' responses to the items in the questionnaire were scored as follows: (5) strongly agree, (4) agree, (3) Neutral, (2) disagree, (1) strongly disagree. The scales of answers consist as the follows:

Table (4:1): Likert Scale degrees

The answers	Grade
strongly agree	5
agree	4
Neutral	3
disagree	2
strongly disagree	1

4.5 Procedure

For applying questionnaire's distribution, the following steps were applied:

- First, obtaining the approval of the supervisor about the questionnaire after making modifications requested.

- Second, distributing the questionnaire to group of experts consisting of 3 experts, having experiences in the subject of research inside and outside the public sector these three experts are:

  -Dr. Mohammad Othman / Industrial Engineering Department/ An-Najah National University

  -Dr. Yahya Saleh /Industrial Engineering Department/ An-Najah National University

  -Dr. Sameer Abu-Eisheh / Civil Engineering Department/ An-Najah National University

- Then, preparing the final version of the questionnaire based on the observations of the experts group. See Appendix (A)

- The questionnaire was translated into Arabic. Then, distributing the Arabic version of the questionnaire to the experts, and then preparing the final form of the Arabic version of the questionnaire based on the vision of the experts group. See appendix(B)

- The questionnaire has been published on Google Documents as an online survey.

- The researcher distributed the questionnaire by hand and online using Google docs; some companies refused filling the questionnaire.

- In order to have more respondent, from the contractors the research got the telephone numbers of the list of the contractors from the PCU

website and phone the general director of the company and asked him to fill the questionnaire after a brief description on the subject of the study

- The researcher distributed 153 questionnaires by hands and online, but only 126 valid questionnaires were returned. Hence, the total response rate for this questionnaire was 83% which is an acceptable response rate.

Finally, all data were extracted from the questionnaires that have been retrieved from the respondents, and were entered to the computer using SPSS software to be analysed.

4.6 Data Processing and Analysis

In this research, the researcher utilized both primary and secondary data sources.

- Secondary Data sources: to address the theoretical aspects of successful lean implementation, the research uses the secondary data resource which consists of all sources of published data including: previous studies, books, journals, articles and websites related to the lean construction.

- Primary Data sources: because this research uses quantitative approaches, the questionnaire is used to collect quantitative data.

- After the completion of the data collection through questionnaires the analysis process started using statistical calculations.

- In this research and in order to analyse the quantitative data, the researcher used Statistical Package for the Social Sciences (SPSS).In this analysis various statistical tests and procedures were used .In this research many tests include (means, frequencies, standard deviation, t-test for independent samples, ANOVA) to analyze the data, answer the questions, and to test the hypotheses.

- In order to represent the collected data, the researcher used frequencies, means, standard deviations and percentages.

- In this research and in order to investigate the significance between two level independent variables and to test the research hypotheses, the researcher applied independent – sample T- test , one – way ANOVA and multiple regression testes .

4.7 Validity of Research Tools

It is important to check the validity of research tools before starting data analysis; validity of research tool refers to the degree to which the research tool measures what is supposed to be measured. Validity has a number of various assessment approaches.

Firstly, the initial questionnaire had been assessed by a reference of three specialists and they made observations that were used in preparing the final form of the questionnaire. Then, the researcher followed the statistical validity that is used upon thirty questionnaires and evaluates research validity which includes internal validity and structure validity Thompson

(2002). To insure the validity of the questionnaire, Pearson test was used to measure the correlation coefficient. So for each item or variable:

- If p-values (Sig.) < 0.05: Then the correlation coefficient of this item or variable is significant at $\alpha = 0.05$.

- If p-values (Sig.) > 0.05: Then the correlation coefficient of this item or variable is insignificant at $\alpha = 0.05$.

4.7.1 Internal Validity of the Questionnaire

Internal validity of the questionnaire is used by calculating the correlation coefficients between each item in one variable and the whole method and tools of data collection variable. This test applied to the third parts of questionnaire which represents the main objectives of the research. Firstly, doing the internal validity on each variable of part three of the questionnaire i.e. factors that support successful lean implementation “by calculating the correlation coefficients between each item in one variable and the total of this variable”.

Table 4.2 shows that the correlation coefficients for the variable are significant at $\alpha = 0.01$, so it can be concluded that the items of the variable "management and planning systems factors that supports successful lean implementation " are consistent and valid to measure what they were set for.

Table (4:2) Correlation coefficient of each item of the variable "management and planning systems" and the total of this variable

No.	items	Pearson Correlation	Sig2 tailed
1	Identifying wastes through new management practices is vital for improving the quality, cost and time	0.648**	0.00
2	Mapping the flow of material and information of any activity helps to identify the non -added value activity	0.755**	0.00
3	Preparing the Gant Chart as pull planning which depends at the end date of the activity may eliminate the wastes	0.714**	0.00
4	Supplying appropriate materials in the right quantities and quality only when we need help to improve performance through reduced inventory levels, and reduce the cost of quality.	0.672**	0.00
5	It is vital that the quality of the project will be the responsibility of each person in the project	0.727**	0.00
6	Adopting models such as Deming's cycle (plan, do, check, act) helps to have continuous improvement	0.533**	0.00
7	Project segmentation to activities in schedule showing the critical path and the milestones helps to complete the project on time	0.582**	0.00
8	Adjusting any variance in the schedule helps to keep the project on time	0.586**	0.00
9	Having (weekly work plan) increases the employee efficiency	0.622**	0.00
10	Having PPC chart helps in identifying the variance	0.632**	0.00
11	Management commitment is essential for adopting new management practices	0.660**	0.00
12	An excellence leadership and management are one of the crucial factors that drive the success of lean implementation	0.534**	0.00
13	Management engagement and supportive are essential for successful lean practices implementations	0.648**	0.00

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table (4:3) shows that the correlation coefficients for the variable are significant at $\alpha = 0.01$, so it can be concluded that the items of the variable

“Human factors "are consistent and valid to measure what they were set for.

Table (4:3) Correlation coefficient of each item of the variable “Human factors ” and the total of this variable

No.	Scale items	Pearson Correlation	Sig2 tailed
14	Work conditions (policies , salary received ,rewards , the length of employment , employee turnover) are essential for having job satisfaction and having positive attitudes towards new change	0.683**	0.00
15	Feeling discomfort leads to reduce motivation, degraded performance and low commitment.	0.784**	0.00
16	Employees commitment to the organizational goals and values improves their performance	0.674**	0.00
17	The employees ability to participate in decision making is essential in minimizing wastes and improving quality	0.611**	0.00
18	Having positive vision to accept the change is essential for successful lean implementation	0.528**	0.00
19	training courses in lean practices improves employees performance	0.575**	0.00
20	Hiring employees who have experience in lean practices is good for improving the company performance.	0.694**	0.00
21	Sufficient and Highly skilled labours of the organization are important to ensure company growth and success.	0.788**	0.00
22	You follow special methods or tools for the participation of individuals in the responsibilities and solve problems to ensure increased productivity	0.597**	0.00
23	You follow new means of communications to improve the work of individuals within a team	0.606**	0.00
24	You follow methods to enhance the work of individuals within the team to ensure increased productivity and quality of their work and increase the security and the means of the site	0.735**	0.00
25	Good vertical and horizontal communication systems reduce the time for decision taking	0.756**	0.00
26	Good communication provides cross functional teamwork	0.658**	0.00
27	Good communication systems help in successful implementation of lean practices	0.683**	0.00

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table (4:4) shows that the correlation coefficients for the variable are significant at $\alpha = 0.01$, so it can be concluded that the items of the variable "organizational factors "are consistent and valid to measure what they were set for.

Table (4:4) Correlation item of the variable "organizational factors " and the total of this variable

No.	Scale items	Pearson Correlation	Sig2 tailed
28	The organizational culture (openness, collaboration, receptivity) is essential for having high employee performance	0.751**	0.000
29	comprehensive strategy (vision, mission) is essential for improving the organizational performance	0.741**	0.000
30	Any new management practice needs a change in the organizational culture.	0.696**	0.001
31	Training courses in lean practices lead to successful lean implementation	0.629**	0.000
32	The company capability to invest in training the employees is essential for successful lean implementation	0.676**	0.000
33	For successful lean practices, implementing the training courses should cover the main contractors and subcontractors.	0.596**	0.000
34	Creation of supportive organizational culture is an essential platform for lean implementation	0.730**	0.000
35	Openness , collaborative , receptivity and data sharing are essential to improve the organizational performance	0.772**	0.000
36	An open communication environment between the general contractors and subcontractors essential for improving the organization performance	0.839**	0.000
37	R&D units in the organization are vital for improving the company performance	0.750**	0.000
38	It is essential for the project to think about innovative methods for performing the activities	0.646**	0.000
39	Adopting new construction technology is essential for improving the organization performance	0.551*	0.021

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.7.2 Structure Validity of the Questionnaire

Structure validity of the questionnaire is used by calculating the correlation coefficients between each variable and all the variables of the questionnaire. Since the second and third parts of questionnaire have different level of Likert scale, this test applies separately on these parts

Table (4:5) shows that the correlation coefficients for this part are significant at $\alpha = 0.01$, so it can be concluded that the variables of the third part of the questionnaire i.e. "factors supporting successful lean implementation " are consistent and valid to measure what they were set for.

Table (4:5): Correlation coefficient of each variable of the third part of the questionnaire i.e. "factors supporting successful lean implementation" and the total of this part.

#	Items	Pearson coloration	Sig2-taild
1	Planning and management systems	0.815**	0.000
2	Human Factors	0.704**	0.000
3	Organization	0.815**	0.000

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.8 Testing Reliability

To test the consistency of the questionnaire's paragraphs, the reliability analysis was conducted. According to Thompson (2002), the reliability of the search tool is the consistency of this tool to measure what it is supposed

to measure. In other words, the research tool is considered to have a high reliability if it produces similar results under consistent conditions(Gliem and Gliem , 2003). A Cronbch's alpha test verified the internal consistency of the questionnaire. Based on recommendations from Cortina (1993), several studies have accepted reliability greater than 0.6. The researcher followed the recommendation by Cortina (1993), and suggest alpha greater than 0.6 as acceptable.

Table (4:6) shows the alpha value for the four core dimensions of Towards Enhancement of Lean Practices, ranging between 0.69 and 0.92, which are acceptable because the values are greater than 0.60.

Table (4:6): Evaluation of the Stability of the Tool Using Cronbach's Alpha

Basic domain	Sub domain	Number of Paragraphs	Cronbach's Alpha(α)
Lean performance indicators		8	0.69
Management and planning systems	Production control	6	0.80
	Work structure (Last planner)	4	0.82
	Management Commitment	3	0.81
	Total	**13**	**0.9**
Human Factors			
	Attitudes	5	0.80
	skills and experiences	3	0.75
	Team work	3	0.86
	Communications	3	0.82
	Total	**14**	**0.92**
Organizational Factors			
	Organizational culture	3	0.64
	Training	3	0.67
	Coordination and communication	3	0.68
	R&D (research and development)	3	0.70
	Total	**12**	**0.86**
Total degree			**0.94**

4.9 Ethical Considerations

The researcher followed ethical standards in all research stages:

- Ensuring that the questionnaire is acceptable from the construction sector.
- The questionnaire did not have any indication to person who fills the questionnaire.
- Confidentiality was maintained in all process and procedures.

4.10 Summary

This chapter dealt with methodology and design. Moreover, the researcher classified the chapter by first presenting the population distribution. Then, the researcher presented the sample in accordance with the study variables. Additionally, the researcher ensured that checks on the validity and reliability of the instrument were enforced.

Chapter Five

Results and Analysis

5.1 Overview

This chapter comprises of three parts: the first part presents and discusses findings from the returned questionnaires and testing research hypotheses, the second part answers research questions, and the last part proposes a conceptual framework for factors supports successful lean implementation.

5.2. Part I: Questionnaire Analysis

In this research, the questionnaire was designed to be consisted of four sections. The first section is about the demographical information of the companies, the second section is designed to assess the perception of the construction contractors about the key performance indicators for lean successful implementation, and the third section is designed to identify the factors that support successful lean implementation. Finally, the fourth section includes three closed questions (yes or no) about the contract and if it should domain all factors that support successful lean implementation. The results and analysis for these parts are provided in the following sections.

5.2.1 Descriptive analysis

According to the questionnaire design, respondents have different demographical information. This section describes the characteristics and

the statistical differences of the demographical information among respondents.

5.2.1.1 Sample Characteristics

Based on the information gathered from the respondents in the first part of the questionnaire, the frequency analysis was used to determine the characteristics of the respondents

- **Company's Location**

Figure (5:1) clarifies the distribution of the sample of participants by company's location in the West Bank as follows: %52.4 from north region, %27.5 from middle region, %19.8 from south region. As shown below the distribution of the sample according to its location is reliable because it follows the distribution of all company's to the West Bank territories according to PUC except some deviation between the south and middle territories because of the difficulties that face the researcher to contact with contractors in these territories.

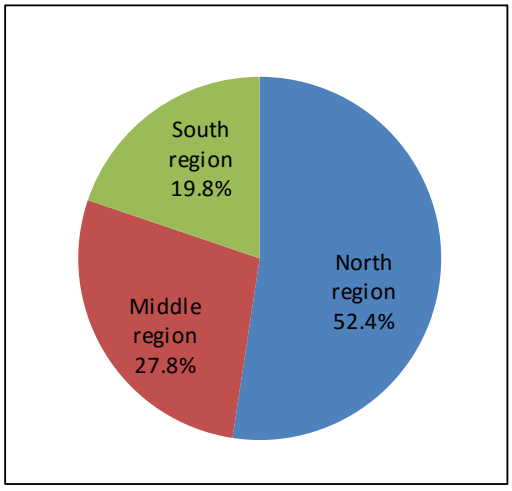

Figure (5:1) the Companies Locations Distribution

- **Company's Experience**

Figure (5:2) clarifies the distribution of the sample of participants by Company experience as follows: %41.3 more than 15 years, %23.8 from (11-15), %23.8 from (5-10) years, %11.1 less than 5 years. Since most of companies that filled the questionnaire have experience more than 15 years, this will strengthen the outcome of this research because the research topic is newly conducted concept in Palestine and depends on the companies experience to fill the questionnaire.

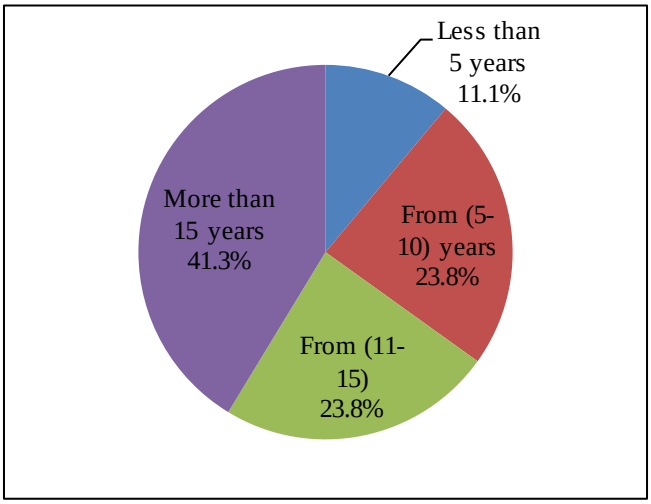

Figure (5:2) The experience of the companies

- **Capital of the Company (Thousand $)**

Figure (5:3) clarifies the distribution of the sample of participants by capital of the company as follows. %44.5 more than More than 500 thousand $, %25.4 from (100-250) thousand $, %19 from (250-500) thousand $, %11.1 less than 100 thousand $.This distribution shows the variety of financial capabilities that reflects the size of construction companies in west bank and their effects on adopting new management practices.

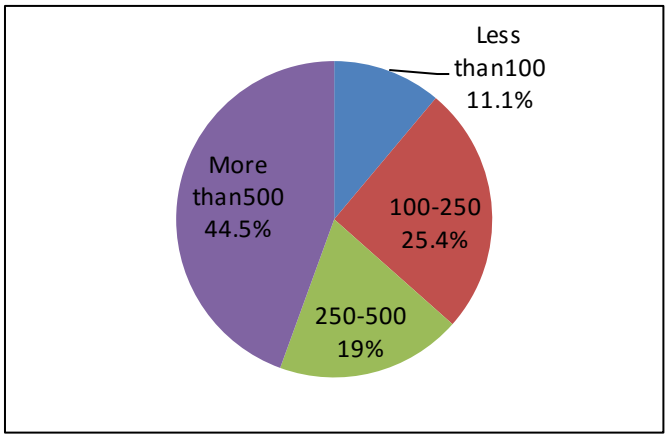

Figure (5:3) Capital of the company (Thousands$)

- **Average size of projects that company involved in (Thousand $)**

Figure (5:4) clarifies the distribution of the sample of participants by average size of projects that the company involved it shows that : %67.5 more than one million, %11.9 from (500- one million), %2.4 From (250-500) thousand $, %18.2 from (100-250) thousand $. These results indicate most of participated companies in this research have financial capabilities and experience in constructing projects that makes them interested in involving with new management trends.

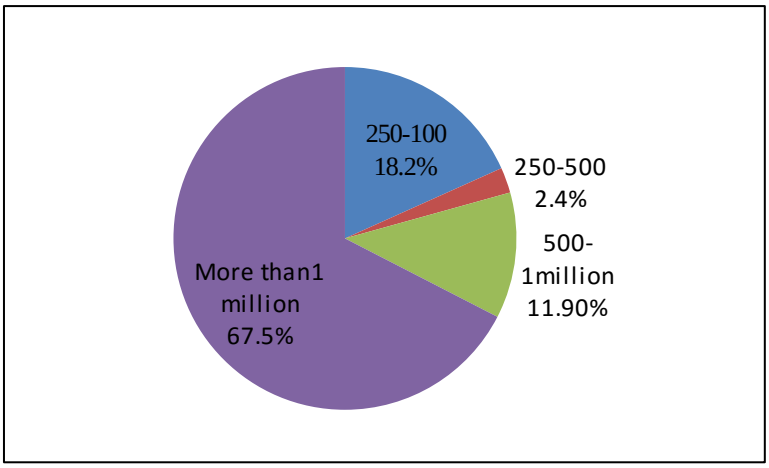

Figure (5:4) Average Size of the projects the company involved(Thousands$)

- **Number of Employees Working in the Company**

Figure (5:5) clarifies the distribution of the sample of participants by employees working in the company as follows: 18.3 more than Thirty employees, %14.3 from (10-less than 19), %27 from (10-less than 19) employees, %40.4 from (1-less than 9) employees. These results reflect some reality because the majorities of the companies depends on the non-permanent engineers so the major percentage show that the companies have few permanent engineers.

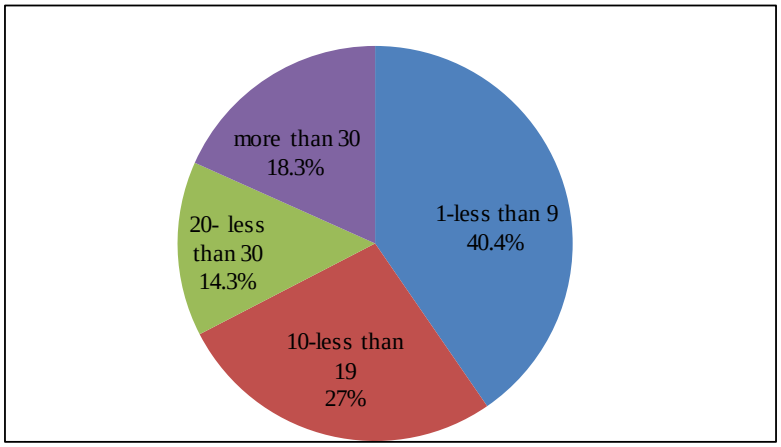

Figure (5:5) number of employees in the company

- **Number of Contract Employees Working in the Company**

Figure (5:6) clarifies the distribution of the sample of participants by contract employees working in the company as follows: %26.2 from (1-less than 4) contract employees, %23.8 from (5-less than 10), %28.6 from (11-less than 15) contract employees, %21.4 (more than 15) contract employees. These results definitely reflect that the majority of the construction companies in West Bank hire temporarily staff upon the availability of the projects in hands.

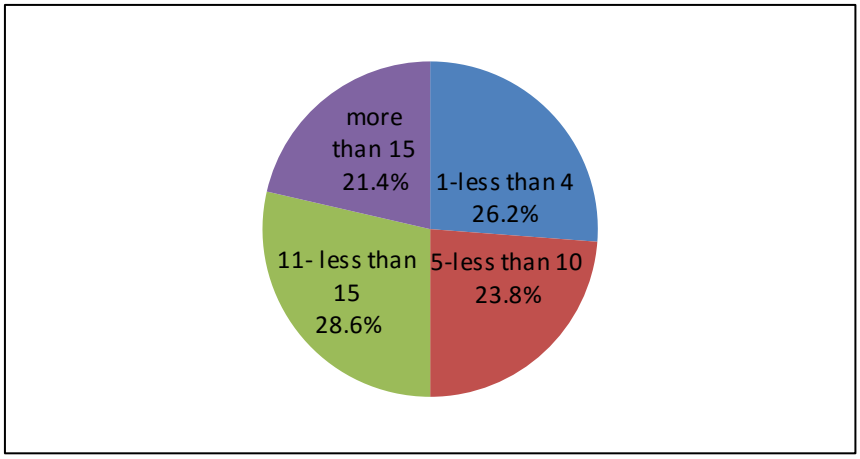

Figure (5:6) The number of the contract employees

- **The Classification Contractors under PCU category**

Figure (5:7) clarifies the distribution of the sample of participants by contractors' classification according PCU as follows: 71.4% from 1st category, 16.7% 2nd category and 11.95% 3rd category. These results reflect that the majority of the construction companies that filled the questionnaire are classified first category according to PCU; this will strengthen the outcome of this research because the research topic is newly conducted concept in Palestine and depends on the companies experience to fill the questionnaire.

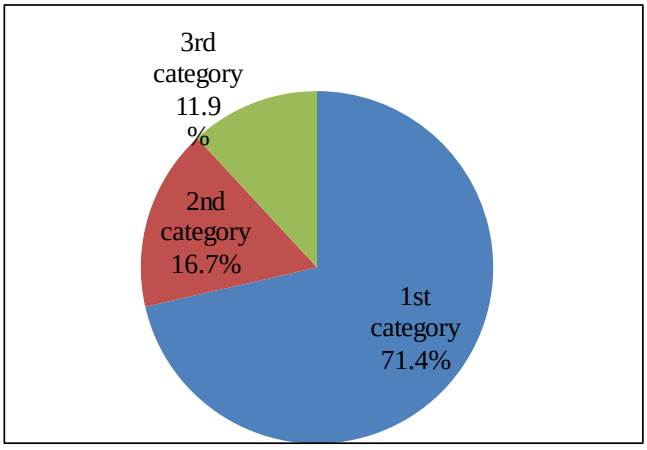

Figure (5:7) Classification of contractors

5.2.1.2 Descriptive Statistics Differences among Respondents

This section outlines the statistical differences among participants related to company's location, company's experience and the capital of the companies.

To illustrate these differences ANOVA test is applied. This test is used in order to see whether the distribution set of values observed for each category of variables differs from a specified distribution.

ANOVA test is used because it compares means of dependent variables which could be divided into three or more distinct groups or levels (Saunders et. al, 2009).

- **Statistical Differences According to Company's Location**

In this study the location of the organizations are located into three locations north, middle and south, therefore ANOVA test is used. Table (5:1) shows that there are no differences in mean, between the locations of the companies related to the following variables: (production control, management commitment, attitudes, skills and experiences, communication, organizational culture ,training , coordination and R&D), since ($P > 0.05$) In Table (5:1) the results show that , there are statistical differences between participants related to the company's location with respect to work structure (last planner) ($P=0.000<0.05$) and teamwork ($P=0.011<0.05$) therefore , LSD test is applied to detect where exactly the

mean difference Lie .Table (5:2) show the results of applying LSD test to work structure and teamwork.

Table (5:1) ANOVA Test for differences among participants according to company's location.

ANOVA-Between Groups		Company's Location	
Factors		Sig	F
1	Production control	0.282	1.281
2	Work structure (Last planner)	0.000	10.864
3	Management Commitment	0.062	2.844
4	Attitudes	0.086	2.503
5	Skills and experiences	0.284	1.272
6	Team work	0.011	4.726
7	Communications	0.023	3.897
8	Organizational culture	0.062	2.254
9	Training	0.095	2.403
10	Coordination	0.301	1.214
11	R&D (research and development)	0.063	3.015

*The mean difference is significant at 0.05 level

- **Work Structure**: ANOVA test shows statistical differences between participants according to their Company's location (P=0.000<0.05). The LSD analysis results in Table (5:2) show that participants located in the south are more perceived about work structure than those located in the middle or in the north.

- **Teamwork**: ANOVA test shows statistical differences between participants according to their Company's location (P=0.011<0.05) .The LSD analysis results in Table (5:2) show that participants located in the

north are more perceived about team work than those located in the middle or south.

Table (5:2) LSD test for the locations of the companies differences among participants (Work structure and Team Work).

ANOVA-Between Groups		Company's Experience	
Factors		Sig	F
1	Production control	0.606	.616
2	Work structure (Last planner)	0.079	2.467
3	Management Commitment	0.073	2.384
4	Attitudes	0.592	.639
5	Skills and experiences	0.168	1.714
6	Team work	0.066	2.600
7	Communications	0.252	1.380
8	Organizational culture	0.016	3.606
9	Training	0.449	.890
10	Coordination	0.539	.726
11	R&D (research and development)	0.002	5.264

*The mean difference is significant at 0.05 level .

Table (5:3) ANOVA test for differences among participants according to the experience of the company

Factors	J	Middle		South	
	I	(I-J)	Sig	(I-J)	Sig
Work structure	North	0.28117	0.053	-0.41455*	0.011
	Middle			-0.69571*	0.000
	South				
Team Work	North	0.45397*	0.005	0.36444*	0.044
	Middle			-0.08952	0.655
	South				

*The mean difference is significant at 0.05 level

- **Statistical Differences According to Company's Experience**

In this study the company's experience are located into four categories, therefore ANOVA test is used. Table (5:3) shows that there are no differences in mean between the experience categories of the companies related to the following variables: (production control , work structure , management commitment, attitudes, skills and experiences, team work, communication ,training and coordination) , since (P >0.05) for these variables . In Table (5:3) the results show that , there are statistical differences between participants according to the company's experience with respect to organizational culture (P=0.016<0.05) and R&D (P=0.002<0.05) therefore , LSD test is applied to detect where exactly the mean difference Lie .Table (5:4) shows the results of applying LSD test to organizational culture and R&D.

- **Organizational Culture :** ANOVA test shows statistical differences between participants according to their Company's experience (P=0.000<0.05) .The LSD analysis results in Table (5:4) show that participants with experience from (11-15) years and more than 15 years are more perceived about organizational culture than those in the companies with less than 5 years and between (5-10) years of experience.
- **R&D :** ANOVA test shows statistical differences between participants according to their Company's experience (P=0.011<0.05) .The LSD analysis results in Table (5:4) show that participants with experiences

- less than 5 years are more perceived about R&D than those with experiences between (5-10) years , (11-15) years and more than 15 years.

Table (5:4) LSD test for the experience of the companies differences among participants (Organizational Culture and R&D)

Factors	**J**	From(5-10)years		From (11-15) years		More than 15 years	
Organizational culture	**I**	**(I-J)**	**Sig**	**(I-J)**	**Sig**	**(I-J)**	**Sig**
	Less than 5 years	0.36349	0.063	-0.08095	0.655	0.04853	0.774
	From(5-10)years			-0.4444*	0.003	-0.31496*	.015
	From (11-15) years					0.12949	0.314
	More than 15 years						
R&D	Less than 5 years	0.53968*	0.005	0.27302	0.149	0.31319	0.076
	From(5-10)years			-0.2667	0.078	-0.22650	0.091
	From (11-15) years					0.4017	0.763
	More than 15 years						

*The mean difference is significant at 0.05 level

Table (5:5) ANOVA test for differences among participants according to the capital of the company.

ANOVA-Between Groups		Company's Capital	
Factors		Sig	F
1	Production control	0.217	1.505
2	Work structure (Last planner)	0.884	0.218
3	Management Commitment	0.445	0.897
4	Attitudes	0.365	1.070
5	Skills and experiences	0.352	1.100
6	Team work	0.363	1.073
7	Communications	0.071	2.405
8	Organizational culture	0.435	0.918
9	Training	0.751	0.403
10	Coordination	0.385	1.023
11	R&D (research and development)	0.069	3.128

*The mean difference is significant at 0.05 level

- **Statistical Differences According to the Capital of the Company**

In this study the capital of the companies are located into four categories, therefore ANOVA test is used. Table (5:5) shows that there are no differences in mean between the capitals of the companies according to the variables production control , work structure , management commitment, attitudes, skills and experiences, team work ,communication ,organizational culture, training , coordination because the (P >0.05) for all the variables.

5.2.2 Assessing the Perception of Contactors towards Key Performance Indicators of Successful Lean Implementation.

This section of the questionnaire should answer the question related to the agreements of the contractors towards key performance indicators of successful lean implementation. This section has (8) items addressing the

main variables for the key performance indicators of successful lean implantation. These KPIs addressing the five KPIs (Cost, time, quality, value and waste) that represent the operational performance and three KPIs (net profit, revenue growth and developing competitive profile) that represents the organizational performance. Likert scale is used to measure the application agreement Likert (1974), Table (5:6) clarifies 1-5 Likert scale for this section: Table (5:7) clarifies Likert Scale level of agreement.

Table (5:6) likert Scale

Grade	The answers
strongly agree	5
agree	4
Neutral	3
disagree	2
strongly disagree	1

Table (5:7) likert Scale level of agreements

mean	key	standard
1-2.33	Low	One standard deviation below
2.34-3.67	moderate	mean
3.68-5	high	One standard deviation above

To assess the proposed KPIs the mean, standard deviation, One-Sample test and relative importance of each item, and total score of level of Lean performance indicators, were found as shown in Table (5:8) .

Table (5:8): mean, standard deviation, One-Sample test and Relative importance to Lean performance indicators

No	item	mean	standard deviation	(T) value	Sig.*	Sort item	Relative importance
1	Your company is interested in minimizing wastes in materials, conveying of materials and labour, transportation and inventory level, waiting time, over production ,over processing	4.404	0.53931	29.238	0.000	1	high
2	You are ready to do any change in the project if this change improves the value to the owner.	3.801	1.11010	8.105	0.000	4	high
3	You follow special tools or standard such as TQM, ISO 9000 or others to control the quality	3.182	1.07630	1.904	0.005	8	moderate
4	You follow special tools or standard such as SPI, PPC for measuring the speed of the project	3.793	.99049	8.994	0.000	5	high
5	You follow special tools or standard such as CPI, TVD for measuring the cost of the project	3.484	1.03332	5.259	0.000	6	moderate
6	The company's success is measured by high revenues from projects	3.396	1.13193	3.935	0.000	7	high
7	Your company depends on management practices that deal with quality and reduce wastes ratios in order to achieve high earnings ratios	3.881	.89091	11.100	0.000	3	high
8	New management tools that improve quality, speed, cost and waste are essential to improve competitive advantage	4.111	.94845	13.150	0.000	2	high
Lean performance indicators		**3.756**	**0.55211**	**15.389**	**0.000**		**high**

*effect statistically significant at the level ($\alpha \leq 0.05$)

Table (5:8) shows that means for items domain lean performance indicators have ranged between (4.4 - 3.1) on a scale Likert, this indicates a high level of agreements among lean performance indicators. These items ranked first in item (1) related to the company's concerns to the types of wastes and its mean reach (4.4), then item No.(2) gets the second place, this item related to the value of the project. This means that contractors are ready to do any change in the project if this change improves the value to the owner. The other high level of agreements items were ranked as items (4, 7, 8) respectively.

In Table (5:8) it is observed that the items (3) and (5) have a moderate level of agreements that means the contractors are not fully familiar with the quality standards and tools such as TQM and the tools that measure the cost of the projects. Finally as shown in Table (5:8) all the key performance indicators for successful lean implementation that presents in the proposed model were accepted and the contractors are ready to accept any new management practices that helps to improve the value of the project.

5.2.3 Assessing the Agreements of Contactors Towards Factors that Support Successful Lean Implementation.

This section of the questionnaire assesses the agreements of the contractors towards factors that support successful lean implementation. This section has three main factors addressing the main items that support successful lean implantation. These main factors are: planning and management factors, human factors and organizational factors.

A Likert scale is used to measure the application Agreement (Likert, 1974). Table (5:6) clarifies 1-5 Likert scale and Table (5:7): that clarifies the Likert Scale level of agreement. The following is the analyses of the third part of the questionnaire that assess the main factors:

1- Planning and Management Factors :

In order to assess the factors that support the successful lean implementation related to planning and management systems mean, standard deviation, One-Sample test and Relative importance of each item, and total score of level of the factor are determined , as shown in Table (5:9) .

Table (5:9): Mean, standard deviation, One-Sample test and Relative to factor Management and planning systems

No.	item	mean	standard deviation	(T) value	Sig.*	Sort item	Relative importance
	Production control						
1	Identifying wastes through new management practices is vital for improving the quality , cost and time	4.1905	0.90963	14.691	0.00	2	high
2	Mapping the flow of material and information of any activity helps to identify the non -added value activity	3.8730	0.92938	10.544	0.00	3	high
3	Preparing the Gant Chart as pull planning which depends at the end date of the activity may eliminate the wastes	3.4048	1.01334	4.484	0.00	6	moderate
4	Supplying appropriate materials in the right quantities and quality only when we need help to improve performance through reduced inventory levels, and reduce the cost of quality.	3.5714	1.01531	6.318	0.00	5	high
5	It is vital that the quality of the project will be the responsibility of each person in the project	4.2619	0.85957	16.479	0.00	1	high
6	Adopting models such as Deming's cycle (plan, do, check, act) helps to have continuous improvement	3.6984	1.03746	7.557	0.00	4	high
	Total score of Production control	**3.8333**	**0.68052**	**13.746**	**0.00**		**high**
	2-Work structure (Last planner)						
7	Project segmentation to activities in schedule showing the critical path and the milestones helps to	4.2460	0.88260	15.847	0.00	1	high

	complete the project on time						
8	Adjusting any variance in the schedule helps to keep the project on time	3.8968	0.87480	11.508	0.00	4	high
9	Having (weekly work plan) increases the employee efficiency	4.0873	0.94674	12.892	0.00	2	high
10	Having PPC chart helps in identifying the variance	3.9683	0.87578	12.410	0.00	3	high
	Total score of Work structure (Last planner)	**4.0496**	**0.72182**	**16.322**	**0.00**		**high**
	3-Management Commitment						
11	Management commitment is essential for adopting new management practices	3.9683	0.95445	11.387	0.00	3	high
12	An excellence leadership and management are one of the crucial factors that drive the success of lean implementation	4.2619	0.87798	16.133	0.00	1	high
13	Management engagement and supportive are essential for successful lean practices implementations	4.1667	1.06395	12.309	0.00	2	high
	Total score of Management Commitment	**4.1323**	**0.82954**	**15.321**	**0.00**		**high**
	Total score of Management and planning systems factors	**3.9689**	**.65077**	**16.712**	**0.00**		**high**

*effect statistically significant at the level ($\alpha \leq 0.05$)

In this research, the management and planning systems were examined through these sub factors: production control, work structure (last planner) and management commitment.

1- Production control

Production control were examined through these sub factors (Waste identifications, value stream mapping, pull approach, JIT, TQM, contentious improvement) these principles were represented by items (1,2,3,4,5,6) respectively. Table (5:9) shows that the means for items domain the production control have ranged between (4.19 -3.4) on a scale of Likert, this indicates a high level of agreement among adoption of these principles in the production control of the construction industry and the successful lean implementation. These items ranked as the first item is No (5) that related to the quality as the responsibility of any one in the projects. Then item No (2) gets the second place this item related to identifying the wastes. This means that contractors agreed among adopting lean principles as new management practices and this may improve the performance of the industry and lead to successful lean implementation. The other high level of agreements items were ranked as (2, 6, 4) respectively. In Table (5:9) it is observed that item No (3) has a moderate level of agreement that means that the contractors are not fully familiar with the pull principles in construction.

Finally, as shown in Table (5:9) the contractors agreed among those adopting lean principles in the production control leads to successful lean implementation.

2- Work structure (Last planner)

Last planner was examined through these sub factors :(Project segmentation, adjusting any variance , weekly work plan ,PPC chart) these sub factors were represented by the items (7,8,9,10) respectively .

Table (5:9) shows that the means for items domain last planner have ranged between (4.25 -3.89) on a scale of Likert , this indicates a high level of agreement among adoption of last planner in the production control of the construction industry and the successful lean implementation . These items ranked as the first item is No (7) that related to the Project segmentation. Then item No (9) gets the second place this item related to having weekly plans. This means that contractors agreed among adopting last planner as new management practices and this may improve the performance of the industry and lead to successful lean implementation. The other high level of agreements items were ranked as (10, 9) respectively.

Finally as shown in Table (5:9) the contractors agreed among that adopting last planner in the production control leads to successful lean implementation.

3- Management Commitment

Management commitment was examined through these sub factors: (Management commitment, an excellence leadership and management, Management engagement and supportive) these sub factors were represented by the items (11,12,13) respectively .

Table (5:9) shows that the means for items domain management commitment have ranged between (4.26 -3.96) on a scale of Likert , this indicates a high level of agreement among management commitment of lean in the construction industry and the successful lean implementation . These items ranked as the first item is No (12) that related to an excellence leadership and management in the projects. Then, item No (13) gets in the second place this item related to management engagement and supportive. This means that contractors agreed among the effect of management commitment and successful lean implementation. The third high level of agreements items were ranked in item No (11).

Finally ,as shown in Table (5:9) the contractors agreed among that effective management commitment leads to successful lean implementation.

2- **Human Factors** In order to assess the factors that support the successful lean implementation related to human factors : mean, standard deviation, One-Sample test and Relative importance of each item, and total score of level of the factor are determined , as shown in Table (5:10).

Table (5:10) mean, standard deviation, One-Sample test and relative to human factors.

No	item	mean	standard deviation	(T) value	Sig.*	Sort item	Relative importance
	1- Attitudes						
14	Job satisfaction: Work conditions (policies , salary received ,rewards , the length of employment , employee turnover) are essential for having job satisfaction and having positive attitudes towards new change	4.1984	0.84872	15.850	0.00	3	high
15	Job stress: Feeling discomfort leads to reduce motivation, degraded performance and low commitment.	4.3413	0.87784	17.151	0.00	1	high
16	Commitment: Employees commitment to the organizational goals and values improves their performance	4.3175	0.76578	19.312	0.00	2	high
17	Involvement: The employees ability to participate in decision making is essential in minimizing wastes and improving quality	4.0159	0.80978	14.082	0.00	5	high
18	Open mindedness: Having positive vision to accept the change is essential for successful lean implementation. (lean management)	4.0317	0.85731	13.509	0.00	4	high
	Total score of Attitudes	**4.1810**	**0.62657**	**21.157**	**0.00**		**high**
	2- Skills and experiences						
19	training courses in lean practices improves employees performance	3.8730	.92938	10.544	0.00	2	high
20	Hiring employees who have experience in lean practices is good for improving the company performance.	3.8413	.95844	9.853	0.00	3	high

21	Sufficient and Highly skilled labours of the organization are important to ensure company growth and success.	4.2381	.77386	17.959	0.00	1	high
	Total score of Skills and experiences	**3.9841**	**.73012**	**15.130**	**0.00**		**high**
	3- Team work						
22	You follow special methods or tools for the participation of individuals in the responsibilities and solve problems to ensure increased productivity	3.9921	.90771	12.268	0.00	1	high
23	You follow new means of communications to improve the work of individuals within a team	3.8651	.88862	10.928	0.00	3	high
24	You follow methods to enhance the work of individuals within the team to ensure increased productivity and quality of their work and increase the security and the means of the site	3.8810	.87276	11.330	0.00	2	high
	Total score of Team work	**3.9127**	**.78676**	**13.022**	**0.00**	**3**	**high**
	4-Communications						
25	Good vertical and horizontal communication systems reduce the time for decision taking	4.1508	0.98847	13.068	0.00	2	high
26	Good communication provides cross functional teamwork	4.2540	0.71483	19.691	0.00	1	high
27	Good communication systems help in successful implementation of lean practices	4.1508	0.80067	16.133	0.00	3	high
	Total score of Communications	**4.1852**	**0.72732**	**18.291**	**0.00**		**high**
	Total score of human Factors	**4.0822**	**.60684**	**20.018**	**0.00**		**high**

*effect statistically significant at the level ($\alpha \leq 0.05$)

In this research the human factors were examined through these sub factors: attitude, skills and experiences, team work and communications.

1-Attitude

Attitude was examined through these items (job satisfaction, job stress, commitment, involvement and open mindedness) these items were represented by (14,15,16,17,18) respectively .

Table (5:10) shows that the means for items domain the attitude factors have ranged between (4.34-4.01) on a scale of Likert, this indicates a high level of agreement among the importance of these factors related to attitude and leads to successful lean implementation. These items ranked as the first item is No (15) that related to minimizing job stress in the work environment and its effects on improving the workers performance that leads to successful implementation of lean practices . Then item No (16) gets the second place this item related to employees commitment. This means that contractors agreed among the effects of employees' commitment and the improvements of the performance of the industry that lead to successful lean implementation. The other high level of agreements items were ranked as (14, 17, 18) respectively. Finally as shown in Table (5:10) the contractors agreed among that attitude's factors are important for successful lean implementation

2- Skills and Experiences

Skills and experiences were examined through these sub factors; performing training courses in lean, hiring employees who have experience

in lean and hiring highly skilled labours these principles were represented by the items (19,20,21) respectively. Table (5:10) shows that the means for items domain the skills and experiences have ranged between (4.23-3.84) on a scale of Likert, this indicates high level of agreement among the importance of these factors related to skills and experiences and the successful lean implementation. These items ranked as the first item is No (21) that related to hiring high skilled employees that improves the operational and organizational performance to leads to successful implementation of lean . Then item No (19) gets in the second place this item related to performing training courses. This means that contractors agreed among skills and experiences as factors improve the performance of the industry and lead to successful lean implementation. Another high level of agreements item is (20).

Finally as shown in Table (5:10) the contractors agreed among that skills and experiences are important for successful lean implementation.

3- Team Work

Team work was examined through these sub factors (the participation of individuals in the responsibilities and solve problems, means of communications that improve the work in team and enhancing the work of individuals within team) these principles were represented by items (22, 23, 24) respectively. Table (5:10) shows that the means for the items domain the Team work have ranged between (3.99-3.86) on a scale of Likert , this indicates a high level of agreement among the importance of these factors related to Team work and the successful lean implementation.

These items ranked as the first item is No (22) that related to adopting methods for enhancing the participation of individuals in the responsibilities and solve problems. Then item NO (24) gets in the second place .this item related to enhancing the individuals to work with team. This means that contractors agreed among team works as factors improve the performance of the industry and lead to successful lean implementation. Another high level of agreements is item NO (23). Finally as shown in Table (5:10) the contractors agreed among that teamwork are important for successful lean implementation

4- Communications

Communications were examined through these sub factors (good vertical and horizontal communication, good communication systems and good communication provides cross functional teamwork) these principles were represented by the items (25, 26, 27) respectively.

Table (5:10) shows that the means for the items domain the team work have ranged between (4.25-4.15) on a scale of Likert , this indicates a high level of agreement among the importance of these factors related to team work and the successful lean implementation . These items ranked as the first item is No (26) that related to good communication and its effects in improving cross functional teamwork .Then item NO (25) gets in the second place. This item related to improving vertical and horizontal communications. This means that contractors agreed among communications as factors improve the performance of the industry and lead to successful lean implementation. Another high level of agreements is

item No (27). Finally as shown in Table (5:10) the contractors agreed among that communications are important for successful lean implementation.

3- Organizational Factors

In order to assess the factors that supports the successful lean implementation related to organizational factors: mean, standard deviation, One-Sample test and Relative importance of each item, and total score of level of the factor are determined, as shown in Table(5:11).

Table (5:11): mean, standard deviation, One-Sample test relative to organizational factors

No	item	mean	standard deviation	(T) value	Sig.*	Sort item	Relative importance
1- Organizational culture							
28	The organizational culture (openness, , receptivity) is essential for having high employee performance	4.1349	.70827	17.987	0.00	2	high
29	comprehensive strategy (vision, mission) is essential for improving the organizational performance	4.2063	.74100	18.274	0.00	1	high
30	Any new management practice needs a change in the organizational culture.	3.7540	.92681	9.132	0.00	3	high
	Total score of Organizational culture	4.0317	.57570	20.117	0.00		high
2- Training							
31	Training courses in lean practices lead to successful lean implementation	3.9921	.69852	15.942	0.00	2	high
32	The company capability to invest in training the employees is essential for successful lean implementation	4.0079	.83423	13.562	0.00	1	high
33	For successful lean practices implementing the training courses should cover the main contractors and subcontractors.	3.8175	.80400	11.413	0.00	3	high
	Total score of Training	**3.9392**	**.60722**	**17.361**	**0.00**		**high**
3- Coordination and communication							
34	Creation of supportive organizational culture is an essential platform for lean	3.9683	.69209	15.704	0.00	2	high
35	Openness , collaborative , receptivity and data sharing are essential to improve the organizational performance	3.9603	.80400	13.407	0.00	3	high

36	An open communication environment between the general contractors and subcontractors essential for improving the organization performance	4.0873	.72685	16.791	0.00	1	high
	Total score of Coordination and communication	4.0053	.58269	19.366	**0.00**		**high**
4- R&D (research and development)							
37	R&D units in the organization are vital for improving the company performance	3.7698	.88691	9.743	0.00	2	high
38	It is essential for the project to think about innovative methods for performing the activities	4.2381	.61226	22.699	0.00	1	high
39	Adopting new construction technology is essential for improving the organization performance	4.0952	.81416	15.100	0.00	3	high
	Total score of R&D	**3.9392**	**.59390**	**17.751**	**0.00**		**high**
	Total score of Organizational Factors	**4.0026**	**.49068**	**22.937**	**0.00**		**high**

*effect statistically significant at the level ($\alpha \leq 0.05$)

In this research the organizational factors were examined through these sub factors: organizational culture, training, coordination and communications, and R&D (research and development).

- **Organizational Culture**

Organizational culture was examined through these sub factors ((openness, collaboration, receptivity), comprehensive strategy (vision, mission) and necessary changing in the organizational culture.) these principles were represented by the items (28, 29, 30) respectively.

Table (5:11) shows that the means for the items domain the team work have ranged between (4.20-3.75) on a scale of Likert , this indicates a high level of agreement among the importance of these factors related to organizational culture and the successful lean implementation . These items ranked, as the first item is No (29) that related to having a comprehensive strategy (vision, mission) and its effects in improving the performance .Then item NO (28) gets in the second place. This item related to the organizational culture positive characteristics (openness, collaboration, receptivity). This means that contractors agreed among the organizational culture as factors improve the performance of the industry and lead to successful lean implementation. Another high level of agreements is item NO (30).

Finally as shown in Table (5:11) the contractors agreed among that organizational culture are important for successful lean implementation.

- **Training**

Training was examined through these sub factors (training courses in lean practices, the company capability to invest in training and the training courses should cover the main contractors and subcontractors). These principles were represented by items (31, 32, 33) respectively.

Table (5:11) shows that the means for the items domain the teamwork have ranged between (4.00-3.81) on a scale of Likert, this indicates a high level of agreement among the importance of these factors related to training and the successful lean implementation. These items ranked as the first item is

No (32) that related to the company capability to invest in training and its effects in improving the performance .Then item No (31) gets in the second place. This item is related to training courses in lean practices. This means that contractors agreed among the training as factors improve the performance of the industry and lead to successful lean implementation. Another high level of agreements is item No (33).

Finally as shown in Table (5:11) the contractors agreed among that training related to lean practices are important for successful lean implementation.

- **Coordination and Communication**

Coordination and communication were examined through these items (supportive organizational culture, (openness, collaborative, receptivity and data sharing), and an open communication environment between the general contractors and subcontractors these items were represented by items (34, 35, 36) respectively.

Table (5:11) shows that the means for the items domain the coordination and communications have ranged between (4.08-3.96) on a scale of Likert, this indicates a high level of agreement among the importance of these factors related to communications and coordination and the successful lean implementation. These items ranked, as the first item is No (36) that related to open communication environment between the general contractors and subcontractors and its effects in improving the performance .Then item NO (34) gets in the second place. This item related to (supportive organizational culture. This means that contractors agreed among the

importance of the communications and coordination as factors improve the performance of the industry and lead to successful lean implementation. Another high level of agreements is item NO (35).

Finally as shown in Table (5:11) the contractors agreed among that communications and coordination are important for successful lean implementation.

- **Research and Development (R&D)**

Research and development (R&D) were examined through these items (The essential role of R&D units, thinking about innovative methods for performing the activities and adopting new construction technology). These items were represented by items (37, 38, 39) respectively.

Table (5:11) shows that the means for the items domain the research and development have ranged between (4.23 - 3.76) on a scale of Likert, this indicates a high level of agreement among the importance of these factors related to research and development and the successful lean implementation. These items ranked as the first item is No (38) that related to thinking about innovative methods for performing the activities and its effects in improving the performance .Then item NO (37) get in the second place . This item related to (The essential role of R&D units). This means that contractors agreed among the importance of the research and development as factors improve the performance of the industry and lead to successful lean implementation. Another high level of agreements is item NO (39).

Finally as shown in Table (5:11) the contractors agreed among that research and development are important for successful lean implementation.

5.2.4 Testing and Analyzing of Research Hypotheses

The research hypotheses are examined to explore any possible significant relationship among respondents at (α= 0.05) towards successful lean implementation in the west bank construction sector due to: (planning and management systems, Human factors, organizational factors and contractual factors). Each of these main factors was examined through the following sub factors:

1- Planning and management systems: production control, work structure (last planner) and management commitment.
2- Human Factors : attitudes, communications, team work ,skills and experiences
3- Organizational factors : organizational culture , coordination and communication, R&D (research and development)

For each of these sub factors there are two hypotheses:

- Null hypothesis: There are no statistically significant relationships between participations at (α= 0.05) towards the effects of these factors on successful lean implementation in the construction industry.
- The alternative hypothesis: There are statistically significant relationships between participations at (α= 0.05) towards the effects

of these factors on successful lean implementation in the construction industry.

If the value of (Sig.) is greater than 0.05, that null hypothesis can not be rejected, so in this case there are no statistically significant relationships between these factor and successful lean implementation in the Palestinian construction industry. On other hand, if the value of (Sig.) is less than 0.05, that the null hypothesis cannot be accepted, so in this case there are statistically significant relationships at α= (0.05) between these factor and successful lean implementation in the Palestinian construction industry.

To test the study hypotheses, multiple regression, and the determination coefficient were used to describe the impact of lean principles on each of success factor for successful lean implementation

1- First Hypotheses:

- $H1_0$: There are no statistically significant relationships between respondents at (α= 0.05) towards adopting lean principles in the production control and successful lean implementation.

Table (5:12) The impact of adopting lean principles in the production control and successful implementation for lean

Dependent Variable:		Model Summary			ANOVA				Coefficients		
		R	R2	Adjusted R2	F	df		Sig.*	β	T	Sig.*
Successful Lean implementation		0.369	0.136	0.129	19.499	Regression	1	0.00*	0.369	9.902	0.00*
						Residual	124				
						Total	125				

*effect statistically significant at the level ($\alpha \leq 0.05$)

The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to "The impact of adopting lean principles in the production control" is smaller than the level of significance $\alpha = 0.05$ also the results shows that T = 9.902 and $\beta = 0.369$. Therefore, null hypothesis was rejected and the alternate hypothesis was accepted, that there is a statistically significant impact at ($\alpha = 0.05$) towards adopting lean principles in the production control and successful implementation for lean. Therefore, we conclude that the adopting lean principles in the construction process have a positive impact on improving both the operational and organizational performances that leads to successful lean implementation.

This is because the contactors are believed in lean principles as new practices that could be adopt in construction process and improves the performance by minimizing the wastes.

2- The second Hypotheses:

- $H2_0$: There are no statistically significant relationships between respondents at (α= 0.05) towards adopting last planner in project management and successful lean implementation.

Table (5:13) : The impact of adopting last planner in project management

Dependent Variable:	Model Summary			ANOVA				Coefficients		
	(R)	(R2)	(R2) Adjusted	F	df		Sig.*	β	T	Sig.*
Successful Lean implementation	0.197	0.39	0.31	15.026	Regression	1	0.00*	0.197	11.358	0.00*
					Residual	124				
					Total	125				

*effect statistically significant at the level ($\alpha \leq 0.05$)

The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to “The impact of adopting last planner in project management” is smaller than the level of significance α =0.05 also the results shows that T = 11.358 and β = 0.197. Therefore, null hypothesis was rejected and the alternate hypothesis was accepted that there is a statistically significant impact at (α= 0.05) of adopting last planner in project management and successful implementation for lean. We conclude that the adopting last planner principles in the construction process have a positive impact on improving both the operational and organizational performances that leads to successful lean implementation. This is due to the fact that the contactors are believed in last planner as new practices that could be adopt in construction process and improves the performance.

3- The third Hypothesis:

- $H3_0$: There are no statistically significant relationships between respondents at (α= 0.05) towards the impact of management commitment and successful lean implementation.

Table (5:14) The impact of management commitment and successful lean implementation

Dependent Variable:	Model Summary			ANOVA				Coefficients		
	(R)	(R2)	Adjusted (R2)	F	df		Sig.*	β	**T**	**Sig.***
Factors for successful lean implementation	0.307	0.09	0.087	12.93	Regression	1	0.00*	0.307	12.148	0.00*
					Residual	124				
					Total	125				

*effect statistically significant at the level ($\alpha \leq 0.05$)

The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to "The impact of management commitment and successful lean implementation" is smaller than the level of significance $\alpha = 0.05$. In addition, the results shows that T = 12.148 and β = 0.307 Therefore, null hypothesis was rejected and the alternate hypothesis was accepted that there is a statistically significant impact of management commitment and successful lean implementation. We conclude that adopting lean practices in the construction industry needs management commitment the due to the fact that contractor believed in the role of the management commitment and leadership to adopt any change in the organization.

4- The Fourth Hypothesis:

- $H4_0$: There are no statistically significant relationships between respondents at (α= 0.05) towards the impact of positive attitudes of the employees and successful lean implementation.

Table (5:15) The impact of positive attitudes of the employees and successful lean implementation

Dependent Variable:	**Model Summary**			**ANOVA**				**Coefficients**		
	(R)	(R2)	Adjusted (R2)	F	df		Sig.*	β	T	Sig.*
successful lean implementation	0.285	0.081	0.074	10.996	Regression	1	0.00*	0.285	8.439	0.00*
					Residual	124				
					Total	125				

*effect statistically significant at the level ($\alpha \leq 0.05$)

The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to "The impact of positive attitudes of the employees and successful lean implementation" is smaller than the level of significance α =0.05. In addition, the results of the analysis shows that T = 8.439 and β = 0.285 Therefore, null hypothesis was rejected and the alternate hypothesis was accepted that there is a statistically significant impact of positive attitudes of the employees and successful lean implementation. We conclude that the contractors are agreed among that "the positive attitudes of the employees is a critical factors for successful lean implementation ". this due to the fact that having employees with highly

job satisfactions and decreasing the stress in the work environment in addition to improving the employee's commitment all these issues make the employees ready to adopt any change in the organization .

5- Fifth Hypothesis:

- $H5_0$: There are no statistically significant relationships between respondents at (α= 0.05) towards the impact of skills and expertise of the employees and successful lean implementation.

Table (5:16) The impact of skills and expertise of the employees and successful lean implementation

Dependent Variable:	Model Summary			ANOVA				Coefficients		
	(R)	(R2)	Adjusted (R2)	F	df		Sig.*	β	T	Sig.*
successful lean implementation	0.273	0.074	0.067	9.998	Regression	1	0.00*	0.273	11.09	0.00*
					Residual	124				
					Total	125				

*effect statistically significant at the level ($\alpha \leq 0.05$)

The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to “The impact of skills and expertise of the employees and successful lean implementation” is smaller than the level of significance α =0.05. In addition, the results of the analysis shows that T = 11.09 and β = 0.273 .Therefore, null hypothesis was rejected and the alternate hypothesis was accepted that there is a statistically significant impact of skills and expertise of the employees and successful lean implementation. We conclude that the contractors are agreed among the positive effects of having employees with good experiences in lean practices and performing training courses in lean and the successful lean implementation.

6- Sixth Hypothesis :

- $H6_0$: There are no statistically significant relationships between respondents at (α= 0.05) towards the impact of good communications and successful lean implementation

Table (5:17): The impact of a good communications and successful lean implementation

Dependent Variable:	Model Summary			ANOVA				Coefficients		
	(R)	(R2)	(R2) Adjusted	F	df		Sig.*	β	T	Sig.*
successful lean implementation	0.244	0.059	0.052	7.859	Regression	1	0.00*	0.244	10.618	0.00*
					Residual	124				
					Total	125				

*effect statistically significant at the level ($\alpha \leq 0.05$)

The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to "The impact of a good communications and successful lean implementation" is smaller than the level of significance $\alpha = 0.05$. In addition, the results of the analysis shows that T = 10.618 and $\beta = 0.244$ Therefore, null hypothesis was rejected and the alternate hypothesis was accepted that there is a statistically significant impact of a good vertical and horizontal communications and successful lean implementation. We conclude that the contractors are agreed among the positive impacts of communications and the successful lean implementation. Improving the vertical and horizontal ways of communication may decrease the time for decision making that leads to minimize the waste in time. Also good communications improve the employee commitment through decreasing the gap between the levels in the organization.

7- Seventh Hypothesis:

- H70: There are no statistically significant relationships between respondents at (α= 0.05) towards working as team and successful lean implementation.

Table (5:18): The impact of working as team and successful lean implementation

Dependent Variable:	Model Summary			ANOVA				Coefficients		
	(R)	(R2)	Adjusted (R2)	F	df		Sig.*	β	T	Sig.*
successful lean implementation	0.477	0.227	0.221	36.56	Regression	1	0.00*	0.477	11.071	0.00*
					Residual	124				
					Total	125				

*effect statistically significant at the level ($\alpha \leq 0.05$)

The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to "The impact of working as team and successful lean implementation" is smaller than the level of significance α =0.05. In addition, the results of the analysis shows that T = 11.071 and β = 0.477Therefore, null hypothesis was rejected and the alternate hypothesis was accepted that there is a statistically significant impact of working as team and successful lean implementation. We conclude that the contractors are agreed among the positive impacts of working the employees in team

and the successful lean implementation. Good ways of communication may improve working the employees in team. This may decrease the time for decision-making and improve the employee's involvement in decision-making.

8- Eighth Hypothesis:

- $H8_0$: There are no statistically significant relationships between respondents at (α= 0.05) towards organizational culture and successful lean implementation.

Table (5:19) :The impact of the organizational culture and successful lean implementation

	Model Summary			ANOVA				Coefficients		
	(R)	(R2)	Adjusted (R2)	F	df		Sig.*	β	T	Sig.*
successful lean implementation	0.368	0.135	0.128	19.478	Regression	1	0.00*	0.368	7.153	0.00*
					Residual	124				
					Total	125				

*effect statistically significant at the level ($\alpha \leq 0.05$)

The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to "The impact of the organizational culture and successful lean implementation" is smaller than the level of significance α =0.05. In addition, the results of the analysis shows that T = 7.153 and β = 0.368 Therefore, null hypothesis was rejected and the alternate hypothesis was accepted that there is a statistically significant impact the organizational culture and successful lean

implementation. We conclude that the contractors are agreed among the positive effects of the organizational culture (openness, collaboration, receptivity) and the successful lean implementation. In addition to that and in order to implement lean practices the organization should adopt a strategy for change. This means that for successful lean implementation the culture of the organization should change toward lean culture.

9- Ninth Hypothesis:

- $H9_0$: There are no statistically significant relationships between respondents at (α= 0.05) towards training and knowledge in lean practices and successful lean implementation.

Table (5:20) : The impact of training and knowledge in lean practices and the successful lean implementation

Dependent Variable:	**Model Summary**			**ANOVA**				**Coefficients**		
	(R)	(R2)	(R2) Adjusted	F	df		Sig.*	β	T	Sig.*
successful lean implementation	0.294	0.086	0.079	11.696	Regression	1	0.00*	0.294	8.69	0.00*
					Residual	124				
					Total	125				

*effect statistically significant at the level ($\alpha \leq 0.05$)

The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to “The impact of training and knowledge in lean practices and the successful lean implementation” is smaller than the level of significance $\alpha = 0.05$. In addition, the results of the analysis shows that T = 8.69 and $\beta = 0.294$ Therefore, null hypothesis was rejected and the alternate hypothesis was accepted that there is a statistically significant impact of training and knowledge in lean practices and the successful lean implementation. We conclude that the contractors are agreed among the impact of performing training courses in lean practices and successful implementation lean .These course needs financial investment that depends on the financial capabilities of the organization so having as strategy to invest in these courses supports the successful implementation of lean .

10- Tenth Hypothesis:

- $H10_0$: There are no statistically significant relationships between respondents at ($\alpha = 0.05$) towards the coordination and communication in the organization and successful lean implementation

Table (5:21): The impact of coordination and the communication in the organization and successful lean implementation

Dependent Variable:	Model Summary			ANOVA				Coefficients		
	(R)	(R2)	(R2) Adjusted	F	df		Sig.*	β	T	Sig.*
successful lean implementation	0.175	0.031	0.023	3.917	Regression	1	0.00*	0.175	9.122	0.00*
					Residual	124				
					Total	125				

*effect statistically significant at the level ($\alpha \leq 0.05$)

The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to, “The impact of coordination , the communication in the organization and successful lean implementation” is smaller than the level of significance $\alpha = 0.05$. In addition, the results of the analysis shows that $T = 9.122$ and $\beta = 0.175$ Therefore, null hypothesis was rejected and the alternate hypothesis was accepted, that there is a statistically significant impact of coordination and the communication in the organization and successful lean implementation. We conclude that the contractors are agreed among the positive impact of coordination and communications and successful implementation lean .This is related to the fact that good coordination between employees in performing the activities and good means on communication may decrease the wastes in the construction process ,and supports the successful implementation of lean practices .

11- Eleventh Hypothesis:

- $H11_0$: There are no statistically significant relationships between respondents at (α= 0.05) towards adopting innovations in the organization and successful lean implementation.

Table (5:22) : The impact of adopting innovations and successful lean implementation.

Dependent Variable:	Model Summary			ANOVA				Coefficients		
	(R)	(R2)	Adjusted (R2)	F	df		Sig.*	β	T	Sig.*
successful lean implementation	0.258	0.069	0.059	8.879	Regression	1	0.00*	0.258	8.748	0.00*
					Residual	124				
					Total	125				

*effect statistically significant at the level ($\alpha \leq 0.05$)

- The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to "The impact of adopting innovations and successful lean implementation" is smaller than the level of significance α =0.05. In addition, the results of the analysis shows that T = 8.748 and β = 0.258 Therefore, null hypothesis was rejected and the alternate hypothesis was accepted that there is a statistically significant impact of adopting innovations and successful lean implementation. We conclude that the contractors are agreed among the positive impact of adopting innovations and

successful implementation of lean practices .Adopting innovations in the organization depends on the role of the research and development unit, so the organization should start to think about having this unit within the organization structure. In another hand, it is essential to think about innovative methods for performing the activities and this supports the successful lean implementation.

Twelfth Hypothesis:

- $H12_0$: There are no statistically significant relationships between respondents at ($\alpha = 0.05$) towards the role of contract in organizing all the relations between the factors that supports successful lean implementation.

Table (5:23): The role of the contracts in organizing all the relationships between the factors that supports successful lean implementation.

contract	Response		sum	df	Chi-Square	Asymp. Sig.
	yes	no				
The Contracts in the project should have a strong involvement of the owner, general contractors and subcontractors.	67.5	32.5	100%	1	66.036	0.00*
In the organization the procurement department should be familiar with lean principles to have contracts that govern any supplying materials depending on minimizing the wastes.	89.7	10.3	100%	1	180.036	0.00*
The organization should have an effective human resource department in order to have efficient recruitment process.	89.7	10.3	100%	1	180.036	0.00*

*effect statistically significant at the level ($\alpha \leq 0.05$)

- The analysis results shows that the p-value (Sig.) for the total of section of the questionnaire related to “towards the role of contract in organizing all the relations between the factors that supports successful lean implementation .” is smaller than the level of significance α =0.05. Therefore null hypothesis was rejected and the alternate hypothesis was accepted

- that there is a statistically significant impact of the contract in organizing all the relationships between the factors that supports the successful lean implementation. We conclude that in order to have successful lean implementation the contract should supports adopting lean in the contraction process .in addition to that contract should supports lean in both the Human's and the organizational factors.

5.3 Parts 2 : Answers of Research's Questions

From the previous results of the questionnaire analysis, the research's questions could be answered, and compared the results with other related work; the research's questions are presented below:

1- Researcher's First Question

What is the level of agreements in the lean performance indictors among the contractors?

This question is answered through the second section of the questionnaire and it measures the agreement of the contractors towards the key performance indicators for successful lean implementation: these indicators measure both the operational and organizational performance of the company. The operational performance is measured by (Cost, time, quality, waste and value) on the other hand the organizational performance is measured by (net profit , revenue growth and developing competitive profile) . To answer this question, these variables were studied using the output of analyzing the second part of the questionnaire.

According to Table (5:8), it’s clear that the respondents at the Palestinian construction sector agreed with these key performance indicators to measure the successful lean implementation in the West Bank construction industry. This table shows that all the items related to these KPI have a high degree of agreement among the contractors except the items that is related to the adopting quality standards and tools that measure the cost of the project when the items have a moderate scale of agreements. Thus, we can conclude that all these KPIs may measure the successful lean implementation in the construction industry and these may be considered as the output of the model for successful lean implementation in the construction industry and the contractors are ready to accept any change in management practices that is may improve these KPIs. This result is consistent with the findings of and (Jeyaraman and Teo, 2010) in their researches.

2- Researcher's Second Question

What are the factors that support successful lean implementation relative to management and planning systems?

This question is examined by these three items: production control, work structure and last planner and management commitment. To answer this question, these variables were studied using the output of analyzing items (1-13) of the third part of the questionnaire.

According to Table (5:9), it’s clear that the respondents at the construction sector agreed on adopting lean principles in production control with the

level of successful lean implementation in the West Bank construction industry. Thus, we can conclude that the Palestinian contractors are interested in lean principles as new management practices that may improve the construction process and adopt these principle leads to successful lean implementation. From the table ,it is concluded that the contactors are highly agreed with the items related to the principles (identifying wastes, value stream mapping, just in time, total quality management and continuous improvement) and they have a moderate agreements with pull approach. Finally it is concluded that adopting lean principles in the production process has a significant impact on the successful lean implementation and this results is consistent with the finding of Koskela (1992) . Moreover, work structure and last planner also examined in the third part of the questionnaire. This principle identifies the contractor's agreements on adopting the last planner practice and its effects on improving the performance that leads to successful lean implementation. In Table (5:9) all the items that examine this principle is significant and have a high level of agreements from this we can conclude that adopting last planner in the construction process improves the performance and leads to successful lean implantation and this results is consistent with the finding Ballarad (2000) and Koskela (1992). Finally for answering this question, management commitment is examined as factors for successful lean implementation as seen in Table (5:9). This factor have high level of agreement and the respondents are agreed among that management commitment and excellence leadership have a positive impact on

successful lean implementation and this results is consistent with the finding (Jeyaraman and Teo, 2010; Pande et.al., 2000).

Finally from the results of analyzing Table (5:9), and answering the questions related to the impact of production control, work structure (last planner) and management commitment. The result of this analysis answered the research's second question and it appears that adopting lean principles in construction process in addition to management commitment leads to successful lean implementation of these principles in the West Bank construction industry.

3- Researcher's Third Question

What are the human factors that support successful lean implementation?

This question is examined by these four items: Attitudes, Skills and experiences, Teamwork and Communications. To answer this question, these variables were studied using the output of analyzing items (14-27) of the third part of the questionnaire. According to Table (5:10), it's clear that the respondents at the construction sector agreed among the positive effects of these factors and the improvement of both the operational and organizational performances that leads to successful lean implementation in the West Bank construction industry.

From the Table (5:10), it is concluded that the contactors are highly agreed with the items related to positive attitudes of the employees. These items are (increasing job satisfaction, decreasing job stress, enhancing the

employees in participation of decision-making, employee's commitment to organization goal and open mindedness). All these items have significant relationships among the positive employees' attitudes and improve the operational and organizational performances that lead to successful lean implementation this results is consistent with finding of Kraus (1995) and Rodwell et al. (1998). Moreover, Skill and expertise also examined in this part of the questionnaire. These factors also have high contractors' agreements as factors that support successful lean implementation the contractors believed on applying training courses in lean practices and hiring employees have experiences in lean practices. These factors are important to have successful lean implementation and consistent with the finding of Jeyaraman and Teo (2010). In Table (5:10) team work is examined as another human factor that supports successful lean implementation this factor also has a significant relationship and consider as factor lead to successful implementation and this result is consistent with Leung et al. (2008). For answering this question, the effective communications are examined as factors for successful lean implementation as seen in Table (5:10). These factors have high level of agreement and the respondents are agreed among the importance of vertical and horizontal communications and successful lean implementation and these results are consistent with the finding of Antony and Banuelas (2001).

Finally from the results of analyzing Table (5:10) and answering the questions related to the human factors that supports successful lean

implementation. The main third research's question that examines the human factors is answered and these factors are considered as factors that lead to successful lean implementation.

4- Researcher's Fourth Question

What are the factors that support successful lean implementation relative to organizational issues?

This question is examined by these four items: Organizational culture, Training, Coordination and communication and R&D (research and development). To answer this question, these variables were studied using the output of analyzing items (28-39) of the third part of the questionnaire. According to Table (5:11), it's clear that the respondents at the construction sector agreed among the positive effects of these factors and the improvement of both the operational and organizational performances that leads to successful lean implementation in the West Bank construction industry.

From the Table (5:11), it is concluded that the contactors are highly agreed with the items related to organizational culture. These items are (openness, collaboration, receptivity) , having comprehensive strategy (vision, mission) and necessary changing in the organizational culture) all these items have significant relationships and improve the operational and organizational performances that leads to successful lean implementation this results is consistent with the finding of Kim and Park (2006). Moreover, the company's capabilities to perform training courses in lean

practices also examined in this part of the questionnaire. These factors also have high contractor's agreements as factors that support successful lean implementation and the contractors believed on applying training courses in lean practices and invest in developing the employees in these principles as factors that are important to have successful lean implementation and these results are consistent with the finding of Kim and Park (2006). In Table (5:11) communications and coordination are examined as other organizational factors that support successful lean implementation. These factors also have significant relationships and are considered as factors that lead to successful implementation and this result is consistent with Antony and Banuelas (2001). For answering this question the R&D is examined as factor for successful lean implementation as seen In Table (5:11). This factor has a high level of agreement and the respondents are agreed among the importance of adopting innovations and successful lean implementation and this result is consistent with the finding of zorhon et al. (2009)

Finally from the results of analyzing Table (5:11) and answering the questions related to the organizational factors that support successful lean implementation. The main research question relative to organizational factors and these factors are considered as factors leads to successful lean implementation.

5.4 Part 3 : Conceptual Framework

5.4.1 Framework Justification

To simplify the findings of the research, and present them in easy form to enable the contractors in the construction sector to take advantage of them, the researcher proposed a framework for a successful lean implantation in the Palestinian construction industry. This framework helps the contactors to improve their performance and adopt lean practices as new management trends.

The framework relied mainly on the first objective which is the output of lean implementation; this output is measured through KPIs that measure the improvement in the organizational and operational performances in the company. These KPI are cost, time, quality, value, waste, net profit, revenue growth and developing competitive profile. The framework is to measure the successful implementation of lean practices an improvement should occur in these KPIs.

The framework relied also on the second objective of the factors that support successful lean implementation which was resulted from the questionnaire analyses. These success factors related to (management and planning systems, human factors, organizational factors and organizational factors). As seen from the results of analyses these factors have significant impact on the successful lean implementation and also there are correlations between these factors.

5.4.2 How the Framework has been Built

In this research and in order to have a model for the factors that support successful lean implantation, statistical strategy that leads to build this model is adopted. This approach started by an exploratory research approach that used though literature review for studies, article, journal papers, books conferences and internet. As a result of these reviewing, the KPIs that may measure the improvement in the performance are determined and considered as dependent variable, in addition to that the factors that support this successful and related to planning and controlling, human factors, organizational factors and contractual factors were determined and considered as independent variables, see Chapter Two section 2.10. The second phase is an explanatory descriptive analytical approach by using quantitative survey that used a questionnaire to assess the agreements of the contractors among the factors for successful lean performance. After that, the collected data were analyzed descriptively and statistically by using Statistical Package for the Social Sciences (SPSS). In this analysis, some descriptive statistical techniques were used to arrive the results. These include t. test, One-Way nova test (ANOVA). Frequencies and percentages were also used. Finally, multiple regressions are used to test the research hypotheses and determine the effects of improving these factors on KPIs in addition to the correlation correlations between them. At the end of this analysis all, these relationships are drawn in order to simplify the presentation of these relations.

5.4.2.1 Correlation

Correlations between critical factors are examined. Table (5:24) shows the correlations of the independent variable factors. There is some relationship between factors. In this study, the factors seem to be related to each other's. This indicated that firms, which are advanced in their practices on some factors, tend to be more advanced on others.

Table (5:24) Correlation matrix between variables for whole sample (n=126).

Symbol	Item	PC	WS	MC	AT	SE	TW	CO	OC	TR	CC	R&D
PC	Production control	1	.720**	.633**	.615**	.630**	.579**	.573**	.545**	.546**	.457**	0.498**
WS	Work structure (Last planner)	.720**	1	.733**	.632**	.650**	.487**	.551**	.383**	.457**	.470**	0.541**
MC	Management Commitment	.633**	.733**	1	.719**	.733**	.563**	.585**	.492**	.517**	.403**	0.480**
AT	Attitudes	.615**	.632**	.719**	1	.721**	.620**	.754**	.464**	.604**	.504**	0.524**
SE	Skills and experiences	.630**	.650**	.733**	.721**	1	.545**	.627**	.521**	.679**	.472**	0.529**
TW	Team work	.579**	.487**	.563**	.620**	.545**	1	.605**	.405**	.476**	.292**	0.398**
CO	Communications	.573**	.551**	.585**	.754**	.627**	.605**	1	.300**	.529**	.503**	0.403**
OC	Organizational culture	.545**	.383**	.492**	.464**	.521**	.405**	.300**	1	.565**	.567**	0.643**
TR	Training	.546**	.457**	.517**	.604**	.679**	.476**	.529**	.565**	1	.649**	0.579**
CC	Coordination & communications	.457**	.470**	.403**	.504**	.472**	.292**	.503**	.567**	.649**	1	0.849**
R&D	Research and development	.498**	.541**	.480**	.524**	.529**	.398**	.403**	.643**	.579**	.849**	1

**P < 0.01 correlation is significant at the level .01 2-tailed

5.4.2.2 The relationships between critical success factors and lean implementation success

The relationship between critical success factors and lean implementation success were analyzed by using multiple regression analysis. The multiple regression was statistically significant (significant level = 0.05). The p value was 0.000 indicated that the critical success factors have positive influence on the success of lean implementation. Table (5:25) shows

the results of multiple regression analysis and Figure (5:8) shows relationships of all critical success factors that affect on the lean implementation success.

Table (5:25) Multiple regression analysis on lean implementation success

NO	symbol	Variables	Lean implementation success			
			unstandardized coefficient B	Standardized coefficient β	*t*	Sig
	C	**Constant**	2.145		5.673	0.000
1	**PC**	**Production control**	0.162	0.320	4.486	0.019
2	**WS**	**Work structure**	0.158	0.187	10.433	0.000
3	**MC**	**Management commitment**	0.179	0.298	11.820	0.009
4	**AT**	**Attitudes**	0.157	0.265	7.429	0.009
5	**SE**	**Skills and experiences**	0.165	0.247	9.591	0.006
6	**TW**	**Team work**	0.276	0.393	13.363	0.001
7	**CO**	**communications**	0.220	0.426	10.183	0.005
8	**OC**	**Organizational culture**	0.163	0.370	6.406	0.002
9	**TR**	**training**	0.159	0.265	8.493	0.003
10	**CC**	**Coordination and communication**	0.196	0.172	8.655	0.004
11	**RD**	**R&D**	0.198	0.245	8.583	0.001
	R = 0.546	**RSQ=0.298**	**Adjusted RSQ = 0.223**	**F= 11.993**	**Sig=0.00**	

Successful lean implementation = C +B1(PC) + B2(WS)+ B3(MC)+ B4(AT)+ B5(SE) + B6(TW)+ B7(CO)+ B8 (OC)+ B9(TR)+ B10 (CC)+ B11(RD)

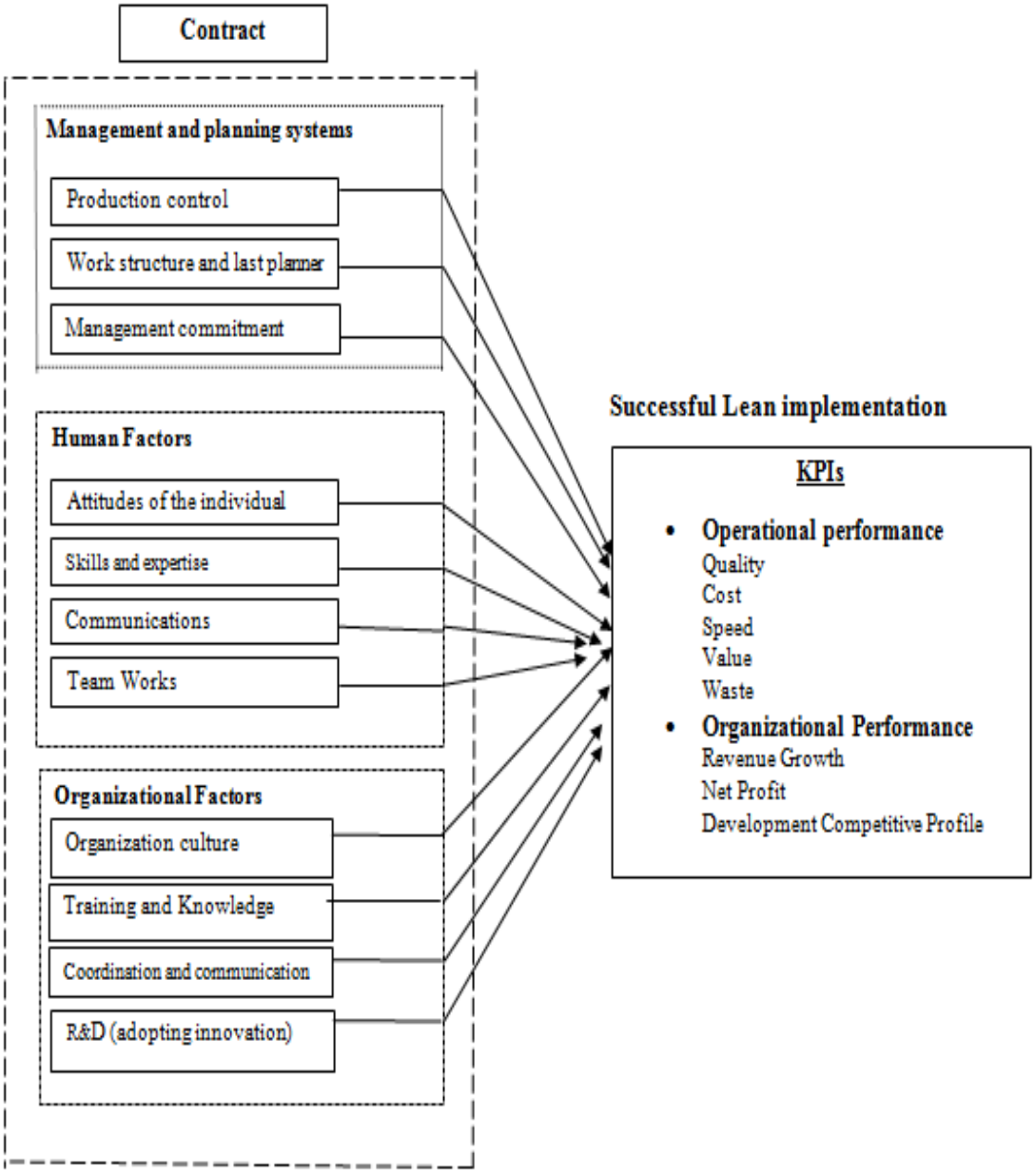

Figure (5:8): Framework of critical factors for Successful Lean Implementation in the West Bank Construction industry.

5.4.5 Strength Points of the Framework

After building this framework, the researcher identified some strengths points that support this framework.

- The strength of this model is related to the deep reviewing in literatures that supports this model with the most essential factors for the successful implementation of lean.
- The factors in this model cover all the parties that influence the construction process.
- This model is a platform for implementing lean in the construction industry in the West Bank.
- The survey that leads to this model covers the construction companies that have a deep experience in construction sector that makes the results more reasonable.

5.4.6 Framework Testing

In order to assess the validity of the framework, the researcher discussed this framework with three experts in construction industry; these three experts are general managers for construction companies in the West Bank. One of them in the north, the second one is in the middle and the third one in the south. The experts are interested in the framework and lean construction as new management practices. According to the successful factors in the model they said that these factors are covered all the sectors in the organization that may affects the performance of the organization. They also said that the performance of their companies could be measured

through the KPIs that present in the framework, and they are fully interested to have index that measures these KPIs. The experts also discussed the factors and their effects on the successful lean implementation and they showed agreements among these factors. Finally they agreed on the framework as a platform for the entering this new management trend in construction and they ready to start assessing their companies and improving the factors that supports adopting lean in their companies.

Finally, this study is considered as first step to enhance lean construction in West Bank. The contractors should adopt lean as a strategic change in the organization that should be enhanced in their vision and mission .After that the companies should assess their situation related to the success factors in the framework and looking for improving these factors to have successful lean implementation in addition to have KPIs to assess the improvement.

Chapter Six

Conclusions, Recommendations

6.1 Overview

In the previous chapter, the results of the study were tabulated and the findings of the study were discussed in detail. This chapter serves as a conclusion for this thesis; the main conclusions, recommendations and thesis contributions are described.

6.2 Research Conclusions

Chapter one in this thesis introduces research objectives, and defines the research problem. The main goals of this research are assessing the factors that support successful lean implementation in the West Bank construction industry and linking them with a framework that represents these relationships and results. Exploratory- descriptive, explanatory and correlative analysis had been used to answer the research questions in this study. This research consists of three phases: the first phase is an exploratory research used though literature review which reviewed previous studies, articles, journal, papers, books, conferences and internet. The second phase is an explanatory descriptive analytical approach by using quantitative survey which tries to assess the agreements of the contractors on the successful lean performance indicators that presents in the proposed model and their agreements among the factors that supports successful lean implementation. The third phase is testing the research hypotheses and building the framework. Through discussing the results of

the statistical analysis and thematic analysis; conclusions in this regard are provided under each research objective.

- **Research Objective 1**

The first objective of this study was to investigate the key performance indicators that measure the successful implementation of lean among the contractors. The researcher, as presented in Chapter 5, discussed in detail all results and findings pertaining to this research objective.

In conclusion, it was determined that the contractors are agreed on the key performance indicators that measure the successful lean implementation. It can be concluded that the operational performance can be measured with cost, time, quality, waste and value. In this study, the contractors are agreed among wastes and value to be additional measures for improving the operational performance of the organizations in addition to the traditional KPIs (cost, time and quality). These two additional items are considered one of the fundamentals of lean management. As result of analyzing these KPIs, it is concluded that the contractors are not fully familiar with adopting standards and tools for measuring the quality and cost for the project. So, these two items should be taken in consideration while planning the projects. On the other, hand the organizational performance can be measured by many indictors. In this study the researcher examined the following three items (net profit, revenue growth and developing competitive profile). These KPIs are highly agreed from the contractors as

indictors that measure the successful implementation of lean in construction industry.

- **Research Objective 2**

The second objective of this research is investigating the key factors supporting the principles and the successful implementation of lean construction tools/techniques among the Palestinian contractors. The researcher, as presented in Chapter 5, discussed in detail all results and findings pertaining to this research objective. These factors are categorized into three parts these parts are (management and planning systems, human factors, and organizational factors). In addition to that the contractual factors are examined in three questions to insure the role of the contract to govern all these relations in the production process.

In the results of analyzing the factors related to management and planning systems It can be concluded that there is a significant relationship between adopting lean principles in the production control such as (identifying the wastes , value stream mapping , pull approach , TQM, JIT and continuous improvement) and the successful lean implementation. In this research, it is concluded that the contractors are agreed among these principle and their effects on improving both organizational and operational performances and they are ready to adopt these practices in the construction process. This means that adopting these principles lead to successful implantation of lean in the construction industry. Another factor that is examined is adopting work structure and last planner in the production process. Analyzing these

factors show that the contractors are highly agreed among this principle and there is a significant relationship between adopting this principle and the successful lean implementations. As a result of analysis this factors it appears that adopting practices like (project segmentation to activities , weekly work plan , PPC charts and adjusting the variance in these charts) all these practices improves the operational performance of the organization and lead to successful implementation of lean in construction process .

Chapter Five also discuss the results of analysis the factors related to human issues. It can be concluded that there is a significant relationships between these factors and the successful lean implementation. It is concluded that the contractors are agreed among the positive effects of positive employees' attitude in the organization and successful lean implementation. This study shows that for improving the performance of the organization it is necessary to enhance the employee's job satisfaction and decreasing the job stress in the work environments and these two factors are important for adopting any change in the organization and leads to successful lean implementation. In addition to that it is important to enhance the employee's involvements that encourage them to participate in decision making. Also employee's commitment is considered one of the most important factors for successful lean implementation because it reduces the employees resistant toward the change. Another human factor that is taken in consideration is the skills and experiences of the employees. This study shows that for successful lean implementation it is necessary to

have employees with good experience with lean practices. These experiences can be taken through hiring employees that have experiences in lean practices or performing training courses in lean practices for the employees and this experience should include the subcontractors work with the company. Teamwork and good communications in the organization are considered factors that support successful lean implementation. So that the organization should improve, the means of communications that supports the employees to work with team in addition to improving the vertical and horizontal communications in the organization.

Organizational factors that support successful lean implementation also discussed in this research. These factors are analyzed and the results are shown in chapter five. It can be concluded that there is a significant relationships between these factors and the successful lean implementation. It is concluded that the contractors are agreed among the positive effects of (openness, collaboration, receptivity) and improving employee's performance. In addition to that it is important for the company to have a comprehensive strategy that support adopting lean in the firm's culture. The top management should accept also changing in organization culture in order to reach the lean culture. Another organizational factor that is taken in consideration is training the employees this is related to the organizational capability to invest in applying training courses in lean practices that leads to successful lean implementation. In this part of study coordination and communications and the role of research and development unite in the organization are considered factors that support successful lean

implementation. Finally the contractual role is examined and it concluded that the contract should govern all these relations and factors to have a good lean implementation in the organization.

- **Research Objective 3**

This study reviewed and identified critical factors enabling to the success of lean implementation in West Bank construction industry. Four main critical success factors were identified including management and planning systems, Human factors, organizational factors, and contractual factors. The aim of this study is to examine the relationship between these critical success factors and the success of lean implementation in West Bank construction companies. Dataset collected was analyzed by using multiple linear regressions. The key statistical finding suggested that there is a significant relationship between these factors to the success of lean implementation. These critical success factors included (production control, last planner, management commitment, attitudes of the individual, skills and experiences, communications, team works, organizational culture, training and knowledge, coordination and communications, R&D and contractual factors. In summary, this study helped in broadening the literature related to critical success factors in a particular context of construction companies. The results provide managerial implications particularly for the West Bank companies intended to implement lean for pursuing higher competitive advantage.

6.3 Hypotheses Conclusions

According to statistical analysis, the research is reached to the following hypotheses conclusions:

- The p-value (Sig.) for the total of section of the questionnaire related to each factor is smaller than the level of significance α =0.05. Therefore, null hypotheses were rejected and the alternative hypotheses were accepted that there is statistically significant impact of each factor and successful lean implementation. These factors related to management and planning systems, human factors, organizational and contractual factors.

6.4 Thesis Contributions

This research adds a contribution to the construction industry in the West Bank. The contribution of this research is represented by developing a framework to facilitate the implementation of lean management in construction projects in the West Bank. That the research recommend to be highly considered from the contractors union, engineers association and the other cooperation in the West Bank to increase the awareness about the importance on implementing lean practices in the construction projects. To our knowledge, this framework for implementing lean management in the West Bank construction projects is considered as the first customized framework in the region that handles the factors that support the successful lean implantation in construction industry.

6.5 Recommendations

Based on the findings of this study and the conclusions drawn above, there are some of the recommendations that can be formulated to adopt lean practices in the West Bank construction industry, as the following:

1. It is recommended that the contractors should asset a set of LC-KPIs to measure and guide improvement (in terms of project quality, cost, speed, value, waste, net profit. revenue growth, and developing competitive profile).

2. In order to integrate lean concepts, it is recommended the Palestinian Contractors Union (PCU) to hold periodical meeting with the contractors to introduce lean concepts in developing the construction projects and increase the effectiveness and efficiency.

3. Contractors, Clients and PCU are recommended to held intensive training course in Lean Construction tools and management practices. This training course should be organized monthly or quarterly by inviting all registered contractors to attend in addition to the subcontractors.

4. Contractors and clients are recommended strongly to consider lean tools such as (Just in time, pull approach, value stream mapping, identifying the seven wastes and last planner, etc.) in the construction process.

5. Contractors are recommended to perform training courses to workers in the company in order to reach the needed productivity

6. While implementing lean it is recommend that, management should be patient for enforcing these practice at every level of the organization is required.

7. The contractors are recommended to enhance job satisfaction and reduce the stress in the work environment.

8. Construction companies recommended to adopt new strategy for changing their culture and have a comprehensive vision and mission for enhancing this change towards lean culture

9. Clients are recommended to start injecting mandatory clause in the contract that supports Lean construction.

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Appendix

Appendix A

Appendix A: The English Version of the Questionnaire about (Towards Enhancement of Lean Practices in the West Bank Construction Industry)

Dear Contractor:

First of all, I would like to thank you for your valuable time and effort that will be allocated in filling this questionnaire.

This questionnaire aims to study the factors that support successful lean implementation in the construction industry in the West Bank.

Lean practices are based on improving the value of final product, and eliminating waste through all processes of a project.

This study identifies the key success Factors that are essential when creating a model for successful lean implementation. The information in this questionnaire will be used only for academic research, with a complete commitment to absolute confidence.

Researcher Name

Wathiq Abu Obaid

Section one: Profile of company

1. Company's Location

☐North region ☐Middle region ☐South region

2. Company experience

☐ Less than 5 years ☐ From (5-10) years ☐ From (11-15) ☐ More than 15 years

3. Capital of the company (Thousand $) is

☐ Less than100 ☐ 100-250 ☐ 250-500 ☐ More than500

4. Average size of projects the company involved in (Thousand $) is

☐ 100-250 ☐ 250-500 ☐500-1million ☐ More than1 million

5. The number of employees working in the company is:

☐1- less than 10 ☐ 10-less than 20 ☐ 20- less than 30 ☐ more than 30

6. Average number of contract employees working in the company is

☐ 1- less than 5 ☐ 5- less than10 ☐ 10- less than15 ☐ more than 15

8. Contractor's classification under PCU* category is

Degree	1st	2nd	3rd	4th	5th
Buildings	☐	☐	☐	☐	☐
Roads	☐	☐	☐	☐	☐
Water & Sewage	☐	☐	☐	☐	☐

*PCU: Palestinian Contractors Union

<u>Section two</u>: the perception of the contractors towards the Lean construction Key Performance indicators (KPI)

These factors examine your perception on the key performance indicators for successful lean implementation. Please, put (√) to the degree to which you agree with these statements

	Lean performance indicators	**Strongly disagree**	**disagree**	**Neutral**	**agree**	**Strongly agree**
	Wastes					
1	Your company is Interested in minimizing wastes in materials , conveying of materials and labor, transportation and inventory level, waiting time, over production ,over processing.					
	Value					
2	You are ready to do any change in the project if this change improves the value to the owner.					
	Quality					
3	You follow special tools or standard such as TQM, ISO 9000 or others to control the quality.					
	Time					
4	You follow special tools or standard such as SPI, PPC for measuring the speed of the project					
	Cost					
5	You follow special tools or standard such as CPI, TVD for measuring the cost of the project					
	Revenue					
6	The company's success is measured by high revenues from projects					
	Net profit					
7	Your company depends on management practices that deal with quality and reduce wastes ratios in order to achieve high earnings ratios					
	Competitive profile					
8	New management tools that improve quality, speed, cost and waste are essential to improve competitive advantage					

Section three : These factors examine the success factor for successful lean implementation

please put (√) to the degree to which you agree with these statement

	Key Success factors	Strongly disagree غير موافق بشدة	disagree غير موافق	Neutral محايد	Agree موافق	Strongly agree موافق بشدة
	أنظمة الادارة و التخطيط 1- ***Management and planning systems***					
	Production control					
1	Identifying wastes through new management practices is vital for improving the quality , cost and time					
2	Mapping the flow of material and information of any activity helps to identify the non -added value activity					
3	Preparing the Gant Chart as pull planning which depends at the end date of the activity may eliminate the wastes					
4	Supplying appropriate materials in the right quantities and quality only when we need help to improve performance through reduced inventory levels, and reduce the cost of quality.					
5	It is vital that the quality of the project will be the responsibility of each person in the project.					
6	Adopting models such as Deming's cycle (plan, do, check, act) helps to have continuous improvement.					
	Work structure (Last planner)					
7	Project segmentation to activities in schedule showing the critical path and the milestones helps to complete the project on time					
8	Adjusting any variance in the schedule helps to keep the project on time.					
9	Having (weekly work plan) increases the employee efficiency					
10	Having PPC chart helps in identifying the variance.					
	Management Commitment					
11	Management commitment is essential for adopting new management practices.					
12	An excellence leadership and management are one of the crucial factors that drive the success of lean implementation					
13	Management engagement and supportive are essential for successful lean practices implementations					
	2- Human Factors (العوامل البشرية)					
	Attitudes					
	Job satisfaction					
14	Work conditions (policies , salary received ,rewards , the length of employment , employee turnover) are essential for having job satisfaction and having positive attitudes towards new change					

	Job stress					
15	Feeling discomfort leads to reduce motivation, degraded performance and low commitment.					
	Commitment					
16	Employees commitment to the organizational goals and values improves their performance					
	I**nvolvement**					
17	The employees ability to participate in decision making is essential in minimizing wastes and improving quality					
	Open mindedness					
18	Having positive vision to accept the change is essential for successful lean implementation.					
	Skills and experiences					
19	training courses in lean practices improves employees performance					
20	Hiring employees who have experience in lean practices is good for improving the company performance.					
21	Sufficient and Highly skilled labors of the organization are important to ensure company growth and success.					
	Team work					
22	You follow special methods or tools for the participation of individuals in the responsibilities and solve problems to ensure increased productivity					
23	You follow new means of communications to improve the work of individuals within a team					
24	You follow methods to enhance the work of individuals within the team to ensure increased productivity and quality of their work and increase the security and the means of the site					
	Communications					
25	Good vertical and horizontal communication systems reduce the time for decision taking					
26	Good communication provides cross functional teamwork					
27	Good communication systems help in successful implementation of lean practices					
	3- Organizational Factors					
	Organizational culture					
28	The organizational culture (openness, collaboration, receptivity) is essential for having high employee performance.					
29	comprehensive strategy (vision, mission) is essential for improving the organizational performance					
30	Any new management practice needs a change in the organizational culture.					
	Training					
31	Training courses in lean practices lead to					

	successful lean implementation					
32	The company capability to invest in training the employees is essential for successful lean implementation					
33	For successful lean practices implementing the training courses should cover the main contractors and subcontractors.					
	Coordination and communication					
34	Creation of supportive organizational culture is an essential platform for lean implementation					
35	Openness , collaborative , receptivity and data sharing are essential to improve the organizational performance					
36	An open communication environment between the general contractors and subcontractors essential for improving the organization performance					
	R&D (research and development)					
37	R&D units in the organization are vital for improving the company performance					
38	It is essential for the project to think about innovative methods for performing the activities					
39	Adopting new construction technology is essential for improving the organization performance					

Section four : Contract

Please answer yes or no of the following statement

1- The Contracts in the project should have a strong involvement of the owner, general contractors and subcontractors.

العقود التي تحكم عملية تنفيذ المشروع يجب ان تكون بمشاركة المالك , المقاول الرئيسيي و المقاول الفرعي .

Yes ☐ No ☐

2- In the organization the procurement department should be familiar with lean principles to have contracts that govern any supplying materials depending on minimizing the wastes .

في الشركة يجب ان تكون دائرة العقود و المشتريات على دراية بمبادئ الادارة الرشيقة لتضمن عقود توريد المواد على اساس تقليل نسب الضياع .

Yes ☐ No ☐

3- The organization should have an effective human resource department in order to have efficient recruitment process.

يجب ان تكون دائرة المواراد البشرية في الشركة فعالة لتضمن تطبيق عملية التوظيف بشكل فعال

Yes ☐ No ☐

Appendix B

The Arabic Version of the Questionnaire about (Towards Enhancement of Lean Practices in the West Bank Construction Industry)

استبيان عن

تعزيز ممارسات الادارة الرشيقة في صناعة الانشاءات الفلسطينية بالضفة الغربية

عزيزي المقاول :

بداية اود ان اشكركم على الوقت الثمين الذي تبذلونة في تعبئة هذا الاستبيان.

هذا الاستبيان يهدف الى دراسة العوامل التي تدعم نجاح تطبيق ممارسات الادارة الرشيقة (lean practices) في صناعة الانشاءات الفلسطينية في الضفة الغربية .

ممارسات الادارة الرشيقة تعتمد على تطوير و تحسين القيمة النهائية للمنتج كما تعمل على تقليل نسب الضياع (Wastes) خلال مراحل تنفيذ المشروع .

هذه الدراسة تحدد العوامل الاساسية الضرورية لبناء نموذج يدعم نجاح تطبيق هذه الممارسات علما ان المعلوما ت التي يحتويها هذا الاستبيان سوف تستخدم فقط للبحث العلمي .

شاكرين لكم تعاونكم ،،،،

.

الباحث

م. واثق محمد أبو عبيد

نبذة عن الإدارة الرشيقة: -

الإدارة الرشيقة هي احدى الطرق الإدارية الجديدة التي تعمل على تطوير وتحسين إنتاجية، فعالية وجودة المنتجات للشركة. ظهر هذا النوع من الأساليب الإدارية بعد الحرب العالمية الثانية في قطاع الصناعات للشركة و خصوصا في صناعية السيارات حيث تم تطويره على يد العالم (Ohno 1988) في شركة تويتا و بعد ذلك دخل هذا النوع من الإدارة في صناعية الطائرات و السيارات بأمريكيا و اليابان.

يقوم هذا النوع من الإدارة على خمسة مبادئ أساسية تعنى بتطوير وزيادة كفاءة العملية الإنتاجية عن طريق تقليل نسب الضياع و الغاء أي نشاطات غير مهمة في العملية الإنتاجية و المبادئ الخمسة هي :-

1- تحديد قيمة المنتج (Value) و يتم تحديدها بالرجوع الى مدى رضى الزبون عن المنتج .
2- تحديد سير العمليات (Value stream Mapping) و يتم من خلالها تحديد سير المواد و المعلومات اللزمة للمنتج من المورد و حتى وصول المنتج الى الزبون .
3- تحديد العملية (Flow) و يتم الاعتماد بها على الغاء أي نشاطات غير مهمة بالعملية الإنتاجية.
4- اعتماد مبدأ السحب (Pull approach) حيث يتم اعتماد التوريد للمواد فقط عند الحاجة مما يقلل من نسب المخزون .
5- تحقيق التطوير المستمر في العملية الإنتاجية (perfection) حيث يعتمد على تصميمي وتطوير العملية بشكل مستمر.

ولتحقيق هذه المبادئ الخمسة تم تطوير عدة أساليب وطرق إدارية خاصة يتم اتباعها لتضمن تطبيق هذه المبادئ. في عام 1992 دخلت هذه الممارسات قطاع الانشاءات وتم تطبيقها في معظم دول العالم حيث أبدت فعالية عالية في تقليل نسب الضياع في المشاريع الانشائية ومازالت الأبحاث مستمر لتطوير و تعزيز و غرز هذه الممارسات في صناعة الانشاءات.

معلومات عامة عن الشركة

1. موقع الشركة

شمال الضفة الغربية ☐ وسط الضفة الغربية ☐ جنوب الضفة الغربية ☐

2. خبرات الشركة بتنفيذ المشاريع

أقل من 5 سنوات ☐ من (5-10) سنوات ☐ من (11-15) سنة ☐ أكثر من 15 سنة ☐

3. رأس مال الشركة بالدولار

أقل من 100,000 ☐ (100,000 -250,000) ☐ (250,000-500,000) ☐ ا كثر من 500 ☐

4. **معدل حجم المشاريع التي نفذتها الشركة بدولار**

(100,000 -250,000) ☐ (250,000-500,000) ☐ (500,000- مليون) ☐ اكثر من مليون ☐

5. **عدد الموظفين العاملين بالشركة**

من (1 -9) ☐ من (10-19) ☐ من (20-30) ☐ أكثر من 30 ☐

6. **عدد الموظفين العاملين بعقود بالشركة**

من (1 -4) ☐ من (5-9) ☐ من (10-15) ☐ أكثر من 15 ☐

7. تصنيف المقاول حسب اتحاد المقاول الفلسطينيين

الدرجة	أولى	ثانية	ثالثة	رابعة	خامسة
ابنية	☐	☐	☐	☐	☐
طرق	☐	☐	☐	☐	☐
مياه ومجاري	☐	☐	☐	☐	☐

الجزء الثاني :-

يقيس هذا الجزء مدى إدراك المقاول لمؤشرات نجاح تطبيق مبادئ الإدارة الرشيقة (Lean management)

يرجى وضع (√) للدرجة التي توافق بها مع الجمل التالية :-

الرقم	مؤشرات نجاح تطبيق الإدارة الرشيقة (lean management)	غير موافق بشدة	غير موافق	محايد	موافق	موافق بشدة
1	تهتم شركتم بتقليل نسب الضياع (wastes) بالمواد , النقل للمواد و العمال , المواصلات وحركة المعدات , مستوى المخزون , وقت الانتظار, الافراط بالإنتاج و المبالغة بالوقت اللازم لإتمام النشاطات					
2	.أنتم على استعداد للقيام باي تغيرات اثناء المشروع من شانها زيادة قيمته للمالك.					
3	تتبعون في شركتكم أدوات أو معايير خاصة مع مثل إدارة الجودة الشاملة، ISO 9000أو غيرها لضبط الجودة.					
4	تتبعون في شركتكم ادوات و معايير لقياس سرعة المشروع مثل حساب (مؤشر أداء الجدول الزمني SPI, نسبة الأعمال المنجزة PPC , الخ).					
5	تتبعون في شركتكم ادوات و معايير لقياس تكلفة المشروع مثل حساب (مؤشر أداء تكلفة المشروع CPI , تصميم القيم المستهدفة TVD)					
6	يقاس نجاح الشركة من خلال الإيرادات العالية من المشاريع المنفذة					
7	تعتمد شركتكم على الأساليب الإدارية التي تعنى بالجودة و تقليل نسب الضياع من اجل تحقيق نسب أرباح عالية					
8	وجود أساليب إدارية جديدة تعنى بتحسين الجودة والزمن والتكلفة امر ضروري لتحقيق ميزة تنافسية.					

الجزء الثالث :-

يقيس هذا الجزء عوامل نجاح تطبيق الإدارة الرشيقة (Lean management) يرجى وضع (√) للدرجة التي توافق بها مع الجمل التالية :-

	عوامل نجاح تطبيق الإدارة الرشيقة	غير موافق بشدة	غير موافق	محايد	موافق	موافق بشدة
	أنظمة الادارة و التخطيط **Management and planning systems**					
1	تحديد نسب الضياع من خلال ممارسات إدارية جديدة أمر ضروري لتحسين الجودة والتكلفة والوقت.					
2	تخطيط سير المواد والمعلومات لأي نشاط يساعد في تحديد النشاطات الغير مهمه					
3	إعداد مخطط غانت على أساس مبد أ السحب والذي يعتمد على تاريخ نهاية النشاط قد تقلص من نسب الضياع					
4	توريد المواد المناسبة في الكميات والجودة الصحيحة فقط عند ما نحتاج اليها تساعد على تحسين الأداء من خلال انخفاض مستوى المخزون، وخفض تكلفة الجودة.					
5	من الأمور المهمة للمشروع ان تكون الجودة مسؤولية كل شخص بالمشروع .					
6	اعتماد نماذج مثل دورة ديمنغ (خطط ،طبق ،دقق ،نفذ) يساعد على أن يكون هنالك تطور مستمر.					
7	تجزئة المشروع الى أنشطة مع وجود الجداول التي تبين المسار الحرج و النقاط المهمة يساعد على إتمام المشروع في الوقت المحدد.					
8	ضبط التباين في خطة المشروع يحافظ على اتمام المشروع في الوقت المحدد					
9	وجود خطط عمل أسبوعية تزيد من فعالية الموظفين .					
10	وجود مخططات توضح نسب الانجاز تساعد في تحديد نسب الانحراف عن المخطط .					
11	التزام الإدارة ضروري لاعتماد ممارسات إدارية جديدة.					
12	القيادة والإدارة المتميزة هي واحدة من العوامل الحاسمة التي تدفع لنجاح تنفيذ الإدارة الرشيقة (lean management) .					
13	مشاركة الادارة العليا و دعمها مهم لنجاح تطبيق ممارسات الادارة الرشيقة (lean management)					
	عوامل نجاح تطبيق الإدارة الرشيقة	**غير موافق بشدة**	**غير موافق**	**محايد**	**موافق**	**موافق بشدة**
	العوامل البشرية **Human factors**					
14	ظروف العمل , سياسات الشركة , الرواتب , الحوافز					

	, طول مدة العمل و معدل تغير الموظفين ضرورية لتحقيق الرضا الوظيفي كما تعتبر دافعا إيجابيا لتقبل اي تغير .					
15	الشعور بعدم الراحة بالعمل يؤدي الى تقليل دوافع العمل عند الموظفين و تقليل الفاعلية و الانتماء.					
16	التزام الموظفين اتجاه اهداف وقيم الشركة يزيد من انتاجيتهم.					
17	قدرة الموظفين على المشاركة في اتخاذ القرار ضروري لتقيل نسب الضياع و تحسين الجودة					
18	وجود رؤية لقبول التغير أمر ضروري لنجاح تطبيق الادارة الرشيقة (lean management) .					
19	وجود دورات في الادارة الرشيقة تحسن من اداء الموظفين .					
20	توظيف موظفين لديهم خبرة بأساليب الادارة الرشيقة (lean management) يحسن اداء الشركة .					
21	وجود طواقم كافية من العمالة المدربة مهمه لنجاح و نمو الشركة .					
22	تتبعون في شركتكم أساليب لمشاركة الافراد في تحمل المسؤوليات و حل المشكلات و ذلك لضمان زيادة انتاجيتهم					
23	تتبعون في شركتكم وسائل اتصال جديدة و متقدمة لتحسين عمل الأفراد ضمن فريق					
24	تتبعون بشركتكم أساليب لتعزيز عمل الأفراد ضمن فريق لضمان زيادة انتاجيتهم و جودة عملهم و زيادة وسائل الأمان بالموقع					
25	وجود تواصل جيد بين الادارة العليا والموظفين و بين الموظفين أنفسهم يقلل من زمن اتخاذ القرار.					
26	التواصل الجيد يؤدي الى العمل ضمن فريق .					
27	وسائل الاتصال الجيدة تساعد بنجاح تطبيق اساليب الادارة الرشيقة (lean management)					
	عوامل نجاح تطبيق الإدارة الرشيقة	**غير موافق بشدة**	**غير موافق**	**محايد**	**موافق**	**موافق بشدة**
	عوامل خاصة بالشركة Organizational factors					
28	ثقافة الشركة (الانفتاح , التعاون , التقبل) مهمة في تحسن اداء الموظفين .					
29	وجود استراتيجية شاملة للشركة (رؤية و هدف) مهم في تحسن اداء الشركة .					
30	اي نظام اداري جديد بحاجة الى تغير في ثقافة الشركة .					
31	وجود دورات تدريبية في اساليب الادارة الرشيقة (lean practices) يؤدي الى نجاح تطبيقها					
32	مقدرة الشركة المالية للاستثمار في تدريب الموظفين مهمة لنجاح تطبيق الادارة الرشيقة (lean management)					

33	لنجاح تطبيق ممارسات الادارة الرشيقة (lean practices) الدورات التدريبية يجب ان تشمل المقاولين الرئيسين و الفرعين					
34	وجود ثقافة داعمة في المؤسسة أمر ضروري لنجاح تطبيق الادارة الرشيقة (lean management)					
35	الانفتاح , المشاركة و مشاركة المعلومات عوامل ضرورية لنجاح المؤسسة					
36	وجود تواصل مفتوح بين المقاول الرئيسي و الفرعي ضروري لتحسين اداء الشركة					
37	وجود وحدة للبحث والتطوير بالشركة امر حيوي لتطوير اداء المؤسسة .					
38	من المهم للمشروع ان تفكر بابتكارات جديدة لتنفيذ النشاطات .					
39	تبنى تكنولوجيا الانشاءات الجديدة ضرورية لتطوير اداء الشركة					

الجزء الرابع : العقود

يرجى الإجابة ب (نعم او لا) للأسئلة التالية

1 - العقود التي تحكم عملية تنفيذ المشروع يجب ان تكون بمشاركة المالك , المقاول الرئيسي و المقاول الفرعي

نعم ☐ لا ☐

2- في الشركة يجب ان تكون دائرة العقود و المشتريات على دراية بمبادئ الادارة الرشيقة لتضمن عقود توريد المواد على اساس تقليل نسب الضياع .

نعم ☐ لا ☐

3- يجب ان تكون دائرة المواراد البشرية في الشركة فعالة لتضمن تطبيق عملية التوظيف بشكل فعال

نعم ☐ لا ☐

جامعة النجاح الوطنية
كلية الدراسات العليا

تعزيز ممارسات الإدارة الرشيقة في صناعة الإنشاءات الفلسطينية/ الضفة الغربية

اعداد
واثق محمد أبو عبيد

أشراف
د. محمد عثمان

قدمت هذه الاطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية بكلية الدراسات العليا ، في جامعة النجاح الوطنية ، في نابلس – فلسطين .

2016

تعزيز ممارسات الإدارة الرشيقة في صناعة الإنشاءات الفلسطينية / الضفة الغربية

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الملخص

يعتبر قطاع الإنشاءات في فلسطين إحدى أهم القطاعات التي تدعم وتشجع الاقتصاد الفلسطيني، إن هذا القطاع وبالرغم من أهميته ما زال يواجه مشاكل عديدة ذات علاقة بالوقت والتكلفة والجودة، الامر الذي جعل النظام الإداري التقليدي المتبع في إدارة المشاريع غير كاف وأصبح هذا القطاع بحاجة الى أساليب إدارية جديدة مثل أساليب الإدارة الرشيقة.

إن الهدف الأساسي من هذا البحث هو قياس وتعزيز الوعي والفهم لمبدأ الإدارة الرشيقة في صناعة الانشاءات الفلسطينية والتحقق من العوامل الرئيسية التي تدعم تطبيق هذه المبادئ بما يخص أنظمة الإدارة والتحكم المتبعة في المشروع والعوامل البشرية وعوامل خاصة بالمؤسسة والعقود، بالإضافة الي تحديد مؤشرات النجاح الخاصة بتطبيقه.

اعتمد هذا البحث بشكل أساسي على المنهج الوصفي والتحليلي وأسلوب الدراسة الميدانية، حيث تمت مراجعة الدراسات والأبحاث السابقة المتعلقة بهذا الموضوع، ومن ثم عمل استبيان يستهدف شركات المقاولات في الضفة الغربية، فقد تم تصميم الاستبيان وتوزيعه على عينة مكونة من 153 شركة مقاولات.

أوضحت النتائج أن هنالك إتفاق بين المقاولين على الأثر الإيجابي لتبني أساليب إدارية جديدة ونجاح تطبيق الإدارة الرشيقة ومن هذه الأساليب: إدارة الجودة الشاملة، تحديد نسب الضياع، رسم مخطط سير العمليات، التوريد عند الطلب، تبني مبدأ السحب للعمليات والتخطط للمشروع بالإضافة الى الأثر المهم لوجود إدارة عليا داعمة.

لقد أشارت النتائج كذلك الى أن هنالك اتفاق بين المقاولين على عوامل تدعم نجاح تطبيق الإدارة الرشيقة تخص العوامل البشرية مثل سلوك الموظف الإيجابي والخبرات والمعلومات وغيرها، بالإضافة الى عوامل خاصة بالمؤسسة مثل ثقافة المؤسسة والتدريب والتنسيق والإتصال وغيرها. كما أظهرت النتائج إن هنالك دور مهم للعقود بضبط كل هذه العوامل والعلاقات. في نهاية الدراسة تم ربط كل هذه العوامل بإطار عمل يوضحها ويظهر أثرها على نجاح تطبيق الإدارة الرشيقة. بالإضافة إلى ربط هذه العوامل بعلاقة رياضية تمكن الشركات من التنبؤ بمدى نجاح تطبي الإدارة الرشيقة إذا كانت قادرة على قياس هذ العوامل المختلفة .

أوصت الدراسة جميع المقاولين بضرورة الإستفادة والتعلم مما تم تنفيذه من مشاريع سابقة وذلك لتقيم وتحديد نقاط القوة والضعف الخاصة بهذه العوامل وذلك من أجل تطويرها، على أن يتم تقيم أثر هذا التطور من خلال مراجعة مؤشرات نجاح الأداء. كما أوصت الدارسة المالكين بوضع شروط إلزامية في العقود تدعم تطبيق مبادئ الإدارة الرشيقة.