T.C.
İSTANBUL KÜLTÜR UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

EXAMINING THE IMPLEMENTATION AND EXECUTION OF LEAN THINKING AND TOOLS IN CONSTRUCTION SECTOR IN DEVELOPING COUNTRIES

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Department: Industrial Engineering

Program: Engineering Management

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June 2023

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2100000143

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ACKNOWLEDGEMENT

I would like to express my gratitude to all those who gave me the possibility to complete this study. I want to thank Dr. Duygun Fatih Demirel for all hishelp and advice with this study. I would like also like to thank my family, I also would like to thank Istanbul kultur university that allowing me to conduct this thesis through it.

Date: 4-6-2023 Masa MutaweOdeh

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

LM Lean managment

LCM lean constucrion management

PCA principal component analysis

KMO Kaiser-Meyer-Olkin Test

Üniversite	**: İstanbul Kültür Üniversitesi**
Enstitü	**: Lisansüstü Eğitim Enstitüsü**
Anabilim Dalı	**: Endüstri Mühendisliği**
Programı	**: Mühendislik Yönetimi**
Tez Danışmanı	**: Dr. Öğr. Üyesi Duygun Fatih DEMİREL**

ÖZET

GELIŞMEKTE OLAN ÜLKELERDE INŞAAT SEKTÖRÜNDE YALIN DÜŞÜNCE VE ARAÇLARININ UYGULANMASI VE YÜRÜTÜLMESININ INCELENMESI

Masa MutaweOdeh

Filistin, inşaat sektörü ile ilgili birçok sorunla karşı karşıyadır; maliyet, zaman aşımı, performans kalitesi ve yönetim gibi konular. Bu sorunlarla başa çıkmak için, bu tür problemleri çözmek için yeni bir yaklaşım olan azaltmalı yönetim prensiplerine başvurulmalıdır.

Bu çalışma, gelişmekte olan bir ülke olan Filistin'de, azaltmalı düşünce ve araçların uygulanması ve yürütülmesini etkileyen engelleri ve bunların yapı siteleriyle ilgili atık üzerindeki etkisini araştırmayı amaçlamaktadır. Bu amaçla, inşaat şirketleri, mühendisler, inşaat işçileri ve Ramallah endüstriyel başkentinde ve Nablus'ta uzman kişiler tarafından doldurulan bir anket kullanılmıştır. Toplanan örneklem 91 yanıt içermektedir. Bu yanıtların SPSS yazılımında uygulanmasıyla sonuçlar 1- Prensip bileşeni analizi, 2- güvenilirlik analizi, 3- çoklu regresyon ve korelasyon analizi ve 4- bağlantı ve korelasyon ölçüsü yoluyla bulunmaktadır.

Sonuç, planlama ve yönetim konularının azaltmalı yönetim prensiplerinin başarıyla uygulanmasında önemli bir etkiye sahip olduğunu göstermektedir. CC = + 0.167 * C1 formülü ile, C1 planlama ve yönetim bileşeni iken CC çekirdek kavramdır.

Bu çalışma, inşaat şirketleri ve üniversitelerde bu müfredatlarla ilgili sürekli gelişime devam etmeleri ve projelerinde LCM'yi uygulamaları konusunda öneriler sunmaktadır, böylece yönetim sorunları üzerinde üstesinden gelinir.

Anahtar kelimeler: inşaat projeleri, Görsel yönetim, planlama ve yönetim.

University	**: İstanbul Kültür University**
Instittute	**: Institute of Graduate Studies**
Department	**: Industrial Engineering**
Program	**: Engineering Management**
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ABSTRACT

EXAMINING THE IMPLEMENTATION AND EXECUTION OF LEAN THINKING AND TOOLS IN CONSTRUCTION SECTOR IN DEVELOPING COUNTRIES

Masa MutaweOdeh

Palestine faces many issues within the construction sector, including cost, time overrun, performance quality, and management. To deal with these issues, the industry must adopt lean management principles as the new approach to solving such problems.

The study aims to investigate the obstacles that impact the execution of lean thinking and tools in Palestine as a developing country and its impact on waste related to construction sites through a questioner which filled out by the target sample of construction companies, engineers, construction workers and expertise in Ramallah the industrial capital and Nablus. The collected sample was 91 responses. These responses are applied in SPSS software to find results through 1- principle component analysis, 2- reliability analysis, 3- multiple regression and correlation analysis, and 4- measure for association and correlation.

The result shows that Planning and management issues significantly affect the execution of lean management approaches successfully. With the formula of CC= +0.167 *C1. Where C1 is the planning and management component, and CC is the core concept.

This study recommends that the construction companies and the education system regarding these university curriculums must keep continuous improvement related to the knowledge regarding lean construction management approaches, and apply LCM in their projects, to overcome the management issues.

Keywords: lean construction management, construction projects, Just In Time, Visual Management, planning, and management.

1. INTRODUCTION

This study aims to investigate to what extent developing nations are adopting lean principles in the construction industry. The construction industry faces considerable challenges in developing productivity and quality for the construction sites, as (Abdelhamid, 2004) presented. Gaining the desired results through smooth work phases to minimize waste will depend on more than a suitable construction plan. However, it also requires an additional significant construction management thinking and implementation. In order to achieve the highest value feasible, lean construction is described as "a strategy to design production phases to eliminate materials,time and labor waste" (Koskela et al., 2002). Lean construction, according to Abdelhamid (2008), is a comprehensive facility design and delivery philosophy with the determining objective of maximizing value for all stakeholders synergistic, and continuous development to contract terms, product design, technique selection for the construction process, supply chain, and workflow dependability on the building site.

In the early 1990s, LC became popular. The International Group for Lean Construction coined the phrase "Lean Construction" during its first conference in 1993 (Abdelhamid 2004). According to Abdelhamid (2007), lean construction involves the comprehensive operation of parallel and continuous improvements in all construction and environmental aspects, including design, construction, implementation, activation, maintenance, salvage, recycling, and reuse. The purpose of the lean method is to supervise, control, and enhance building procedures while keeping costs low and adding value to the client (Koskela et al., 2002).

Adopting the "lean" concept means minimizing waste throughout project phases and sustaining a constant flow of materials in a production line (Abdelhamid, 2007). When LC principles are used to eliminate waste and maximize productivity, process stages, materials utilized, and actions required are frequently reduced. As shown by Nahmens and Ikuma (2009), these modifications will help to reduce the likelihood of an accident or exposure to hazards.

A revolutionary approach to managing construction is lean thinking. It was obtained to restructure performance concerning three ideal conditions: (1) a completely customized product, (2) instant delivery, and (3) no inventory in stores. These ideal conditions lead to increase waste reduction with value maximization (Ballard1999).

The lean idea requires establishing units of multi-skilled professionals a team leader leads. Any action should be done within the team's operation process, and instructions must be executed by team members working together to update and expedite productivity. The elimination of rework steps is part of the lean manufacturing process because rework should not be a part of the manufacturing process or processes (Almeida, 2002).

Womack and Jones (2003) list five fundamental tenets of lean production: Create Flow creating, Pull establishment, Perfection, identify value, the value stream's mapping.

Throughout the project life cycle, lean affects how operational stages are completed. A lean production proccess aims to optimize quality and reduce waste to be applied to particular approaches in a new project delivery process.

1.1. Background information

1.1.1. Concept of lean management

Organizations could use the lean concept of thinking as a management control tool to increase productivity, efficiency, and product or service quality. This type of thinking has been discussed by many researchers (Bertelsen, 2004; Alarcon et al., 2006; Antonio, 2002; Ballard, 2000; Abu Ismaiel, 2013; Johansen & Walter, 2007). System production of toyota was established in Japan following World War II, which depended on the fluctuating demand. A model for a mass production system was expanded by Ohno (1988), which grew the management ideology. Koskela (1992) presented that Ohno developed lean thinking to improve new strategies for production systems which were identified based on the production's implementation.

While lean management is A new perspective on managing and controlling construction sites, creating a lean atmosphere space in the workplace involves highly - anticipated and effective planning. On a daily basis, all levels of an organization must put in their total effort and work together to achieve enhanced efficiency and waste reduction, resulting in increased production, quality, and safety (Anvari et al., 2011).

Adopting lean construction tools to the construction sector may assist in resolving the difficulties that occur during work phases. However, if not managed correctly, lean construction is risky and needs special knowledge to be implemented. A detailed assessment of the obstacles is required to implement lean construction concepts and raise the likelihood of achieving the goal of eliminating waste.

1.1.2. Construction industry

In addition to maintaining, repairing, and rehabilitating existing infrastructures, construction is defined as the act of producing all forms of physical infrastructure, superstructures, and related facilities (Wells, 1984). Construction is a broad industry with an economic aspect that encompasses many stakeholders and is intricately tied to industrial disciplines such as materials used, labor, energy, finance, and equipment (Hillebrandt, 1985).

Koskela (1992) lists four construction-related factors, which are briefly mentioned below:

- The uniqueness of each project.
- Construction site.
- Short-term multi-organization
- Regulation of action

Koskela also categorizes additional elements exclusive to this sector, such as cost, reliability, complexities, and uncertainties.

According to (Salim, 2010) construction industry includes four categories:

- Large-scale and heavy construction sector.
- Residential building sector.
- Industrial Commercial sector
- Institutional sector.

While Moavenzadeh & Rossow (1975) Presented Two general classifications for the construction industry sector: 1- repetitive and routine operations that achieve the requested requirements, such as factories, buildings, bridges, and industrial facilities. 2- Social and complex services that satisfy demands that only arise occasionally, such as large structures and power plants.

Paez et al. (2005) asserts that construction is the project's final form on the land, which will exist after completing all its steps. Since each site is distinct due to its circumstances, the variety of priorities and expectations of customers and designers impact the manufacture of unique products (Warszawski, 1990).

1.1.3. Construction management

Project management and project execution are linked. Among the most significant aspects influencing operations performance is managing project activities in the construction sector. After studying 15 case study the United Kingdom by Adams and Brown (2000), they observed impacting Building Project Management (BPM) on time, cost, quality, and performance was unsuccessful in managing the performance in accordance to Timing, cost, and quality are the three main performance evaluation factors, as planned.

The elements influencing these improvements were examined by the researchers in order to enhance construction efficiency. Lehtonen and Wegelius (2001) for continuous input on operational activities, senior manager and operational managers of the organization were both studied. According to (Ng et al., 2002), recording and storing implementation reports will benefit business reference, mostly for resolving claims disputes and maintenance and repair projects.

Cheung et al. (2004) studied the relation between the managers of projects and their performance of it. They discovered that creating a system for monitoring project performance as Web-based will help project managers track and project performance assisment.

According to Karim and Marosszeky (1999), the building projects industry's efficiency and key performance indicators (KPIs) include cost, quality, time, and client satisfaction, as well as owner changes, line of work, and performance of the organization, as well as health and safety issues throughout all stages of construction projects.

Several difficulties and obstacles affect the construction sector; some have already exited, and some are fresh to the industry as (Muir, 2005) presented the majority of these difficulties are caused directly by construction actions, while others are generated by indirect activity. Furthermore (Ofori, 1980) mentioned that no country is unaffected by the significant issues and challenges that these sectors experience among all the project phases despite the construction project type, but in general, developing nations struggle with more difficulties and complexity while it has limited resources.

Regarding (Moavenzadeh & Rossow, 1975), there are four major categories of challenges facing the construction sector throughout the construction phase :

- Managerial
- Financing
- manpower
- and supplies.

In developing countries, difficulties with labor (manpower) and workers management arise since it often relies on training, managing development, and skills which take considerable time and effort. (Moavenzadeh & Rossow 1975).

While it also needs to work on issues relevant to the capital, such as high financing costs, a limitation of credit for renting out equipment, cost overruns, and holding back the rest of the payment as a deposit to protect against defective building. Besides the shortage of supplies in local markets has become one of the primary concerns regarding materials used during construction in developing nations, the expense of construction materials is critical regarding both transport costs and the volume of manufacturing, alongside materials' production, which includes problems in quality, safety, and monitoring. (Moavenzadeh & Rossow 1975).

1.1.4. The construction industry in Palestine

According to Abu Shaban (2008), the building sector will keep on playing an important part in Palestine's economy. Furthermore, the industry of construction is known as a complicated sector that faces numerous challenges and issues, such as low productivity, quality goods, profit margins, and an unfortunate on-site working environment (Abu Shaban,2008). As a result, the construction sector must develop new operational processes and technologies to become more competitive change its shape, and gain more benefits. With all of the significant technical advancements, global connectivity, and tremendous competition, traditional management techniques, tools, and processes could no longer achieve the same satisfactory results or increase a the performance of the company (Kotter,2007). The ability of firms and employees to respond, decide, and act to conduct and adjust to change is critical to their success (Kotter,2007). (Mertins and Jochem, 2001) argued that a company's ability to modify and adapt to new situations and conditions successfully is a significant advantage since the efficient restructuring of change processes demands the use of certain methodologies and tools. Another competitive advantage arises from seeking for alternatives to gain lower production costs during the process of construct and improve products quality. Lean construction is a new management strategy that has been proposed as a strategy to enhance a construction company's performance (LCI, 2012). "Drive more value by using less of everything" is the core theme of the lean management principle.

1.2. Aim of the study

This research aims to study the implementation and execution of lean thinking and tools in Palestine (developing countries) and its impact on reducing waste related to construction sites. Besides surveying to determine to understand the idea of lean thinking. Hence, the objectives of this study listed below:

- Identify the lean construction management approaches and determine the tools that have been applied so far and to what extent they have been applied.
- Identify the barriers that impact the execution of some tools.
- Identify the KPI of lean managmanet.

1.3. Thesis questions

- What are the applied techniques of LM implemented?
- What are the applicable tools of lean management that need to be considered in the industry of construction in Palestine ?
- What are the reasons that affect the execution of both groups, and to what extent?

1.4. Hypothesis

Knowing that the current construction industry has its' obstacles and issues that impact the workflow process in Palestine, like; poor understanding of the term "lean management," low health and safety conditions, inadequate skilled workers, cost overruns, insufficient output, etc. If new managerial concepts such as lean construction are efficiently adopted, all of the aforementioned issues can be resolved depending on the relationship between the engineers, workers, designers, and engineering companies’ skills and experiences with the effective implementation of lean management tools.

Furthermore, the impact of the coordination and the vertical and horizontal hierarchy communication between employees on LM execution.

1.5. Research Significance

This research aims to highlight the development of the management side in the construction industry in Palestine, which has remarkable importance on it.

It aims to study two cities in Palestine (Ramallah as the economic capital, and Nablus as the second ecomomic city in Palestine) to test the application of the LM tool, which will lead to developing a framework plan that will be considered to apply the LM techniques in the most appropriate way taking into consideration all the barriers and obstacles that may occur during the phases of the project. This research is more specific than the general study made in 2016 in Palestine to test only the knowledge of LM in engineering companies in the west bank while they used the traditional way of building in Palestine.

1.6. Structure of Thesis

This research includes five chapters which are;

- Chapter One: Introduction part that includes the background, aim of the study, thesis questions, hypothesis, and research significance.
- Chapter two: consist of literature review.
- Chapter three: is the steps of methodology and
- Chapter four: contains the implementation and results.
- Chapter Five: This part is about the conclusion and reccomendation of this research.

2. LITERATURE REVIEW

2.1. Lean Construction Approach Management

In order to achieve the highest value feasible, According to Koskela et al. (2002), "a strategy to design production phases to eliminate waste of materials, time, and labor" is what lean construction is.

According to Abdelhamid (2007), lean construction involves the comprehensive operation of parallel and continuous improvements in all construction and environmental aspects, including design, construction, implementation, activation, maintenance, salvage, recycling, and reuse. The purpose of the lean method is to supervise, control, and enhance building procedures while keeping costs low and adding value to the client (Koskela et al., 2002).

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2.2. Waste of Construction

Wastes occur due to inadequately managed processes, resources, and techniques, which extends and adds to the cost of the production process, Liker (2004). The difficulty in minimizing the waste guides the waste classification procedure in project phases linked directly to the construction industry.

Identifying the waste types required to eliminate it using the best procedure. The seven categories of waste are classified as: shipping, storage, movement, waiting, overproduction, over-processing, and defects Christina (2019).

Construction waste-generating phases are categorized by Bossink and Brouwers (1996) into six groups:

- Designing
- Procuring
- storage of material
- operations
- remaining (Debris)
- Other

While Garas et al. (2011) classified the waste types related to time and material as follows:

Waste of time because of:

- waiting durations
- stoppages
- observations
- Informational inconsistency
- inadequate performance
- the interconnections of specialties
- delays
- unexpected equipment damage

Materials waste related to:

- ordering excessively

- extra manufacturing
- improper handling
- uncontrolled storage
- defected production
- destruction

Figure 1 presented by Raghavan (2014) describes the waste causes for four categories of waste: material, quality, labor, and equipment.

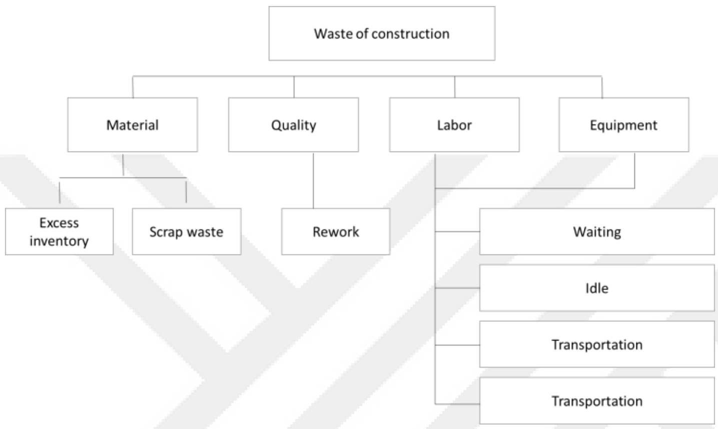

Figure 1: Construction Waste Classification (Raghavan et al., 2014)

2.3. KPI of lean construction

The following there are two types of KPIs:

- Operative performance indicators
- Organization performance indicators

2.3.1. Operative performance indicators

Operational performance is often used to estimate the quality of a lean implementation. The expressions operational performance and internal process are used equally. During the construction phases, in terms of minimizing expenses and waste, improving product quality, adaptability, deliverables, output, growth, and operational performance represents internal performance (Jeyaraman & Teo, 2010).

Al-Aomar (2012) linked operational performance to the achievement of lean execution; moreover, he presented lean construction key performance indicators (LC-KPIs) as:

Quality (Sigma Rating)

Cost

Speed

Value

Waste

Which is described as:

Sigma Rating value: the quality of the completed tasks, internal or external (related to the project itself); this value will be found at each task's end of each period. Which will also be compared with the company plan and standards to measure the quality of the project.

Waste and value: These are the KPIs that show to what extent the LM tools are implemented and measure the results of adopting it in construction phases,

Table1 Describes five studies that show the KPIs of lean construction:

Table 1: Lean construction KPIs.

Source / KPIs	Quality	cost	Time	waste	Value
Lema and Samson (2022)	✓	✓	✓	✓	✓
Cheung et al. (2004)	✓	✓	✓	✓	✓
Iyer et al. (2005)	✓	✓	✓	✓	✓
Aakanksha Ingle, (2015)				✓	✓

2.3.2. Organizational Performance Indicators:

This performance presents the financial side, which includes: 1- revenue, 2- growth, 3- net profits, 4- Profit/revenue, 5- Return on asset, and 6- Aspects that are not financial, such as research and development. This aspect of performance is necessary to reflect the progress of lean implementing Jeyarman and Teo (2010).

2.4. Lean management Techniques

In the construction sector, lean construction adopts lean production rules to minimize waste, maximize production and efficiency, and perform. The reliability of operation and workforce flow is considered to be significant construction criteria; however, LC has transformed the classical perspective of the projects into a unique viewpoint in order to obtain conversion and illustrate the philosophy of production's flows and values, besides minimizing the time cycle of production, waste elimination, and minimizing the liability to vary or change. Consistent improvement, pull production control, and continuous flow has played a strong role in affecting the guides of the application of lean construction (Paez et al., 2005).

Lean construction tools were categorized into three types of operative approaches , as shown in Table 1 (Paez et al., 2005).

Table 2: Categories of Lean Techniques:

Levels	Technique of Lean construction	Related lean tools
level 1	Material kanban cards	Kanban system
Level 2	Visual managment tools Quality managmanet tools Concurrent engineering	Inspection visually Multipurpose design T.Q.M
Level 3	Last planner system Plan conditions of work enviroment regular huddle reports	Kanban system Production leveling Toyota verification of assembly line

Table 2 presents the Classifications of Lean tools levels explained as Straight implementation for the LC tools in the first level, then a revision done to the techniques, and finally in the third category, which includes the all in all LC tool.

2.4.1. Just In Time (JIT):

This tool presented to be a management theory developed by Toyota Production System shortly after WWII that focuses on three core perspectives: people, plants, and framework structure. It was initially suggested as a strategy for managing inventory levels. The system began as a management concept aimed at balancing quality and cost (2002, Almeida).

The concept of JIT achieves the tasks of supplying the required materials at the scheduled times and dates; this term was evolved by the Japanese who developed the Toyota Production operation systems, which later transformed into the term lean production system in the English language (Tommelein & YiLi, 1999).

Jorgensen and Emmitt (2008) also stated that the right transportation and inventory requirements are often included to be achieved and ready to be part of the just-in-time (JIT) delivery term.

Based on the fact adopting the JIT system will lead to reducing the cost of material waste and storage. The (just in time) technique minimizes waste in the steps that lead to an increased cost load without value. Moreover, it minimizes overproduction waste through project phases. Some of the essential characteristics of the JIT procedure are: Limiting the number of suppliers, Plant Layout, Defective parts, Setup time, and Flexible workforce (Almeida, 2002).

2.4.2. Visual Management

According to (Salem et al., 2006), visualization and supervision are necessary for the construction procedure phases to avoid uncertainty in the information. Visualization makes identifying and determining the workflow on the construction site much easier.

Based on O'Connor and Swain's (2013) discussion, good visual management achieves consistently high performance through successful communication; furthermore, understanding the plan from a better perspective, the status and achievement of a plan, production, and any activity or problems that have impacted the plan in addition to the condition of any solution to solve any issues that occurred.

2.4.3. Five S Process:

O'Connor and Swain (2013) presented that 5S contributes to a structured process to achieve and develop the basic standard system, organization, and framework of a site construction field. It also ensures efficient operations safely with the lowest level of waste. The (5S) includes codes and rules for the site work organization besides organizing each worker's workspace area to gain maximum efficiency with minimum waste.

While Salem et al. (2006) illustrated that this tool is a five steps process: sort, straighten, standardize, shine, and sustain. This technique generates a clear environment space work to obtain better workflow at the sites of a construction project.

2.4.4. Concurrent Engineering Technique

Paez et al. (2005) defined it as "the simultaneous execution of various development tasks in multidisciplinary teams to obtain an optimal product regarding functionality, quality, and productivity."

Rolstadas (1995) presented that this tool had achieved various team development tasks to gain the preferable outcomes on operation, efficiency, and production.

Moreover, Evbuomwan and Anumba (1998) illustrated that it is a step of tasks to generate the designs and construction procedure to reach the aim of reducing lead times, upgrading quality, and minimizing the financial load by the integration of shop drawings, materials, structure, construction, and execution activities and collaboration in working practices.

2.4.5. Kaizen (Continuous Improvement):

Consistent growth is a fundamental component of the lean manufacturing system (Tazel, 2007). Constant upgrading can be classified into two main classifications: continuous improvement and periodical leaps. Since the commencement of the lean production concept, the approach of constant improvement (Kaizen) has been steady yet continuous (Ohno1988). According to Howell (1999), Systematic approach and operational development are the key elements of lean construction.

Tazel (2007) also discussed that continuous improvement interferes with every step of the process, from the training mechanism and equipment to all the principles of the LC production system. Furthermore, it creates a secure work area space with pleased employees and team members who are also in the scope of work of the Kaizen concept.

2.4.6. Last Planner System (LPS):

Ballard (2000) defined LPS as an approach that creates workflow and guides project variability related to the construction industry sector. LPS became a monitoring tool that focuses on connections between steps, time schedules for tasks, and production controls system to gain improvement for the flow of subsistence. This system provides improvements on the execution team sector side and increases workflow in addition to production unit control.

Based on Aziz and Hafez (2013), the Last Planner System focuses on shift monitoring from the workers to the procedure steps of tasks to improve work through consistent training and corrective behavior to generate production at the most achievable supply chain rate.

As Ballard presented, the most important advantage of the LPS is bringing a realistic plan rather than an idealistic one that may not be feasible.

2.5. The Framework of Lean Construction

According to Johansen and Walter (2007), there must be an integration between LC and the project's phases to achieve the highest value of lean construction techniques, which are presented below:

1. Design phase
2. Procurement phase
3. Management Area
4. Planning and Control
5. Collaboration Area
6. Behavior Area
7. Supply
8. Installation phase.

While Kim and Park (2006) identified the needed base to achieve the aim of lean construction through:

- Production controlling: which includes controlling the workflow and unit production, which depend on the reliability of the flow that will, by default, minimize the workflow variability with a purpose to the total system achievement.

- Work of structure plan: Structuring lean work is a designed procedure that anticipates iteration between the "What" to be constructed and "How" the construction will be done. Moreover, the change in this part related to “ What" without considering "How" (Kim & Park, 2006).

- Human Resource Management: The need to manage and control workers is a complicated process since having a smaller, extremely productive, and highly motivated team is essential. Human resource management (HRM) is important for communication between employees (Kim & Park, 2006).

- System of Production: Elements of production control, including production cycle variability, activity/contract mentality, control systems, lack of understanding, and poor learning, are some of the self-management guidelines suggestions (Lean construction institute,2002)

2.6. Barriers to lean implementation:

Various studies were conducted to identify the difficulties of implementing lean construction, while few types of research were done to examine these barriers (Abdullah, 2009).

Alinaitwe (2009) identified 31 challenges as obstacles to construction companies in Uganda affecting the goal of implementing lean construction successfully. However, he highlighted the main obstacles to implementing LC, including a lack of realistic design, production process, and accessibility of benchmarks. According to Kim(2006), Lean construction was difficult to implement since it took so long to complete each step.

The following obstacles that interfere with the execution of lean approaches have been categorized (Abdullah, 2009):

- Lack of supervision and attention from upper management.
- Difficulties in understanding the lean construction theory.
- Insufficient knowledge of the needs for the lean construction concept
- inadequate lean construction .
- shortage of appropriate instruction from an administrator.
- poor communication between clients, consultants, and contractors
- employees’ behavior and group-working skills
- Additional execution time than the scheduled periods in the implementation plan.

Other Barriers are categorized by (Sarhan, S. and Fox, 2013) into10 categories:

2.6.1. Contracting and Procuring:

According to Mossman (2009), traditional procurement procedures will not build an adequate between parties of the project, which will impact the implementation of lean tools, besides adopting unneeded protocols and procedures; however, improper relationships will appear when one of the parties dominates the other.

To avoid the inclusive participation of all the parties inckuded in the project and separate the designing step from the construction approach, it is necessary to authorize the contractor to deal with the work. It is essential to develop a supportive

atmosphere that emphasizes a direct relationship between the design and construction processes to achieve LC successfully (Abdullah 2009).

2.6.2. Committing to Conventional Management Principles

One of the significant issues to adequately adopting LC concepts is the willingness of construction firms to depend on typical construction thinking rather than considering a new type of thinking (2009) Abdullah et al.

Common 2000 highlights that production difficulties are observed and revised to be dealt with only when a huge mistake is made. While (Mossman, 2000) recommends that organizations wait until an emergency occurs before acting since it may be too late to adopt fresh strategies.

2.6.3. Issues Regarding Finances

financial challenges need to be carefully addressed, according to (Bashir et al., 2010) and Mossman (2009) :

- inflation,
- inadequate project funding, a risky environment for manufacturing,
- missing the required supportive environments to enable lean approaches,
- limited wages
- poor training and learning regarding the needed equipment

2.6.4. Issues Relating to Culture and Human Behavior

Adapting lean thinking techniques through construction phases is a way to eliminate "waste," fosters "continuous flow," and increase customer value requires a creative,

synergistic approach. To improve the benefit of lean construction through the construction phases, the companies need to realign their customs and behavior.

Mossman (2009), Abdullah (2009), and (Common, 2000) illustrated some lines regarding the communication between parties involved in the projects that impact improving the implementation of lean construction successfully, which is:

- absence of collaboration
- lack of self-evaluation
- secretive behavior
- ineffective hierarchy communication.

Moreover, these three researchers observed significant social biases that impacted the framework which defines the qualified subcontractors and employees selection form process.

2.6.5. Education Background Issues

(Abdullah, 2009, Mossman, 2009) presented that although managers, educators, researchers, and professionals from various countries are continuing to disseminate knowledge about lean construction, educational barriers may threaten the adoption of LC.

Among those obstacles are:

- shortage of technical skills
- rejecting new approaches to the HR development
- Inadequate education, inadequate awareness and comprehension
- a lack of teamwork skills

3. METHODOLOGY

This research concentrates on the challenges and barriers which impact the implementation of lean construction (LC) principles. The research adopts six steps starting from identifying the aim of the research up to conducting results; the procedure involves a questionnaire survey and interviews to gather the responses, which are 91 responses since This research adopted findings through questionnaire survey and face-to-face interviews to fill 24 questions for the external variables and five questions for the demographic variables. The collected samples are analyzed in SPSS software. To analyze sequential steps of the methodology includes Principal Component Analysis, Reliability Analysis, Multiple Regression and Correlation Analysis, and finally, Measures for Association and Correlation are performed.

3.1. Methodology steps and flow chart:

Figure 2 explaines the research methodology steps which is starting from defining the aim of the study , target , core concept , external variables and last step were the Questionaire. After all these steps the results was found through principal component analysis , Reliabitly analysis , multipleregression and correlation analysis and finally measure for assovation and correlation.

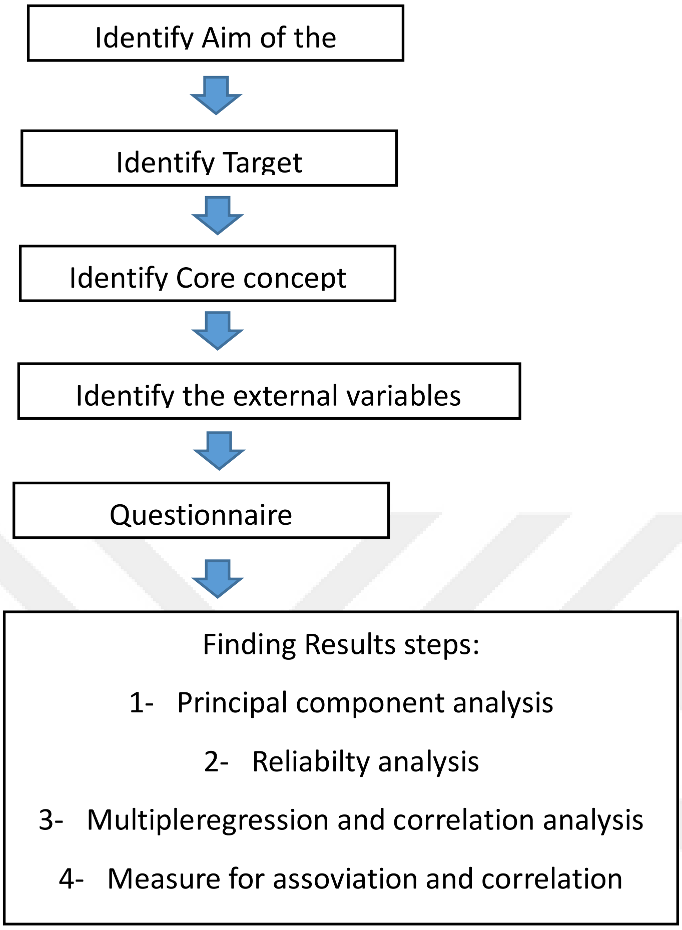

Figure 2: Methodology steps in a flow chart

3.1.1. Aim of the Research and Thesis Questions.

The aim of this paper is to study the execution of lean thinking and tools in Palestine (developing countries) and its impact on reducing waste related to construction sites besides surveying to determine an understanding of the idea of lean thinking. Hence, the aims of this study are :

- LC management principles definitions
- Identify the barriers that impact the execution lean construction management tools.

Thesis questions:

- What are the applied techniques of LM implemented?

- What factors affect the implementation of both groups, and to what extent?

3.1.2. Definition of the Target Population:

The target sample of this research is the Engineering companies, workers, and Consultant engineering offices in:

- Nablus (one of the largest cities, including Al-Najah National University).

- Ramallah (The economic capital).

3.1.3. Definition of the Core Concept:

Identifying the Barriers preventing the successful execution and implementation of principles of lean management.

3.1.4. List of External Variables:

- Lack of realistic design: It affects the efficiency of a lean implementation as it leads to time-wasting during construction time, trying to fix the problem to make it suitable for the site.
- Unprofessional supervising: It impacts the visual management action, an important management tool.
- Difficulties in understanding the theory of lean construction: which lead to unsuccessful lean tools implementation regarding insufficient knowledge about lean management.
- Time overrun: This impact the Just in Time method as it is a strategy for managing inventory levels aimed to balance quality and cost to supply the required materials at the scheduled times and dates.
- Committing to conventional management principles: One of the significant issues to adequately adopting LC concepts is the willingness of construction firms to depend on typical construction thinking rather than considering a new type of thinking (2009) Abdullah et al.
- Unprofessional Production controlling :

  This affects controlling the workflow and unit production, which depends on the reliability of the flow that will, by default, minimize the workflow variability with a purpose to the total system achievement.

- Financial challenges: need to be carefully addressed, according to (Bashir et al., 2010) and Mossman (2009) :
  a. inflation,
  b. inadequate project funding, a risky environment for manufacturing,
  c. missing the required supportive environments to enable lean approaches.
  d. limited wages
  e. poor training and learning regarding the needed equipment
- Skills and Experiences: These will be examined through
  1. Education
  2. Team Work
  3. Horizontal communication.
  4. Training and work background
- Issues relating to culture and human behavior: Mossman (2009), Abdullah (2009), and (Common, 2000) illustrated some lines regarding the communication between parties involved in the projects that impact improving the implementation of lean construction successfully, which is:
  1- absence of collaboration
  2- lack of self-evaluation
  3- secretive behavior
  4- ineffective hierarchy communication
- Inadequate work of structure plan: structuring of lean work is a designed procedure that anticipates iteration between the "What" to be constructed and "How" the construction will be done And the changing in this part related to " What" without considering "How" (Kim & Park, 2006), which will be affected if it is made improperly.
- Communication: Since communication is important to achieve lean management aims, it will be tested through :
  1. Vertical Communication
  2. Horizontal communication
  3. Communication with clients

- Issues regarding Contracting and Procuring: the department of procurement must have knowledge about lean principles regarding having contracts control supply the materials taking into consideration minimize the waste.

- Education background issues: (Abdullah 2009, and Mossman, 2009) presented that although managers, educators, researchers, and professionals from various countries continue to disseminate knowledge about lean construction, it appears that educational barriers may still threaten the adoption of LC.

3.1.5. List of Demographic Variables

- Location
- Years of experiences
- Capital of the company
- Classification of the company

3.1.6. Core Concept Diagram

The following diagram named as figure 3 explained the definition of Core Concept , external variables and demographic variables and the relationship between these factors.

The Core Concept

Identifying the Barriers preventing the successful execution and implementation of principles of lean management.

External Variables

1- Lack of realistic design
2- Lack of supervision and attention from upper management
3- Difficulties in understanding the theory of lean construction

4- Additional execution time
5- Contracting and procuring:
6- Committing to conventional management principles
7- unprofessional production controlling

Demographic Variables

1- Location
2- Years of experiences
3- Capital of the company
4- Classification of the company

8- financial challenges
9- inflation,
10- inadequate project funding, a risky environment for manufacturing,
11- missing the required supportive environments to enable lean approaches,
12- limited wages
13- poor training and learning regarding the needed equipment
14- Skills and Experiences:
15-
16- Issues relating to culture and human behavior
17- absence of collaboration
18- lack of self-evaluation
19- secretive behavior
20- ineffective hierarchy communication
21- Inadequate work of structure plan
22- Communication issues
23- Inadequate lean construction education
24- shortage of technical skills,

Figure 3: Core Concept, external variables, and demographic

3.2. Principle Component Analysis

Principle component analysis (PCA) is categorized as one of the exploratory approaches to factor analysis since it is the initial step of statistical procedures to be applied in research analysis.PCA, is a tool for minimize the number of components in groups by collect variables into a smaller package that keeps most of the large information of set . Moreover, Principle component analysis is a process of extraction determining the groups, factors, or components which will be extracted from the research model (Jaadi, 2021b).

Steps of PCA as follows:

1- Standardize the collection of continuous starting variables

2- Calculate the covariance matrix to discover correlations.

3- identifying the main components, calculate the covariance matrix's eigenvectors and eigenvalues

4- Creating a feature vector For selecting which primary components to preserve

5- Create a feature vector to determine which primary components need to be preserved,

6- Rearrange the data into the axes of the main constituents.

PCA techniques are known as exploratory (descriptive) techniques since it is different from confirmatory approaches because they cannot enable the researcher to predict the number of groups (components or factors) into which the variables would be subdivided in advance (Jaadi, 2021b).

PCA is the mother method for MVDA (multivariate data analysis), which aims to observe trends, jumps, clusters, and outliers by presenting a multivariate data table as a reduced set of variables (summary indices).

The concept was first introduced by Pearson, who defined the analysis as identifying "lines and planes of closest fit to systems of points in space" [Jackson, 1991].

Statistics show that PCA locates lines, planes, and hyper-planes in the K-dimensional space that, as closely as possiblecharacterize the data using least-squares estimation. When employing least squares techniques, the variance of the coordinates on a line or plane that roughly approximations a group of data points should be as large as possible (Jaadi, 2021b).

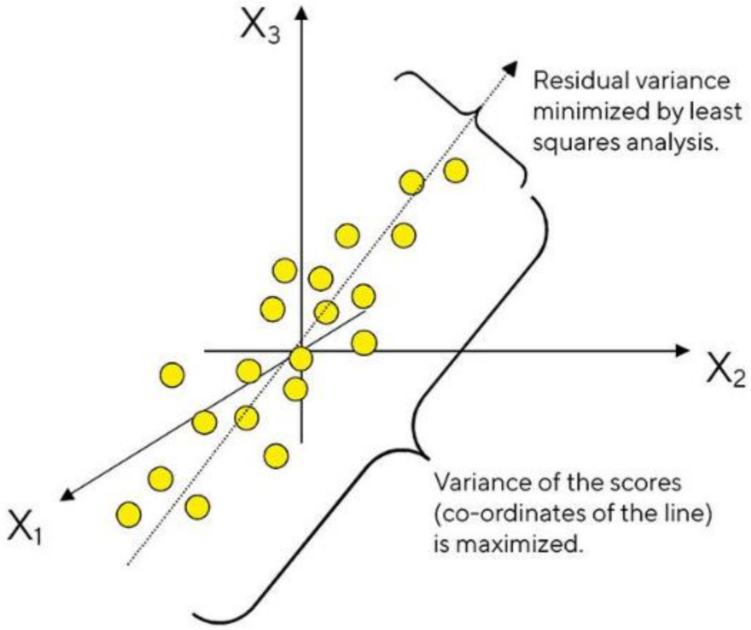

Figure 4: PCA procedure work.

PCA produces a data visualization that maximizes the variability of the projections vectors and reduces residual variation in the least squares sense (Sartorius, n.d.-d).

The number of components is determined by how significant SPSS considers the groups with eigenvalues larger than 1. The target in this situation is to reduce the number of variables by combining the variables into a smaller number of factors.

A specific factor's variables are generated to calculate an exact target. Also, the factor is given a new title based on its values. However, the investigator performs these new names rather than the software itself (Use And Interpret Principal Components Analysis in SPSS, n.d.-b).

The main objective for conducting principle component analysis is to minimize the number of external variables. Moreover, The Kaiser-Meyer-Olkin sampling adequacy coefficient and the Burkitt test for spherical statistics must meet the requirements of the Kaiser-Meyer-Olkin coefficient for the researcher to implement the principal component analysis.

As Stephanie (2021c) explains, The Kaiser-Meyer-Olkin (KMO) Test is a scale to measure to what extent the data is suited for Factor Analysis. While it generates ratings that range between 0 to 1 as the base for analyzing the statistic as follow:

Table 3: KMO scale.

	Status
0.00 to 0.4	Unacceptable
0.50 to 0.59	Miserable
0.60 to 0.69	Mediocre
0.70 to 0.79	Middling
0.80 to 0.89	Meritorious
0.90 to 1.00	Marvelous

If this coefficient is 0.59 or below, this expresses that the group of factors has heterogeneous properties, which means that there is a need to enlarge the number by two means:

- Expand the target sample scale.
- Investigate the kurtosis and skewness coefficients of each model variable.

Equation 1 KMO test's equation:

$$KMO_j = \frac{\sum_{i \neq j} r_{ij}^2}{\sum_{i \neq j} r_{ij}^2 + \sum_{i \neq j} u} \quad (1).$$

Where:

- R = [rij] is the matrix's correlation
- U = [uij] is the partial covariance matrix,
- Σ = summation

The researcher establishes the data table for the principal component analysis findings using the SPSS software output after achieving the KMO values. This data table contains four titles which are:

- number of components extracted

- percentage of explained variation
- labels of components
- composition of variables within each component.

3.3. Reliability Analysis.

In order to test the reliability Frost (2022) explained that Cronbach α. is used as the internal consistency as a measurement tool in SPSS, using the bellow formula:

Equation 2 internal consistency test eqautions

$$\alpha = \frac{N\bar{c}}{\bar{v}+(N-1)\bar{c}} \quad (2)$$

Where:

N = items number

$\bar{c}$ = show covariance between item and another .

$\bar{v}$ = variance of an item.

The information that will be used in this tool must be at an interval scale; however, to achieve internal consistency, the Cronbach α should be 0.70 or higher regarding the Cronbach alpha scale.

There needs to be more than the level of Cronbach alpha to state that an instrument is internally consistent and reliable to achieve that testing and retesting approach or parallels forms should be adopted. Lavrakas, P. (2008), Salkind, N. (2015).

3.4. Multiple Regression and Correlation Analysis

Correlation coefficient presents the degree of interaction and direction of a relationship among variables with a number between -1 and 1. Regression is the mathematical form of this relationship regarding the type of correlation tool. (simple correlation coefficient, multiple correlation coefficient, canonical correlation coefficient.) depending on the number of variables. Bhandari, P. (2022).

Table 4: Correlation scale

Correlation Coefficient amount	Type of correlation	Means
1	Perfect positive correlation	The other variables change in the same direction as the changed variable.
0	Zero correlation	The variables do not relate to one another.
-1	Perfect negative correlation	The other variables shift in the opposite direction from one another when one variable changes.

A correlation coefficient's explanation:

The correlation coefficient is a sign of the strength of the relation among variables with a value that always falls between 1 and -1.

- Sign: The coefficient's sign demonstrates either the variables are changing in unison or opposition; A positive number indicates that the variables change in unison in the same path, whereas a negative value indicates that they move in the opposed path.

- Absolute value: The degree of a correlation is also indicated by the absolute value of a correlation coefficient; the higher the absolute value, the greater the correlation (Bhandari, 2022b).

Table 5: Correlation coefficient meaning.

Correlation coefficient	Correleation strength	Correlation Type
-0.7 to -1.0	Very strong	Negative
-0.5 to -0.7	Strong	Negative
-0.3 to -0.5	Moderate	Negative
0 to -0.3	Weak	Zero
0	None	Positive

0 to 0.3	Weak	Positive
0.3 to 0.5	Moderate	Positive
0.5 to 0.7	Strong	Positive
0.7 to 1.00	Very stong	Positive

In regression models, the coefficient of correlation is used to determine the degree of variation in one variable as stated by the variance of the other variable. Linear connection is greater, and the absolute value of the correlation coefficient is larger the closer the dots are to the straight line. A model's linearity can be recognized by examining its simple correlation coefficient, r. The regression model is linear if the absolute r value is larger than or equal to 0.70 and nonlinear otherwise. This analysis has five sequential steps, including:

- Linearity test
- Multicollinearity
- F test
- r2
- Durbin – Watson test for autocorrelation analysis

t-test for beta coefficients, (Bhandari, 2022b).

3.5. Measures for Association and Correlation

The association and correlation measurements are applied in a research model to explore the relationship between the demographic factors and the core concept. There are four levels of measurement for the variables in statistical analysis. Both qualitative and quantitative data can be categorized using these measuring scales. For qualitative data, association measures are valid for nominal and ordinal scales. Quantitative data on interval and ratio scales are analyzed using correlation calculations (Voxco, 2021b).

4. IMPLEMENTATION AND RESULTS

The data from 91 samples, each containing 23 questions, are collected through the field study and put into SPSS Statistics 26 software for the analyses stated in the methodology part. The findings can be found in the following pages.

4.1. Principal component analysis

Ninety-one samples were entered into SPSS for principle component analysis using the model's independent variables. In order to apply PCA, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy must be greater than 0.5, and the sign for Bartlett's test of sphericity must be less than alpha 0.05 to be 95% confident that our data is homogenous.

Table 6: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.698
Bartlett's Test of Sphericity	Approx. Chi-Square	899.230
	df	253
	Sig.	.000

The output file shows that the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and sig of Bartlett's Test of Sphericity is satisfied.

According to the total variance explained table, it was recognized that the 23 questions formed in 7 components' Eigenvalues are greater than 1. Moreover, the cumulative percentage of explained variation with the components formed here was 68.238%. Related to results in the rotated component matrix, table ( ) below is constituted. This table shows the components formed according to the principle component analysis.

Table 7 Results of principal component analysis

Number of factors extracted	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
Percentage of explained variation	12.829	12.604	11.005	9.290	7.800	7.399	7.310
Labels of components	Planning and management issues	Skills, background, and experiences issues	Controlling and work plan issues	Lack of knowledge about lean management and time controlling	Employees working environment issues	Lack of communication skills	Financial issues
Composition of variables within each component	Q6-Q23-Q2-Q1-Q24-Q7	Q13-Q14-Q15-Q16-Q8	Q19-Q21-Q18-Q12	Q5-Q4	Q10-Q17	Q20-Q22	Q9-Q11

4.2. Reliability Analysis

After principle component analysis, it can be seen that the research model now has eight instruments. These are the core concept CC with a single item of Q3, C1 with items of Q6, Q23, Q2, Q1, Q24, and Q7. C2 with items of Q13, Q14, Q15, Q16 and Q8. C3 with items of Q19, Q21, Q18 and Q12. C4 with two items of Q5 and Q4, C5 with two items of Q10 and Q17. C6 with two items of Q20 and Q22. C7 with again two items of Q9 and Q11. Since C1, C2, C3, C4, C5, C6, and C7 have more than one item, reliability analysis must be performed to prove internal consistency.

In the reliability analysis, Cronbach α must be tested for each component to find whether it is greater than 0.7. Being greater than 0.7 means that our answers given by the respondents for the questions in each component are consistent with each other; in other words, it means that the answers for the questions in the same component are similar.

First, the internal consistency for component C1 is searched. Cronbach α appeared to be 0.809, greater than the suggested value of 0.70. Likewise, for component C2 which was also searched and its' Cronbach α = 0.763, which means C2 is satisfied; moreover, Cronbach α = 0.728 for component C3. While the Cronbach α for component C4 is 0.662, which is less than 0.7, that means it needed to delete one of the two items that are included in C4; since Q4 in the rotated component matrix has lower factor loading, which is 0.698, and Q5 has higher factor loading 0.793, Q4 will be excluded from Component C4. However, C5 has a Cronbach α = 0.724, meaning all variables will be included. For component C6 which includes Q20 and Q22, it is Cronbach α = 0.453, which means the same as C4 that the variable with lower factor loading will not be considered, and this leads us to exclude Q22 with factor loading 0.469 and only consider Q20 with a factor loading 0.733. the same for component C7 which has Cronbach α = 0.595, which means we must exclude one of Q9 and Q11. Q9 has factor loading = 0.872 and Q11has 0.744. Q11 will only be considered in C7.

According to the internal consistency test table 8 includes the updated variables for each component;

- Q4 deleted from C4
- Q22 deleted from C6
- Q11 deleted from C7

Table 8: Results of internal consistency analysis

Number of factors extracted	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
Percentage of explained variation	12.829	12.604	11.005	9.290	7.800	7.399	7.310
Labels of components	Planning and management issues	Skills, background , and experiences issues	Controlling and work plan issues	Lack of knowledge about lean management and time controlling	Employees working environmen t issues	Lack of commu nication skills	Financial issues
Compositio n of variables within each component	Q6-Q23-Q2-Q1-Q24-Q7	Q13-Q14-Q15-Q16-Q8	Q19-Q21-Q18-Q12	Q5	Q10-Q17	Q20	Q9

4.3. Modified Research Model

The following diagram named as figure 5 explained the new definition of Core Concept , external variables as components and demographic variables and the relationship between these factors.

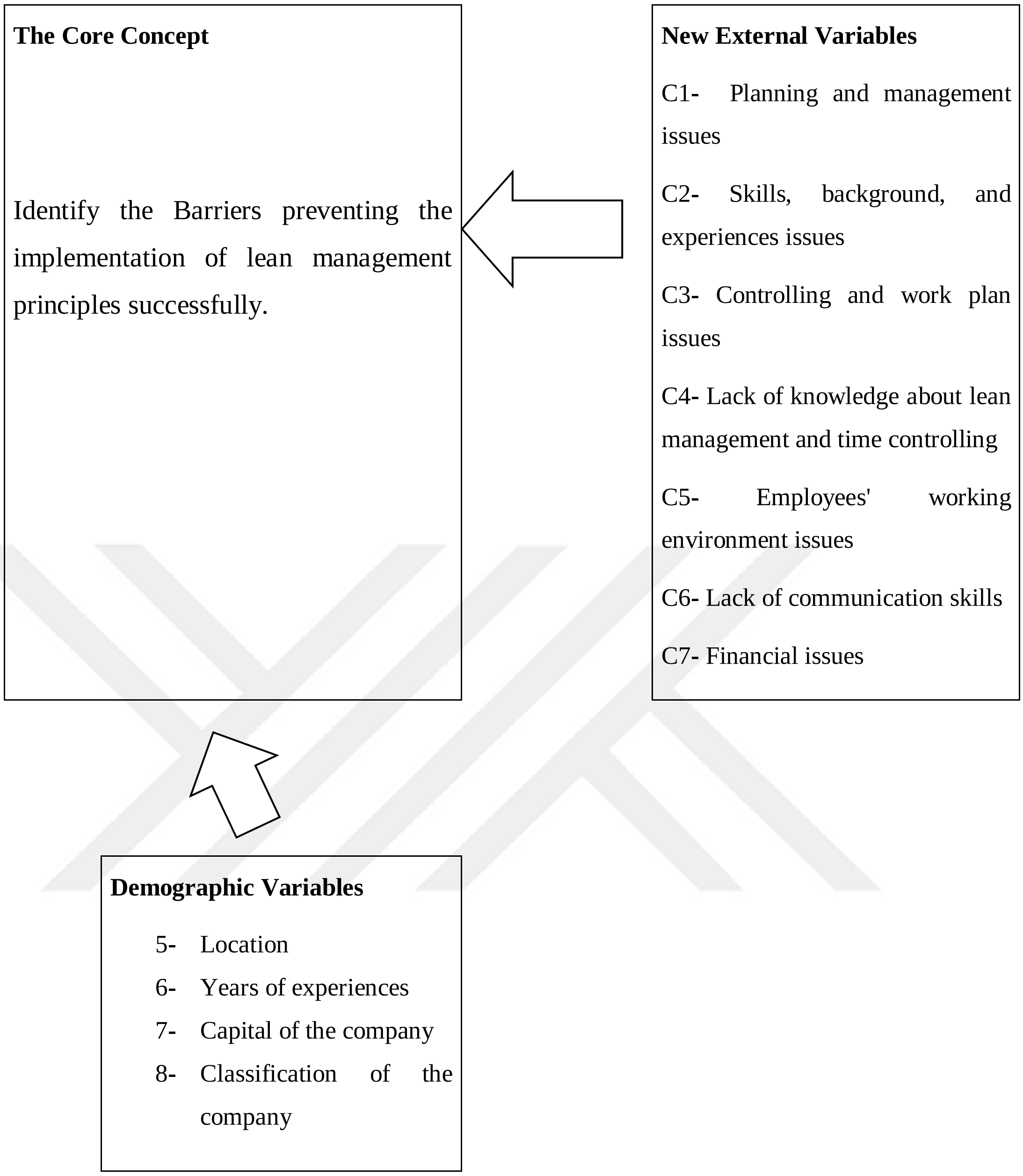

Figure 5: Modified Research Model

4.4. Multiple Regression and Correlation Analysis

In this part of the study, the modified research model was inspected by multiple regression and correlation analysis according to the principles stated in the methodology part. The modified model suggests that Q3, which is the core concept instrument, is the dependent variable, and components C1, C2, C3, C4, C5, C6, and

C7 are independent variables to be used in the regression model to find the linear relationship between each of the components and the Core concept.

The Pearson correlation between each component and core concept must be greater than 0.7, and the Pearson correlation between components less than 0.7.

With the SPSS output file, only C1 has a Pearson correlation greater than 0.7 with a core concept of=0.774, which means this is the only linear relationship.

Our model formula is:

$$CC = \beta_\circ + (\beta_1 * C_1) \quad .(3)$$

According to the regression Model summary table between CC and C1, R is 0.774, and the Adjusted R Square is 0.595.

Table 9: Regression model summary table between CC and C1

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.774[a]	.599	.595	.52010	2.120

Since the R is greater than 0.7 and the Adjusted R Square is greater than 0.5. this means that variable C1 explains 59.5% of the changes in the core concept.

The f test is done to see whether our model $CC = \beta_\circ + (\beta_1 * C_1)$ is statistically valid.

If the sig value for the F test (which corresponds to the p-value of this test) is less than the alpha=0.05 significance level, then we conclude that our model is valid. In the Anova table, the sig is =0.00, which means the model is valid.

Table 10: ANOVAa table

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	36.035	1	36.035	133.213	.000[b]
	Residual	24.075	89	.271		
	Total	60.110	90			

According to the output file of the SPSS in the coefficients table regarding Constant and C1, our β0 = -0.57 and β1 = 0.169

Table 11: β0 and β1 Coefficients values.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.057	.328		-.175	.861
	C1	.169	.015	.774	11.542	.000

This means that the model formula is = CC=-0.57 +0.169 *C1. (3)

To determine whether the regression coefficients (β0 and β1) are statistically significant, we apply a t-test to them. If sig values for these coefficients (t-test's p-values) are less than alpha=0.05 significance level, then we can use these coefficients since sig for t is more than 0.05 for β0, we must exclude b0 from the model.

After excluding β0, the new model summary table showed that the Adjusted R Square is = 0.981, which means it has increased.

Table 12: R and R square values after excluding β0**.**

Model	R	R Square[d]	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.991[a]	.981	.981	.51729	2.119

Furthermore, the new Anova table showed that the sig is 0.00, which means the model is valid.

and regarding the new Coefficients table β1=0.167

Table 13: Anova table after excluding β0.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1261.917	1	1261.917	4715.814	.000[c]
	Residual	24.083	90	.268		
	Total	1286.000[d]	91			

Table 14: New β1 Coefficient values.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	C1	.167	.002	.991	68.672	.000

That means that the final model is $CC = 0.167 * C_1$.(4) Moreover, the explanatory power of the model, which was found to be 0.981 as the adjusted r^2 value from a model summary table of the output, states that the differences occurring in independent variables explain 98.1%, almost 100 % of the differences occurring in the dependent variable.

In conclusion, planning and management issues significantly affect identifying the barriers that prevent the successful implementation of lean management principles.

4.5. Measures for Association and Correlation

Completing multiple regression and correlation analysis, measures for association and correlation for investigating the relationships between the demographic variables and the core concept were applied.

- Location is on a nominal scale.
- Years of experience, Capital of the company, and Classification of the company are on an ordinal scale.

In order to examine the relationship between the core concept and the nominal scaled demographic variable, which is the location, the core concept variable was transformed into a categorical variable of CCC by categorizing data into two groups according to its median value, which was found to be 4.

After transforming the core concept variable into CCC, the relationship between location (1-Nablus or near it and 2-Ramallah or near it), CCC was searched. Since the two variables were in nominal scale, crosstabs of 2 x 2 tables were used, and the sig statistic of the phi coefficient was obtained as 0.021, which is less than 0.05. This means we have a relationship between them, and the phi value must be between -1 to 1; here, the phi value is 0.242, which is positive, as shown in table 15. This means there is a relationship between location and the core concept; in other words, when the answers are 2, the barriers that prevent the successful implementation of lean management increase.

Table 15: Phi value for CCC and location.

		Value	Approximate Significance
Nominal by Nominal	Phi	.242	.021
	Cramer's V	.242	.021
N of Valid Cases		91	

To find the relationship between each of the demographic variables and the core concept, Spearman's rho sig must be tested to find if there is a relationship between them or not; if Spearman's rho sig is less than 0.05, this means that there is a relationship, if not, there is a relationship.

- Spearman's rho sig related to years of experiences and core concept = 0.598; there is no relationship.
- Spearman's rho sig related to the company's capital and core concept = 0.161; there is no relationship.
- Spearman's rho sig related to employees number of company and core concept = 0.817; there is no relationship.
- Spearman's rho sig related to the company's classification and core concept = 0.430; no relationship exists.

4.6. Discussion

As presented before planning and management issues related to component C1 significantly affect the research core concept C3 which is identifying the barriers that prevent the successful implementation of lean management principles in the construction sector in Palestine.

C1 includes :

- Q6: Our company depends on typical construction thinking than fresh strategies which affects Continuous Improvement and problem solving.

- Q23: rejecting innovative human resource management and development prevents the professional implementation of lean techniques.
- Q2: noncontinuous visual management preventing my company from achieving consistently high performance.
- Q1: my company experiences time-wasting trying to rectify unrealistic design issues to make it appropriate for the site.
- Q24: our company doesn’t adopt parallel plans for doing tasks to achieve Time reduction and quality improvement.
- Q7: Experience variability of workflow is a result of unprofessional Production controlling which in turn affect the purpose of the total system achievement.

Component C1 consists of six questions that were gathered by PCA in SPSS software showing that it has the most impact on implementing construction lean management principle.

While other components related to skills background and experiences issues (C2), lack knowledge about lean management and time controlling (C4) , employees working environment issues (C5) , lack of communication skills (C6) and financial issues (C7) has less impact on implementing construction lean management principles.

As a result, the model equation is defined as $CC = 0.167 * C_1$.(3)

As the study shows that location as a demographic variable is also affect the core concept since SPSS tests showed that there is a relationship between them, while other demographic variables; company’s capital , number of employees , classifications and years of experiences have no relationship since its’ Spearman's rho sig is more then 0.05. which is a logic compared with the reality of implementing LCM principles in Palestine.

5. CONCLUSION

Determining the obstacles to implementing lean management principles is significantly influenced by planning and management issues in Palestine in the construction sector; a questionnaire was applied to investigate this issue. With 91 collected samples from Ramallah and Nablus filled by engineers, construction companies, site workers, and expatriates, this formula was obtained CC= +0.167 *C1, Where C1 is the planning and management component I and CC is related to the core concept. This study recommends; the top management needs strongly adopt a culture of educating their workforce regarding new management strategies and methodologies, such as lean construction and hiring lean construction experts to have a position as directors to enhance workers and engineers involved in the projects. While it could be extended through other developing countries, or other sector related to engineering.

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APPENDIX A_

APPENDIX A: The English Version of the Ouestionnaire about (Examining the implementation and execution of lean thinking and tools in the construction sector in developing countries)

I would like to thank you for your effort filling the questionnaire which is about Examining the implementation and execution of lean thinking and tools in the construction sector in developing countries.

Resarcher Name :

Masa MutaweOdeh

Section 1:

1-Company's location :

☐ Nablus or near it ☐ Ramallah or near it .

2- Company's experinces

☐ less than 5 years

☐ from 5 to 10 years

☐ from 11 to 15 years

☐ more than 15 years

3- Capital of the company

☐ 20,000 USD

☐ 20,000 USD to 50,000 USD

☐ 50,000 USD to 100,000 USD

☐ more than 250,000 USD

4- Number of employees

☐ from 1-5

☐ from 6 to 15

☐ from 16 to 25

☐ more than 25

5- classification of company

☐ consulting

☐ third

☐ second

☐ first

Section 2 :

question	**Strongly agree**	**Agree**	**Moderate agree**	**disagree**	**Strongly disagree**
1- my company experiences time-wasting trying to rectify unrealistic design issues to make it appropriate for the site.					
2- non-continuous visual management prevents my company from achieving consistently high performance					
3-My Company faces important barriers while implementing lean management principles.					
4-insufficient knowledge about lean management leads to unsuccessful lean tools implementation.					
5- time overrun impact the balance between quality and cost due to Non-compliance with delivery scheduled times and dates.					

6- our company depends on typical construction thinking than fresh strategies which affects Continuous Improvement and problems solving.					
7- experiences variability of workflow as a result of unprofessional Production control which in turn affect the purpose of the total system achievement.					
8- The first and foremost effect of inflation is on our company on the budgets and profit margins which will impact implementing Lean management principles such as supplying the required materials at the scheduled times and dates.					
9- insufficient funding for some of our projects will not lead to achieving effective application of lean construction.					
10- missing the required supportive environments					

prevents enabling lean approaches in our projects					
11- limited wages do not affect the satisfaction of the employees, or their productivity, so it had no impacts on the application of lean approaches in their work environment					
12-hiring employees with no experience in lean practices and equipment will slow down improving lean implementation					
13- Curriculums don’t include enough information to teach lean principles as a necessary method to achieve continuous improvement.					
14-Lack of teamwork skills will impact employees' production.					
15- not following the regulations that rule horizontal communication will affect achieving the tasks in the right					

manner.					
16- insufficient background experience will not lead to the successful implementation of lean tools during our work phases.					
17- inappropriate employees' behaviors and attitude affect the impact of improving the implementation of lean construction successfully					
18- regarding inadequate work plan structure we face low employees efficiency.					
19- inaccurate schedules and timeline showing the projects' steps influences quality and deliverable dates … etc					
20- not following the regulations that rule vertical communication will affect achieving the tasks in the right manner.					

21-unclear agreements and poor communications lead to difficulties in project implementation					
22-inadequate knowledge about lean management tools in the procurement department lead to difficulties in project implementation					
23-rejecting innovative human resource management and development prevent the professional implementation of lean techniques					
24-our company doesn’t adopt parallel plans for doing tasks to achieve Time reduction and quality improvement.					