# THE ROLE OF MODERN METHOD OF CONSTRUCTION IMPLEMENTATION ON CONSTRUCTION PERFORMANCE:

# THE CASE OF SELECTED RESIDENTIAL BUILDINGS IN ADDIS ABABA

**A Thesis Submitted for Partial Fulfillment for the Degree Master of Science in Management Specialized in Quality Management and Organizational Excellence**

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**The Role of MMC Implementation on Construction Project Performance: The Case of Selected Residential Buildings in Addis Ababa**

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**January, 2020**

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**DECLARATION**

I, the undersigned, declare that this MSc thesis entitled "The Role of MMC Implementation on Construction Project Performance: The Case of Selected Residential Buildings in Addis Ababa" is my original work, prepared under the guidance of Mohammed Seid (PhD). All sources of materials used for the thesis have been duly acknowledged.

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**ENDORSEMENT**

This MSc thesis entitled "The Role of MMC Implementation on Construction Project Performance: The Case of Selected Residential Buildings in Addis Ababa" conducted by Selam Abebe has been submitted to Addis Ababa University, Faculty of Business and Economics, with my approval as a university advisor.

Name: Mohammed Seid (PhD)

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**Abbreviations**

| | |
|---|---|
| BC | Building Contractor |
| CSF | Critical Success Factors |
| CIDB | Construction Industry Development Board |
| ECIDP | Ethiopian Construction Industry Development policy |
| EOT | Extension of Time |
| GRP | Glass Reinforced Plastic |
| IBS | Industrialized Building System |
| ICH | India Concept House |
| KPI | Key Performance Indicators |
| MMC | Modern Methods of Construction |
| MUDC | Ministry of Urban Development and Construction |
| OSM | Off-Site Manufacturing |
| ROI | Return on Investment |
| SE | Small Enterprises |
| WW2 | World War 2 |

*Abstract*

*Developing countries are dependent on the growth and development of physical infrastructures and construction industry plays a vital role for countries like Ethiopia. The objective of this study was to understand the practice of MMC in Addis Ababa housing sector. This research is conducted to assess the role of MMC implementation on the performance of construction projects on selected residential buildings in Addis Ababa. It is descriptive and qualitative in kind. Qualitative approach was Chosen because, there are fewer projects that have used MMC, MMC is new to Ethiopian building sector and to explore the experiences of MMC in-depth. Interview was used as an instrument of data collection. The research analysis shows how effective a MMC is on the project time, cost, quality, and customer satisfaction parameters of construction projects of selected residential buildings. To select the respondent purposive data sampling technique was applied by checking the availability of the data, since the term is not well known. Qualitative analysis is used to describe the benefits of implementing MMC, and its effectiveness on time, cost, quality, and customer satisfaction parameters of the contractors' projects. The finding of the research elaborates that MMC is more effective on internal factors time, cost, and quality of the contractors' construction projects.*

***Key Words**: Modern Method of Construction, offsite construction, pre fabrication, Industrialized Building System, housing delivery in Ethiopia, construction in Ethiopia and construction quality in Ethiopia.*

# Chapter one

# Introduction

## 1.1 Background of the study

The idea of quality management is to assure efforts to get the required level of quality for the product/service which are well planned and organized. From a construction company point of view, quality management in construction projects should mean maintaining the quality of construction works at the essential standard so as to achieve customers' satisfaction that would bring durable competitiveness and business survival for the companies (Tan & Abdul-Rahman, 2005). Quality management is seriously required for a construction company to continue in existing construction market which is extremely difficult and competitive. Harris and McCaffer (2001) explained that quality management has to grant the environment within which related tools, methods and measures can be arranged successfully leading to operational achievement for a company.

Modern Methods of Construction (MMC) are defined as those which give an efficient product management to supply more products of better quality in short time. It has been defined in various ways: pre-fabrication, off-site production, off-site manufacturing (OSM) and Industrialized Building System (IBS). But while all OSM are MMC, not all MMC are OSM, MMC can take place also on-site (Burwood and Jess, 2005).

The term, modern methods of construction (MMC), comes from the United Kingdom as a standard name for off-site and on-site methods of construction. Off-site MMC refers to modern methods of construction which have predominantly been manufactured and assembled in a factory controlled environment. On-site MMC refers to modern methods of construction which brings together systems or components that are predominantly assembled on site (Kyjakova and Baskova, 2016).

Modern methods of construction (MMC) are helping the construction industry to finish projects on time and to budget by improving communications between stakeholders and their pre-

engagement with a project. Completion of a construction project with a planned budget is seen as a main criterion of project success by clients, contractors, consultants and related stakeholders (Eskandari Torbaghan, M.,Luiu,C. & Burrow,MPN., 2017).

The successes factors of MMC are it saves time, increases quality, enhance customer satisfaction and it is environmental friendly. For better uptake of MMC in the construction well education on the technology industry in order to compete globally and adjust to economic changes for all participants is essential. The industry should also unite with the initiative by the government to better uptake of off-site manufacturing and to increase the standard of the construction industry. The experience and difficulties in adopting MMC should be shared and an exchange of knowledge to motivate and educate other countries to move to a higher level of development for the construction industry is essential (Azman, Ahamad, Majid and Hanafi, 2010).

### 1.2 Statement of the problem

Several reports have criticized the construction industry, particularly in terms of productivity, quality and quality system (Ali & Rahmat, 2010), and most of project managers focus on the cost and time rather than quality of construction projects, but the scholars highlighted more attention should be towards quality (Mane & Patil, 2015). Construction projects have been known for their cost overrun and delayed completion (Touran & Lopez, 2006). Most construction companies face many problems, such as workmanship defects, project delay, and cost overrun in completing their projects. Since over the past three decades, the globalization and competition have been increasing (Neyestani & Juanzon, 2016). Thus, the globalization and competition are the most important reasons that each construction company needs to improve and correct its system for achieving its objectives by management tools.

The construction industry plays major role in the economy of developing countries. For example, in many developing countries, major construction activities account for about 80% of the total capital assets, 10% of their Gross Domestic Product (GDP), and more than 50% of the wealth invested in fixed assets. In addition, the industry provides high employment opportunity, probably next after agriculture (Jekale, 2004).

As Idoko (2008) noted, many projects in developing countries face considerable time and cost overruns, fail to fill their proposed aim or even totally terminated and abandoned before or after their completion. Moreover, the progress of the construction industry in developing countries generally lags far behind from other industries in those countries and their counter parts in developed nations. The construction industry in developing countries failed to meet expectations of governments, clients and society as a whole as Jekale (2004) generally concluded. Successful project can be defined as achieving the project objectives as on time, within cost, and quality (scope) to meet client's prerequisite (Kerzner, 2010).

The construction industry is growing in Ethiopia at a high-speed and it brings a great development to the country and to the city specifically, but it is also undeniable that there are various quality problems arising with it as well. The construction industry in Ethiopia is challenged by several problems which tend to confront the sector and thus making efforts at developing the construction industry very difficult and complex (Jekale, 2004)

On a study of condominium housing projects in Addis Ababa Dires (2016) stated that the rate of construction project completion is weak because of the fast increasing rate of major defects in building as a result of poor workmanship and poor-quality materials which have been identified as the major cause of defects in the Ethiopian construction industry. It is also very clear that not only the low-cost projects, but also the private owned projects are usually not free of construction defects. This experience results in the compromising of the overall project success and the poor rating of customer satisfaction.

Different MMC practices and products have been developed that have completely changed the behavior of housing industry from what it had been before. This change is amazing and is in the way to bring more and more developments in construction sector (“Modern Methods of Construction”, n.d.). Modern Methods of Construction plays an important role in the quality of the deliverable of construction projects. Having stated the abovementioned issues, this study assesses the role of MMC implementation on the performance of the construction on selected residential buildings contractors in Addis Ababa. And it’s effectiveness on the main elements of

the selected construction projects; cost, time, quality/scope, and also customer satisfaction for the overall project success.

No researches are done in MMC in Ethiopia context. This research aims to fill the research gap in MMC in Ethiopia context by assessing the implementation of MMC technology for project performance and customer satisfaction.

### 1.3 The Research Motivations

The researcher chose the title because most construction projects in this country have quality defects and problem in on time delivering the projects to the clients.

This research tries to contribute knowledge on how MMC contribute to quality and saves time in construction projects.

### 1.4 Questions asked while choosing the title

- Why has the research been established?

Most Construction projects in this country suffer time and quality problems and MMC plays main role in delivering projects with good quality and on-time.

- What does the research try to achieve?

To contribute knowledge on how MMC contribute to quality and saves times in construction projects.

- Who will benefit from or affected by this research?

Stake holders in construction industry, policy makers and myself

### 1.5 Research Questions

1. What are the benefits of implementing MMC on residential construction projects in Addis Ababa?

2. What is the role of MMC implementation for project performance regarding the time of project delivery, the project budget, and the desired quality of residential construction projects in Addis Ababa?

3. What is the contribution of MMC implementation for customer satisfaction of residential construction projects in Addis Ababa?

### 1.6 Objective of the study

#### 1.6.1 General Objective

The general objective of this research is to assess the role of MMC implementation in Addis Ababa on selected residential buildings.

#### 1.6.2 Specific Objectives

Examine the effectiveness of MMC implementation on the main elements of construction projects (construction quality, the time length of the project, and cost of the project) in relation to customer satisfaction within implementation in Addis Ababa on selected residential building projects.

Explore the remedies to minimize workmanship defects, project delay, and cost overrun of construction projects for continuous improvements of the effective implementation of MMC in implementation in Addis Ababa on selected residential buildings.

### 1.7 Scope and Limitation of the Study

This research paper focuses on the application of MMC technology by selecting representative residential building contractors at the managerial level and that have already applied MMC in their projects. The study is limited to residential buildings that have applied MMC and geographically to Addis Ababa city.

### 1.8 Significance of the Study

The findings of this study will benefit the stakeholders in the construction industry, policymakers and myself; considering that MMC plays an important role in the quality of construction works, cost-minimizing, and time-saving aspect of construction project management. Building contractors who have not implemented MMC will understand the importance of applying MMC, and contractors who have implemented MMC will understand the importance of maintaining the practice for continuous improvement with this study. This study and its finding will encourage the use of new approach of construction system and hence promotes better quality construction and innovative system to the construction industry.

### 1.9 Organization of the Paper

This research paper contains five chapters. The first chapter contained the introductory part. It included background of the study, statement of the problem, research motivations, questions asked while choosing the title, research questions, objective of the study, scope and limitation of the study, significance of the study, and organization of the paper. In the second chapter literature review is included and it dealt with the review of related literatures which contain definitions and experiences of MMC from different countries perspective. Methodology follows literature review which is the third chapter. Research analysis and findings are covered in the fourth chapter, it includes previously presented theory and the main findings are also presented. Finally, findings summary, conclusion and recommendations are included in the fifth chapter.




**Figure 1: Structure and organization of the thesis**

# Chapter two

# Literature review

## 2.1 Project performance

In the construction industry; time, cost and quality have been defined as the important criteria of measuring success. However, other several ideas have appeared from different researchers. The study of project success and the critical success factors (CSFs) are considered to be a way to improve the effectiveness of a project (Ramlee, Tammy & Noor, 2015).

There is still a disagreement between project management researchers as to what composes project success and how it is to be measured (Klagegg, Samset, & Magnussen, 2005). Wit (1988) and Pinto & Slevin (1988) pointed out that it is still not clear how to determine project success since project stakeholders perceive success or failure factors differently. They assumed that project success should be viewed from different perspectives of the individual owner, developer, contractor, user, and the general public. Wit (1988) clarified that the most suitable criteria for success are the project objectives. The point to which these objectives have been met determines the success or failure of a project. The criteria for success of the project management effort tend to be restricted to cost, time and quality performance. Although, when measuring project success, one must consider the objectives of all stakeholders throughout the project life cycle and at all levels in the management hierarchy. Therefore, to believe that, with such a multitude of objectives, one can objectively measure the success of a project is somewhat an illusion. Success is measured both objectively (cost and time) and subjectively (quality and satisfaction) (Wit, 1988).

Kerzner (1998) explains definitions of project success, and presents a list of critical success factors that can affect project performance at different stages of a project life cycle. As he mentioned, the definition of project success has changed over the years. In the 1960s, project

success was measured entirely in technical terms: either the product worked or it did not. In the 1980s, the following definition for project success was offered (Kerzner H., 1998): project success is stated in terms of meeting three objectives: completed on time, completed within budget, and completed at the desired level of quality.

The quality of a project was defined as meeting technical condition. Note that all three of these measures are internal to a project, and do not necessarily indicate the preferences of the end user or the customer. In the late 1980s, after the introduction of TQM, a project was considered to be a success by not only meeting the internal performance measures of time, cost and technical specifications but also making sure that the project is accepted by the customer; and resulted in customers allowing the contractor to use them as a reference (Kerzner H., 1998) which is external to the project.

The success criteria for a construction project is not only to evaluate the cost, time and quality as success factors but also to include successful project management, organizational success and the customer satisfaction (Siguroursan, 2009). Reviewing of the relevant literature suggests that different criteria were hypothesized by different researchers (Chan, Scott, & Lam, 2002).). These scholars have summarized ten Critical Success Factors (CSFs) of projects through their research. Those CSFs are known as Cost, Time, Quality, Satisfaction, Management, Safety, Technology, Organization, Environment, and Resources (Ramlee, et al., 2015). But this research is bound to only the first four CSFs so emphasis is given to Cost, Time, Quality, and Satisfaction.

With the above factors in mind, a range of Key Performance Indicators (KPIs) to measure the performance of a construction project is developed, both objectively and subjectively. With reference made to Chan's (1996; 1997) and Naoum's (1994) earlier research, each KPI is discussed practical approaches to measure these KPIs are introduced. The measures of the KPIs in this case only the four criteria are mainly divided into two groups; objective measures (time and cost) and subjective measures (quality and satisfaction). The first group is to use mathematical formula to measure the criteria quantitatively. The other group of criteria is based

on subjective opinions and personal judgment. A three to seven-point scale scoring could be applied to measure these KPIs (Chan, 2001).

### 2.1.1Objective measures

- **Time**

Time is the length of completion of a project. It is planned to enable the construction output to be used by the client's future plans (Hatush & Skitmore, 1997). From (Chan, 2004), time can be calculated in terms of construction time, speed of construction and time variation. Construction time is the absolute time that measures the number of days or weeks from start on site to practical completion of the project. Speed of construction is the relative time, which is defined by gross floor area divided by the construction time. Time variation is measured by the percentage of increase or decrease in the estimated project in days/weeks, discounting the Extension of Time (EOT) granted by the client.

- **Cost**

Cost is another important measure. Cost is defined as the degree to which the general conditions promote the completion of a project within the estimated budget (Bubshait & Almohawis, 1994). Cost is not only limited to the tender sum only, it is the overall cost that the project acquires from start to end, so it includes any costs that arise from variations, modification during construction period, and the cost created by the legal claims, such as litigation and arbitration. The measure of cost can be in form of unit cost, percentage of net variation over final cost. Unit cost is a measure of relative cost and is defined by the final contract sum divided by the gross floor area. Percentage net variation over final cost is the ratio of net variations to final contract sum expressed in percentage term. It gives an indication of cost overrun or cost under run. Yeong's (1994) approach is used in measuring this term.

### 2.1.2 Subjective measures

- **Quality**

Quality is another basic that measures success. In the construction industry quality is defined as the totality of features required by a product or services to satisfy a given need; fitness for purpose (Parfitt & Sanvido, 1993). Nowadays, quality is the guarantee of the products that persuade the customers or the end users to purchase or use. Specification is one of the criteria that were advocated by (Corbett & Rastrick, 2000).They defined it as the workmanship guidelines provided to contractors by clients at the beginning of project. The measure of technical specification is to what extent the technical requirements specification is achieved.

- **Customer Expectation and Satisfaction**

Customers are those who use the final product/ services. Ensuring the completed projects to meet the customer's expectation and satisfaction is essential. Lim & Mohamed (1999) consider satisfaction an attribute of success. Enshassi & Al-Ghuraiz, (2003) believe that if customers are satisfied, the project can be considered successfully completed in the long run.

It is learned from the above statements that measuring the success of a project once it's brought to completion is a valuable practice. It provides a learning opportunity for future undertakings, and, the opportunity to assess the true effectiveness of the project. In order to have a holistic view, objective and subjective criteria need to be considered as mentioned previously. A project performance and success is therefore measured by the above measures to state whether or not a project has experienced cost overrun or it is within budget, time overrun or it is within schedule, if it is within technical specification or not, and whether it has satisfied the client or not, depending on the project and the measurer. It is by these measures that a project manager labels the project performance as a success or a failure, and the effectiveness of MMC on the critical factors of the project objectively and subjectively.

## 2.2 Construction in Ethiopia

Study in 2014 shows that, the population of Ethiopia is 96 million and Addis Ababa is about 3.5 million. From the whole population 17 million people classified as poor. In Africa, Ethiopia is listed as the least urbanized country. Since 1991, Addis Ababa has been known as both by fast economic and population growth. The rapid population growth in Addis Ababa continued to exceed the capacity of low-cost housing for the poor. In Addis Ababa to build low-cost condominium houses in a relatively short time was limited by the rising cost of labor and construction materials and this made it difficult to efficiently address the housing needs of the growing population in a timely manner. In 2013 as a result of the challenges Urban Housing Policy and Strategy was introduced by Ethiopia government (MUDC, 2014).

These days the construction of condominium houses has become difficult to be affordable by most of the people and most of the time finishing and construction inputs are poor quality. The study showed that the condominium building in Addis Ababa has failed to meet the housing needs of the poorest of the poor (Keller and Mukudi, 2017).

## 2.3 Modern Methods of Construction (MMC)

MMC is the term used by the UK to describe offsite technologies by moving work from the construction site to the factory (Gibb, 1999).

MMC is a new technology in construction industry that improves the requirements of speed, quality and reliability on site. In the main, these systems are manufactured off-site under a dry roof in factory style conditions or by newer on-site technologies. The off-site products are then normally delivered to site by truck and craned into position. The size of the element is often determined by the size of the roads or the difficulties encountered in accessing the site, such as bridges and tunnels (MMC techniques, 2019).

UK first found out the manufacturing system from Japan through the Toyota perception that builds up the Toyota Homes' for house manufacturing in 1975 (Gann, 1996). The idea has given new significance to the customer in having the both properties made up by Toyota. In 1940s,

Toyota came out with a new approach on the organization of manufacture, the use of plant, management resources, quality control and relationships between manufacturers and users. Womack (1990) identified that approach as the new system of mass production which is more efficient and responsive system and named it as ‘lean production’.

The UK construction industry features has a historically low level of exercising compared with other developed countries. Sectors like electricians, joiners and bricklayers were the three skills contributing to the increased demand for offsite products. Contractors think skills shortage as plumbers were the only trade which they felt was not increasing the demand for offsite to a significant degree. On the other hand, the majority of suppliers thought that the lack of concreters, steel erectors and steel fixers contributed little to the increased demand for offsite.

The lack of skills would seem perfect for the increased use of offsite but skilled workforce is required to enable innovations such as offsite to be applied.

Raising the awareness and increasing the perception of offsite, particularly to clients and the general public in order to relieve the technology of its poor historical ‘prefab’ image. This could be done by promoting and marketing the benefits and advantages of offsite more widely, both by individual companies and by the Government, and by highlighting good practice (Goodier and Gibb, 2005).

Quality Control in construction is the practice of making sure that the project is constructed to plan, that the tolerances allowable by industry standard and engineering practices have been met or improved, and that the completed project meet with the quality standards of the architect, engineer, owner, and general contractor. On construction projects there are dozens of subcontractors, all of which have specific responsibilities. Supervisors and project managers try to sustain high quality standards but they can't be everywhere at once (D.Ashokkumar, 2014).

The building sector has yet to undergo a complete phase of industrialization. Yet, if a car was manufactured the way a building is delivered, very few people would be able to be the owner; if a computer was produced the way a building is delivered, it would cost a lot of time (Richard, 2005).

Offsite MMCs are prefabrication components or parts of structures, manufactured in factory, then transported and assembled on-site. Onsite MMCs are building blocks and parts of structures takes place directly on site. Almost all of the good quality products are manufactured in factories around the world. Cars, planes, ships, computers, printers and cell phones are manufactured in factories. In addition, even site built homes use many components that were produced in factories. Modular homes take a shorter time for construction compared with site-built homes. This is due to the fact that while the modular is being built in the factory, another crew is building the foundation at the same time (Chen, 2010).

### 2.4 Adoption of MMC

Many countries are using MMCs on a wider scale, particularly Scandinavia and Germany. Many companies export products/ houses made with MMCs, and Japan now builds 40% of its new houses by using MMCs. Many other countries have recognized the benefits of MMCs, but are not widely using them (Rahman, 2014).

OSM adoption requires fundamental structural changes to the industry and underlined that OSM changes the way people in the building industry work, both in terms of the process and product (Blismas and Wakefield, 2009).

UK is not adopting industrialization in construction and techniques such as offsite construction as it is expected.

The most used offsite type by more UK clients and designers are framing systems, volumetric modular buildings, cladding systems and bath/toilet/kitchen pods (Goodier and Gibb, 2005).

Factors that drive the growing interest of MMC in UK are an increased demand for housing, mostly in the SE and for low occupancy houses and increasing pressure from government to follow the manufacturing sector, despite its difference to construction. Housing supply in the UK decreased since WW2 and shortage in housing supply is limiting economic growth, restricting access to housing and affecting the distribution of wealth within the society (Barker, 2004).

In Nigeria projects are not properly planned and it leads to unknown project time and terminated projects. Nigeria is in immature stage of adopting MMC at medium and small scale construction, but the large construction companies are showing sign of adoption of the concept. Clay and timber are plentiful in Nigeria which uses as MMC to solve hosing problem, but Nigerians have refused to accept these materials as a means of their construction (Adedamola, n.d.).

There is a housing problem in Nigeria and it is caused by number of factors such as high population growth, skills shortage and unwillingness to accept new construction practice (Kolo et al., 2014).

In Malaysia, the IBS (industrialized building system) was introduced in 1964 by the Housing and Local Government after making reference to the accomplishment of different European countries. Ever since 1998 people in Malaysia started to accept IBS over the traditional method as a result of awareness program by Construction Industry Development Board (CIDB) on the benefits of IBS.

From early 1960's to 2010 IBS components have evolved from frame system, panel system and box system to pre-cast concrete systems, formworks systems, steel framing systems, prefabricated timber framing systems, block work systems and Innovative. Mostly used IBS component in Malaysia are pre-cast concrete systems and formworks systems. (Azman et al, 2010).

Modern methods of construction are one way to achieve sustainable construction. Sustainable construction in Slovakia divided into economic, environmental, and social. It must be supported by appropriate method of construction, construction material within the sustainable design and management of construction. Slovakia's MMC adoption for buildings is motivated by demands for faster construction, skills shortage and sustainability of construction. Investors in Slovakia are frequently working for the development of new and better building materials based on the conventional principles because of the public attitude to use natural materials. The investors still do not favor the sustainable natural construction materials but proven known methods and technologies. Consequently, the construction market is not required for the development of

construction skills and professionals dealing with using of traditional materials by modern methods of construction (Spisakova and Mackova, 2015).

### 2.5 MMC experience on different countries

China

MMC is known in China as Industrialized Building (IB). It is agreed through many research that IB have a main role within the Chinese residential development. It improved quality, productivity, cost- effectiveness, safety and sustainability (Zhang et al. 2014). However, the application of prefabricated construction was found restricted due to the lack of understanding the potential benefits of prefabricated houses. The challenges of the prefabrication technology in China were persistently mentioned. The main challenges included lack of manufacturing capability, product quality problems and lack of supply chain (Arif and Egbu 2010).

The competences of MMCs are justified by recent examples from China a 15-story hotel was built in China in just one week and another prefabricated 30-story tower was erected in just two weeks (Rahman, 2014).

India

In India, a growing demand for housing was reported. The projected demand was nearly 27 million houses required by 2012. It was noted that 99% of those houses were needed by households within the lower income group. Therefore, the Indian Government and construction manufacturing industries embraced a larger volume of housing production with good quality. India has established prefabricated and modular technologies in its construction sector. The India Concept House (ICH) represents construction of affordable housing using prefabricated technology. ICH is considered as an innovative prefabricated housing solution that could help to achieve cost savings and reduce construction time by 90%. The prefabricated building system enables a 23 square meter house to be built in four weeks and 93 square meter house to be built

in six weeks. The ICH conceives as both a dwelling for inhabitation and as a process by which houses are produced through a managed supply chain. ICH designed as 23, 46, 70 and 93 square meter increments that facilitating expansion from one room to four rooms. The prefabricated houses are generally considered as cost effective, quick to assemble and sustainable. However, the maturity of prefabricated technology was found to be steadily developing. It was suggested that the improvement to prefabrication maturity should include the whole supply chain of prefabricated house building (RCIS 2011).

Malaysia

The research found that the prefabricated house building in Malaysia has reached market maturity. The Malaysia Government has accepted the Industrialized Building Systems (IBS) in the housing projects to improve delivery timing, and producing affordable and quality houses (CIDB 2012). Besides adopting IBS, the government has well established IBS legislation and building codes to improve the uptake of high quality prefabricated houses for the construction sector. Nevertheless, supply chain system was urged to take care of the competency of future house building supply (Azman et al. 2010).

Tanzania

Kalokola (2014) stated that prefabricated houses are still in immature state in East African countries. Mwamila and Karumuna (1999) studied the advantages of applying semi-prefabricated concrete construction methods in the Tanzanian housing industry. The stressed benefits included saving of up to 19% of direct total costs and reducing construction time up to 57%. The idea of prefabricated house building started in Dodoma, the capital of Tanzania, in 2013. The Capital development authority was responsible of planning and development. This conceptual idea expected to deliver many low cost houses within a short period. Future studies on this project may shade new light to Tanzanian housing growth and house quality development.

Egypt

The Egyptian housing sector has been experiencing a scarcity of providing affordable houses for the low-income group of population. The Central Agency for Public Mobilization and Statistics (CAPMAS) reported shortage of around 40,000 houses annually (CAPMAS 2013). The factors contributing to the situation can be classified into economic, legislative, social and construction methods. Although there is major concern over the housing situation, the combined efforts of both public and private sectors have struggled to meet the growing demand. Addressing the shortage situation by suggesting new construction methods and building materials were found to be minimal. The MMC in the Egyptian context was found under the name of prefab. It was found that the experience of prefab in Egyptian context only limited to caravan offices or precast concrete. The market of prefab is merely produce temporary offices and caravans for the major infrastructure projects or precast buildings (Arabian Construction House for Prefab Building 2014).

Nigeria

Kolo et al. (2014) stated that the OSM in Nigeria still gradually developing based on learning from other developed countries. They stressed the core OSM uptake barriers in Nigeria including reluctance to innovate, small number of codes and standards, supply chain integrations, and skill requirements. To address these barriers, governmental support is an essential in helping to establish OSM as a practical substitute to traditional methods. They observed the need to encourage the awareness of OSM should be through better government policies, and through skilled supply chain partners.

Saudi Arabia

The awareness of prefabrication technology was positive in the construction sector within Saudi Arabia. The prefabrication technologies were found limited to concrete components. It was only applied in building bridges, wall and front panels for multistory buildings, and temporary structures such as site offices and portable toilets. The idea of prefabrication was not well-accepted as an important part of construction processes. The development of manufacturing

sector and the upgrade of construction- related-manufacturing were considered as possible ways of increasing the adoption of prefabrications technology in Saudi Arabia (Aburas, 2011).

### 2.6 MMC initiatives

Clients and designers think that it is the client who usually drives the use of offsite on a project, together with the contractor, designer and architect. On the other hand contractors feel that it is more themselves and the architect who are the drivers. Suppliers on the other hand, think they themselves are one of the drivers, together with the client and the contractor and that the designer and architect are less so. Suppliers think that the take-up of offsite is highly influenced by clients' resistance to offsite. The main method to overcome clients' resistance is provision of examples and case studies of previous successful uses of offsite. The other main methods included client experience and increased partnership and marketing, all different ways of informing, educating and/or convincing the client of the possibilities and advantages of offsite. Cost reduction in MMC products were only used by less than half of the suppliers in the survey, even though the increased expense of offsite was the main barrier to use mentioned by clients/designers and contractors. More than half of the suppliers possibly sold the use of offsite on other factors like speed of construction, quality and value rather than cost (Goodier and Gibb, 2005).

### 2.7 Advantage of MMC

(Chen, 2010) belief that MMC in the construction industry has improved efficiency and better quality as well as several benefits as reduced construction time, lower overall construction cost, enhanced durability, better architectural appearance, enhanced occupational health and safety, material protection, less construction site waste, less environmental emissions, and reduction of energy and water consumption.

Main barriers hindering the increased use of offsite are the belief that using offsite is more expensive. Even though offsite is known for its reduced initial cost and reduced whole life cost suppliers often argue that offsite is not compared in the right manner in order to take into account

advantages such as reduced onsite construction time and economies of scale. The major benefit of offsite compared with traditional construction is thought to be the reduced construction time on site followed by increased quality, more consistent product, reduced snagging & defects, increased value, increased sustainability, reduced initial cost and reduced whole life cost (Goodier and Gibb, 2005).

Offsite manufacture removes much of the construction process from the construction site, leading to several efficiency, productivity and environmental benefits. These include; reduced onsite labor, saves weeks on project times, reducing overheads, better ROI for clients, less waste, less material used, less onsite faults, better health and safety and more environmentally friendly (offsite construction information portal, n.d.).

Successful implementation of MMC in construction industry can offer different benefits compared to conventional in-situ systems. High speed of construction, cost savings, reduction of unskilled workers, faster and better quality control of construction are the significant advantages of IBS (Abedi et al., n.d.).

Literatures on the use of offsite construction in Nigeria (Kolo et al., 2014; Pour et al., 2017), in India (Arif et al., 2012) and in Slovakia (Kyjakova, 2016) show that offsite construction has several advantages:

- **Time**

The application of MMC on site reduced time for construction and consequent product delivery. The overall time spent on site usually depends on the material produced on-site and offsite and it is mainly affected by the material delivered, skilled man power and weather condition. In offsite construction most of the components are manufactured in factory and assembled on site, this will minimize the amount of time spent on site.

(Haseeb et al., 2011) suggested that for minimizing delay in project is to reduce the change in drawing during the construction. In Pakistan delay occur in large construction projects because

of the change of government due to which construction is stopped and new government propose new design for construction as well as bill are not easily passed by new government.

- **Quality**

The exact definitions of quality differed slightly from person to person, but they remained in two basic categories: conformance to requirements; and customer satisfaction (James L. Burati Jr., Member, ASCE, Michael F. Matthews, and Satyanarayana N. Kalidindi, 2018).

It is Easier to control quality at the factory than on-site and better quality in the manufacturing of components and less error will be experienced with improved product consistency and easier quality control at factory. MMC improves the three requirement of quality; durability, whole life cost and performance.

- **Cost**

MMC thought to be expensive than on- site production, but it reduces life cycle cost, better quality building which in turn reduce maintenance cost, reduction of waste and reduction of overhead costs.

MMC can be achieved in the areas of cost assurance and minimize risk, less overall lifecycle costs, better quality of building which will in-turn lead to reduced maintenance cost, reduced preliminaries and site overhead, reduced construction time which can result in cost benefit from early occupation of the property.

- **Environmental sustainability**

MMC reduces buildings and on-site wastes up to 40% of the landfill and reduce waste on the construction site and environmental pollution during construction.

- **Logistics and site operation**

MMC helps constructions with limited access and working space such as airports, prisons, roads and rail projects since it reduces the amount of time spent by the contractors.

### 2.8 Limitation of using MMC

Study on engineering and managerial department about barriers of implementing and adoption of MMC in UK and china found out different barriers. Inflexibility to late design change, higher initial cost, higher overall cost, and incompetency for small projects and higher cost for long-distance transportation are the top five barriers. The author discussed, even though the study was conducted only in UK and China the research questions and objectives were supported on a broad literature review. It was suggested that the study may also be extended to other economies, with modifications to suit country-specific circumstances and conditions, which may be identified through the use of the same or similar research instruments (Rahman, 2014).

MMC has been believed as one of the most effective methods, but the construction industry has found difficulties implementing it (NHBC Foundation, 2016). Literatures on limitation of uptake in Nigeria (Pour et al., 2017), in India (Arif et al., 2012) and in Slovakia (Kyjakova, 2016) show that:

- **Cost**

Factories that produce components and modules for MMCs involve high startup costs to set up suitable machinery and a prefabrication yard for the production of the components and modules. They also need to purchase all applicable materials at the start of the project, which leads to higher initial costs. Moreover, the majority of factory overhead costs such as labor are fixed, not considering of production. The construction cost per unit becomes high if precast components are of small quantities. In contrast, many site-based overhead costs are only incurred if construction takes place. Therefore, it is not easy to use MMCs to respond to variable demand. These lead to MMCs with higher initial costs and potentially higher overall costs than traditional methods.

MMC in some companies considered to be higher initial cost, they argue that saving on-site are not taken into account in financial models and others had been unable to accomplish major savings to counter the higher initial costs.

- **Risk**

Some companies are afraid to take risks by using new approach and the result on cost, labor needed, site problems and mostly clients' reaction to wards MMC application.

- **Standardization**

MMC is considered to be standard or repetitive design and early fixation of design needed which limit the construction industry to make changes.

- **Transportation**

Transportation is seen as one limitation and adding cost since transporting large unit material to site might be difficult and costly.

- **Lack of sub-contractors skill**

Lack of understanding and skills to install the component is seen as another limitation of using MMC.

# Chapter three

# Research methodology

Research methodology is defined as a science of studying how research is done systematically, it help to solve research problems. Methodology shows how problems are studied, what information are collected using which methods, and how information is analyzed to arrive at the conclusions and to develop recommendations (Kothari, 1990).

## 3.1 Research approach

Research approaches can be categorized as either quantitative or qualitative. Quantitative data includes close-ended information such as that found to measure attitudes, behaviors, and performance instruments. The analysis of this type of data consists of statistically analyzing scores collected on instruments like questionnaires or checklists to answer research questions or to test hypotheses. On the other hand, qualitative data consists of open-ended information that the researcher usually gathers through interviews, focus groups and observations. The analysis of the qualitative data typically follows the path of aggregating it into categories of information and presenting the diversity of ideas gathered during data collection (Creswell, 2009).

This research used qualitative approach. This approach was Chosen because, there are fewer projects that have used MMC, MMC is new to Ethiopian building sector and to explore the experiences of MMC in-depth. It also helps investigate the current practices and experiences of the contractors regarding MMC implementation on their construction projects. Qualitative study is also better to describe and analyze small sample units.

## 3.2 Population of the research

This research paper concentrates on geographical location and awareness level. This research is conducted by making its population the project managers that are located in Addis Ababa. Although there are various types of contractor categories and grades, the target population for this research is selected residential building project managers that have applied MMC.

### 3.3 Method of data collection

Two types of data were collected for this research. Primary data was collected in the form of semi-structured interview questions to the selected project managers. And the secondary data was found by referring books, journals, and articles that can back up the MMC implementation practices around the world.

Interview was chosen because, there are fewer projects that have used MMC, MMC is new to Ethiopian building sector and to explore the experiences of MMC in-depth. And the respondents will not be biased when responding to questions that are related to company project performance. Also, this method will reduce the non-response rate and obtain richer data about the MMC implementation practices during the interview session. Selection of data collection method depends on different factors such as nature and scope of the investigation, availability of funds, the time needed and precision required. The type of research and data needed dictate what type of data collection methods to be used (Saunders, Lewis and Thornhill, 2009).

### 3.4 Sampling Technique

Data analysts can use probability and non-probability data sampling methods. Probability methods use random numbers that match with points in the data set to ensure that there is no relationship between points chosen for the sample (Biscobing and Pullen-Blasnik, 2018).

Non-probability data sampling methods include convenience sampling, consecutive sampling, purposive (judgmental) sampling and quota sampling.

Convenience sampling data is gathered from an easily reachable group. Consecutive sampling data is gathered from every subject that meets the criteria until the predetermined sample size is met. Purposive or judgmental sampling is when the researcher selects the data to sample based on predefined criteria. Quota sampling is when the researcher ensures equal representation within the sample for all subgroups in the data set or population (Biscobing and Blasnik, 2018). Purposive sampling method was used to select construction projects that have applied MMC in Addis Ababa by checking data availability and since the term is not well known in Addis Ababa.

In purposive sampling, people or other units are chosen for a particular purpose (Leedy and Ormrod 2005). It is a useful sampling method consisting of receiving information from a sample of the population that one thinks knows most about the subject matter (Walliman, 2005). Semi structured interviews with relevant parties such as contractors' project managers and was used to obtain qualitative data.

It was difficult to gain information about all the individual companies practicing MMC. This was related to a number of factors, including:

- Many companies, particularly the smaller ones, do not have websites,
- Many companies do not specifically advertise the fact that they make MMC items,
- Perceived uncertainties about what MMC actually is, and
- People have misunderstanding about MMC term.

The researcher has obtained the sample contractors' list by asking different governmental authorities and non-governmental offices such as Statistics Agency and Ethiopian Standards Agency and through calling Contractors Association directly because organizations like these are expected to hold such information. Therefore, as per the effort made, a total of 7 respondents were selected. Since the population size is small, the sample is a census. A semi-structured interview was conducted on all sampled contractors. Although the sample of this research is only 7 contractors, there is a condition that the residential contractors who use MMC in their project could be more than 7 in Addis Ababa and one shall bear in mind the acclaimed statement while reading this study. Since the application of MMC in Addis Ababa is limited this research first determined sample companies then companies that currently applied MMC are selected and represented by the project managers purposively.

### 3.5 Qualitative approaches

(John Creswell, 2015) defined different types of approaches in a qualitative research;

Ethnography approach is when the researcher put him/herself in the target participant's surrounding to understand the goals and cultures.

Narrative approach unites order of events, usually from just one or two individuals to form a connective story.

Phenomenological is when the researcher want to describe an event, activity, or phenomenon. In this study the researcher will use a combination of methods, such as conducting interviews, reading document, watching videos, or visiting places and events to understand the meaning participants place on whatever's being examined.

Grounded theory explains the theory behind the events.

Case study involves deep studying and understanding through multiple types of data sources.

(Jeff Sauro, 2015), described the five types of qualitative approaches methods related to focus, sample size and data collection methods as stated below.

**Table 1: Five types of qualitative methods**

| Methods | Focus | Sample size | Data collection |
|---|---|---|---|
| Ethnography | Context or culture | 0 | Observation |
| Narrative | Individual experience and sequence | 1-2 | Stories from individuals and documents |
| Phenomenological | People who have experienced a phenomenon | 5-25 | Interviews |
| Grounded Theory | Develop a theory from grounded in field data | 20-60 | Interviews, then open and axial coding |
| Case study | Organization, entity, individual or event | - | Interviews, documents, reports, and observation |

Studying the different types of qualitative approach the researcher has chose to use phenomenological type approach and interviewed seven project managers who applied MMC in their projects (people who have experience in MMC).

### 3.6 Validity and Reliability

Validity and reliability are conceptualized as trustworthiness, rigor and quality in qualitative study. (Yin, 2014), suggested that a triangulation may apply to ensure the validity and reliability of a research.

In this research theory triangulation and data triangulation were used to increase the validity and reliability of the study. Theory triangulation was realized by critical literature review and data triangulation was realized using several source of information (interviews with different project managers and document study). Judgmental (purposive) sampling was used to select project managers to response with respect to the interview questions and to further investigate the application of modern methods of construction for project quality used by the contractors based on experience value.

### 3.7 Qualitative Data Analysis Methods

Several methods are available to analyze qualitative data. The most commonly used data analysis methods are:

Content analysis: It is often one among the foremost methods to study qualitative data. It is used to study documented information within the sort of texts, media, or maybe physical items. When to use this method depends on the research questions. Content analysis is usually used to study responses from interviewees.

Narrative analysis: This method is used to study content from various sources, such as selected personnel interviews, observations from the field, or surveys. It focuses on using stories and understandings of people interviewed to answer the research questions.

Discourse analysis: This method is like narrative analysis but it studies interactions with people. However, it focuses on analyzing the social context during which the communication between the researcher and the respondent occurred. It also uses information that the researcher get by looking at the respondent's day-to-day environment.

Grounded theory: It uses qualitative data analysis to describe why a certain phenomenon happened. It does this by reviewing different similar cases in different situations and using the

data to develop causal justifications. Researchers may change the justifications or create new ones as they study more cases until they arrive at an explanation that fits all cases.

By studying the above methods of analysis, this research, narrative analysis is used for the semi-structured interview data. The collected data from the interview questions by the selected contractors are gathered and analyzed by comparing and contrasting the interview stories. Then the connection between the answers and the previous studies are narrowed to easily present the findings. Since it is a qualitative study, all data retrieved through interview may vary in content, but the categorization will help to generalize the findings. Therefore, contractors that are in the highest time overrun, cost overrun, quality problems, and customer complaints were analyzed respectively. Then, a summary of each data is organized from the data collected and presented that show the analysis of the MMC practices implemented by the contractors to have maximum effectiveness on their construction projects are developed.

Qualitative modes of data analysis provide ways of discerning, examining, comparing and contrasting, and interpreting meaningful patterns or themes. Meaningfulness is determined by the particular goals and objectives of the project at hand: the same data can be analyzed and synthesized from multiple angles depending on the particular research or evaluation questions being addressed (Qualitative data analysis methods and techniques, n.d).

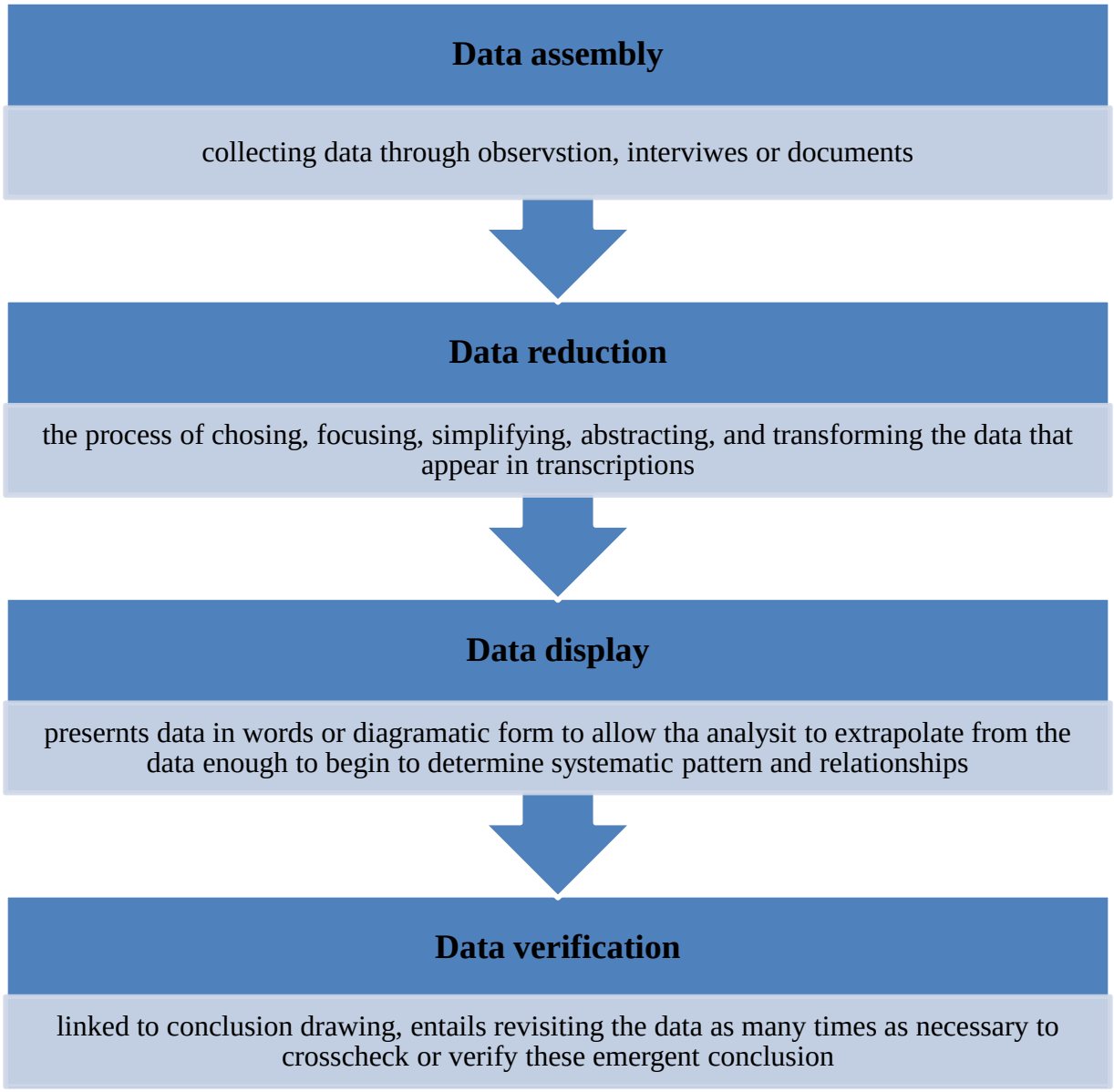



**Figure 2: Data analysis steps**

# Chapter four

# Research analysis and Findings

The analysis of this research is primarily done to find an answer to the research questions raised and to discuss the objective stated in the first chapter. For this research, descriptive analysis type is chosen. By using descriptive analysis, the needed objectives are clearly elaborated and it is covered in the upcoming sub-sections.

## 4.1 Effectiveness of MMC on critical factors of construction projects

The descriptive analysis of the effectiveness of MMC on vital factors of construction projects shows the following findings. Respondents were asked to describe the number of construction projects they executed in the last five years. And of those projects, how many of them showed evidence of project delays, cost overruns, quality problems, and received most complaint from customer.

**Table 2: Effectiveness of MMC summary**

| Contractors list | No. of projects in the last 5 years | Time overrun (no.) | Cost overrun (no.) | Quality problem (no.) | Customer dissatisfaction / compliant(no.) |
|---|---|---|---|---|---|
| Contractor no. 1 | 20 | 5 | 6 | 1 | 6 |
| Contractor no.2 | 16 | 16 | 16 | 10 | 16 |
| Contractor no.3 | 12 | 6 | 7 | 8 | 8 |
| Contractor no.4 | 8 | 3 | 2 | 0 | 3 |
| Contractor no.5 | 7 | 0 | 0 | 1 | 1 |
| Contractor no.6 | 7 | 2 | 4 | 2 | 4 |
| Contractor no.7 | 4 | 0 | 1 | 0 | 1 |

Of the 7 contractors, 5 of them had experienced time overrun, 6 of them cost overrun, and 5 of them quality problems. The contractors that showed the most time overrun are contractor no. 2 and contractor no.3. The contractors that experienced the highest number of project cost overrun are contractor no.1, contractor no.2 and contractor no.3. The contractor that had the highest number of project quality defects are contractor no.2 and contractor no.3. The contractors that had the highest number of customer dissatisfaction (compliant) are contractor no.2 and contractor no.3, but all contractors had experienced some degree of compliant from the customers.

### 4.1.1 MMC Effectiveness on Time of Projects

The interviewees were asked whether they believed or agreed on MMC effectiveness measuring items for time of projects that are commonly agreed by different scholars or not, and to explain why. From the list of items described as effectiveness measures of the time parameter of project performance by MMC implementation derived from the literature review, the respondents have found MMC to be effective on most of the views. It is commonly agreed by scholars that implementing MMC reduces project delay that occurs as a result of defects, snagging, and change of designs. And when asked, the interviewees responded that implementing MMC has helped their organizations save time by minimizing the amount of time spent on site because in MMC products are produced in a factory and assembled onsite. They have also agreed that MMC reduces delay by reducing defects and snagging since the products are manufactured in a controlled environment.

As agreed by many scholars, MMC also results in a more reliable construction project scheduling, delivery, and reducing duration of projects due the amount of time spent on site relies on the amount of factory produced components and those traditionally produced. Construction time on average is affected by material shortage, skill shortage and bad weather conditions. In the case of MMC, these problems have been addressed because most of the building components are manufactured in factories and transported to site; this reduces the amount of time spent on site. As a result of the short time spent on site, it is easier to predict completion date. Most of the interviewees also agreed on the above effectiveness measures.

The findings of this study show the relationship between MMC implementation effectiveness on time and the contractors that had experienced the highest delay in percentage. It is mentioned above that the contractors that had experienced the most project time overrun are contractor no.2 and contractor no.3. Both contractor no. 2 and 3 are indifferent to most of the effectiveness level measures of project time, in relation to MMC implementation. Contractor no.2 even disagrees that MMC implementation leads to better performance. These contractors said that they have not gained tangible benefits from implementing MMC because in Ethiopia importing goods is somewhat always time taking process during freight.

Contractor no.5 and no.7 did not experience project time overrun at all and both contractors agree with regards of the problems implementing MMC in Ethiopia, it helped them in reduction of delay.

Therefore, the contractors who used MMC in their project got effective results on reduction of project delay than who did not.

### 4.1.2 The Implementation Effectiveness on Cost of Projects

Similar to the effectiveness measure from time of a project, interviewees were asked question regarding the effectiveness of MMC for cost of projects. These measures were retrieved from reviewing literatures by different scholars. There is mixed perception on the effectiveness of MMC on cost of the project. Some scholars described as a main barrier to use, some companies find that savings on-site, for example, resulting from shorter construction duration and health and safety benefits are not taken into account in financial models. Others had been unable to achieve significant site savings to counter the higher capital cost. The factories that manufacture components and modules for MMCs require high startup costs to set up appropriate machinery and a prefabrication yard for the production of the components and modules. They also need to purchase all relevant materials at the start of the project, which leads to higher initial costs. Moreover, the majority of factory overhead costs such as labor are fixed, regardless of output.

The main barrier in using modern method of construction industry is the high initial capital, higher design, crane and transport cost incurred. The high initial capital can be overcome by

sufficient volume and ability to reduce mould cost with repetition use of the design. The higher repetition in use of the design may save the cost of mould and the ability produce design layout suit especially for high rise building and high repeatable of houses design. That is why high technology is required in order to have the ability to produce any types of building and to achieve the high end standard of modular building which is produced by manufacturing.

It is agreed by many scholars reduction of cost of a project can be achieved in the areas of cost assurance and minimize risk, less overall lifecycle costs, better quality of building which will in-turn lead to reduced maintenance cost, reduced preliminaries and site overhead, reduced construction time which can result in cost benefit from early occupation of the property. The other thing the respondents have agreed on that they had experienced reduced costs/improved profitability despite the potential for MMC to offer reduced preliminary costs, improved cash flow and lead to faster sales revenues.

The respondents were uncertain on two of the effectiveness measures for cost and they said that they were not as effective for them as expected. These views are that MMC resolves problems of construction projects effectively without changes on the amount of project, and lowers production cost by fewer nonconforming products, less rework, lowered rejection rates, streamlines processes and fewer mistakes. They had argued that once a problem occurred, it will incur extra cost to resolve it regardless of MMC implementation or not. But the respondents were in agreement that MMC lowers correction cost by realizing the defects earlier. They have explained that although some mistakes cannot be avoided, their effect can be minimized by detecting the mistakes earlier before the damage is irreversible or can cause the company loss for correction. Most of the respondents said that they have a contingency plan for such kind of malfunctions included in their budget.

The contractors that had the highest rate of cost overrun among the respondents are contractor no. 1, contractor no.2, and contractor no.3. All seven respondents have a common feeling towards effectiveness of MMC on cost and all interviewees agreed that the availability of cheap labor which offsets the cost benefit of using MMC is a root cause of the slow adoption in Addis Ababa. As long as it is easy for the industry to find workers, labor rates will remain low and builders will find it unattractive to change into simplified solutions such as MMC. It is also

added that if there is to be greater use of MMC risks within the supply chain need to be addressed. There are concerns about the size, quality and capacity of suppliers and their ability to sustain high volume output. Other issues include a need to build-in the ability to provide bespoke designs and interiors and overcome the constraints of standardization, the need for an early design freeze and transport logistics.

### 4.1.3 MMC Implementation Effectiveness on Quality of Project

To analyze the role MMC plays on the quality of project and how effective it is for the construction projects, few measures for effectiveness were derived from literature review and respondents were asked whether each item was effective or not and why. As agreed by many scholars, achieving greater quality was one of the major benefits of MMC and also one of the key deriver to its adoption in other countries. These effectiveness measures for quality of a construction project are that MMC, matches project scope with project proposal and fulfills with contract specifications, helps as an effective quality assurance process, decreases product defect rate, improves quality awareness and understanding of the quality objectives in the organization, improves product and service quality, contributes to achieving defined quality objectives for the construction projects, increases effectiveness and efficiency in meeting the organization's quality objectives. The respondents agreed that MMC is effective regarding the quality of their construction projects on most of the views. The interviewees explained that implementing MMC has helped their company to improve quality.

As mentioned earlier on the cost and time parameters analysis, Contractors no. 2 and 3 had the most project time overrun and cost overrun. These contractors also experienced the highest number of project quality problems. Although these contractors agreed on that quality can better be achieved within a factory and also product consistency can be better achieved in a controlled environment (factory), it will be compromised while installation and low capacity exists within the supply chain, which constrains procurement choice with some having encountered disappointment with delivery performance and product quality.

### 4.1.4 MMC Implementation Effectiveness on Customers' Satisfaction of Project

As mentioned on the literature review, customer satisfaction is one of the main goals and mission of construction companies. Respondent were asked how effective MMC is on customer satisfaction of their construction projects. Similar to the other three parameters, time, cost, and quality, possible effectiveness measures for customer satisfaction are retrieved from reviewing different scholarly literature. These effectiveness measures of MMC on customer satisfaction are that MMC decreases clients' complaints, improves customers' relationship and communication.

As agreed by many scholars, MMC will resolve many problems that might rise between contractors and client, because it improves the main conflict reasons such us quality and construction time. The interviewee also agreed that many of the problems in construction industry arise due to late project delivery, cost increment after the contract and quality defects, this worsen the relationship between customer and contractor.

The contractors that had the highest rate of complain among the respondents are contractor no.2, and contractor no.3. Most of the contractors have received complaints from their customers on the construction projects in the last five years even though they have applied MMC, due to a supply chain problem, shortage and delivery of materials that is usually related with foreign currency shortage and untimely letter of credit (LC) from banks have reduced the application of MMC on projects. Many Scholars agree on supply chain management and partnering concept has not been fully understood by the industry. The teamwork between contractors, manufacturers and suppliers is weak in many cases. Improving the systems and supply chain is the important to achieving MMC success for contracting companies.

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# Chapter five

# Findings summary, Conclusion and Recommendations

## 5.1 Summary of Key findings

In this study of Modern Methods of Construction implementation effectiveness on selected residential construction projects by contractors who participate in the major residential building constructions in Addis Ababa, the major findings that are discovered are listed as follows:.

Although these contractors had implemented MMC, they still face issues regarding time, cost, quality, and customer satisfaction of projects in the construction of residential buildings.

The respondents agreed that the availability of cheap labor which offsets the cost benefit of using MMC is a root cause of the slow adoption in Addis Ababa.

The contractors have not gained full benefits from implementing MMC. The respondents believe that implementing MMC leads to a better quality of project deliverable, reduces construction time, and improves customer satisfaction. But these contractors did not necessarily agree to institution's competitiveness improvement in the industry. So, they have not benefited the full potential of MMC implementation.

The contractors with the highest project quality problems are also the contractors with the highest time overrun and cost overrun.

The respondents believe that they have applied MMC to some extent but not in a satisfactory level, due to a supply chain problem, shortage and delivery of materials that is usually related with foreign currency shortage and untimely letter of credit (LC) from banks.

### 5.2 Conclusion

Implementation of MMC is an effective technique to reduce cost and time overrun and to increase quality and customer satisfaction for construction companies. The study found out the application of MMC in Addis Ababa is not satisfactory level. The effectiveness of MMC implementation for the performance of construction projects on the critical factors of a project is overall important for residential building contractors in Addis Ababa as well as it was for other contractors on different parts of the world which was proven by many scholars as pointed on the literature review.

The interviewed project managers replied that the main reasons for using MMC in their projects are; the improved building quality and reduced levels of snagging, reductions in site labor and a faster build, with improved programming and greater overall construction efficiency. The limitations on applying MMC were price higher than the traditional construction system, professional skill shortage and it was agreed by all the interviewees that the availability of cheap labor which offsets the cost benefit of using MMC is a root cause of the slow adoption in Addis Ababa.

Priority is given by the contractors in the order of; quality, time, and cost next to customer satisfaction for the construction projects. Although there is always room for improvement on project executions; project delay, project cost overrun, workmanship defects, and customer complaints can be minimized through implementing MMC standards and principles thoroughly, and by following up on the process to sustain a continuous improvement.

Finally, this research paper is a preliminary study and is a part of an ongoing research, which will in the long run try to further increase the practices of successful MMC implementation along with introducing the collaborative technologies in construction industry, particularly in the MMC project delivery in Addis Ababa residential buildings. Additionally, it is hoped that the results of the main research will hopefully provide and form the basis of an important management with in the MMC construction supply chain and project stakeholders in order to support the Ethiopian construction industry.

### 5.2 Recommendation

Recommendations for action and recommendations for future research are listed below.

#### 5.2.1 Recommendation for action

From the findings of the research; the government play the main role for the growth and use of MMC should consider generating skilled man power on MMC production and assembly from universities and needs to support through policy and funding, the up skilling of the existing workforce to meet the needs of MMC. Government should manage supply chains and try to give risk mitigation to potential new entrants, SMEs and suppliers.

The construction industry should set better examples for fellow manufacturing industries by exercising an excellent MMC implementation.

It is suggested that the construction companies should exercise the implementation of MMC on more of the tenets other than customer attraction for the effectiveness and efficiency of the project outcomes.

This research recommended the construction industry to find ways to capture and disseminate technologies, lesson learned, and best practices from successful countries and companies to accelerate our learning curve on MMC and to guide the way forward.

An online portal is also suggested to distribute international trends, products and processes associated with the MMC.

The MMC technology needs to be recognized by existing government agencies which can provide an inspection process not only to guarantee consistent quality but also the achievement of structural capacity, fire rating and other requirements. The merchants are to be provided training, seed capital, components design, and selected private sector consultant to start up production factories. The location of this manufacturing plant has to be located in the areas with available labor.

The labor needs to upgrade their skills to be involved in MMC. This would add more value by providing a more expert labor force which would ultimately improve the competitive advantage

of the industry in facing the issue of adoption from traditional to the MMC. They must be equipped in design, installation and project management skills which are important to MMC.

Supply Chain Management has not been fully understood by the industry. Currently, the teamwork between contractors, manufacturers and suppliers is weak in many cases. Improving the procurement system and supply chain is the key to achieving MMC success for contracting companies.

### 5.2.2 Recommendations for further study

- The researcher believes a further work on this area is vital in order to improve the application of MMC in Addis Ababa building construction.
- For future research, it is recommended to identify the best ways for the sustainable development of construction projects from the perspective of implementation of a MMC.
- A research can be done on the other critical success factors (CSFs) of projects such as; Management, Safety, Technology, Organization, Environment, and Resources in relation to MMC.
- A research can be done on barriers of implementing MMC in Ethiopia.
- A research can be done on the effect of using MMC on unemployment.
- Further study on all types of construction is also recommended.

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**Appendix**

**Dear interviewee,**

My name is Selam Abebe and I am currently undertaking a M.Sc. degree in Management at Addis Ababa University Faculty of Business and Economics. In fulfillment of this MSc. degree I am carrying out a research on "The Role of MMC Implementation on Construction Project Performance: The Case of Selected Residential Buildings in Addis Ababa."

The objective of the research is to assess the role of MMC implementation in Addis Ababa on selected residential buildings.

This research is conducted for academic purposes and your answers will help in understanding of MMC role in Addis Ababa residential building sector and improving the sector for the future. Therefore please try to answer the questions wisely and truthfully.

The interview questions are concentrating on research questions and the research is trying to answer the following research questions;

1. What are the benefits of implementing MMC on residential construction projects in Addis Ababa?
2. What is the role of MMC implementation for project performance regarding the time of project delivery, the project budget, and the desired quality of residential construction projects in Addis Ababa?
3. What is the contribution of MMC implementation for customer satisfaction of residential construction projects in Addis Ababa?

Modern Methods of Construction (MMC) are defined as those which provide an efficient product management to provide more products of better quality in less time. It has been defined in various ways: pre-fabrication, off-site production, off-site manufacturing (OSM) and Industrialized Building System (IBS). But while all OSM are MMC, not all MMC are OSM (Burwood and Jess, 2005).

The interview will last roughly 30 minutes to one hour, so please plan accordingly.

**Thank you in advance for agreeing to participate in this research!**

**Interview guide**

**Part I: Demographic background**

1. What is your professional background?

**Part II: Construction Experience of the contractor**

1. For how long has your company implemented MMC?

2. How many projects have you executed in the last five years?

- Of those projects, how many of them were behind schedule?
- Of those projects, how many of them were over budget?
- Of those projects, how many of them were less than the desired quality?
- Of those projects, how many of them were the most complained about from client?

**Part III: Benefits and role of MMC on project time, cost, quality, and customer satisfaction.**

1. Do you agree with the following commonly agreed benefits of implementing MMC or not? Please explain why?

- Reduces cost
- Leads to better performance (MMC helps you finish projects on time)
- Leads to better quality
- Improves customer satisfaction

2. Do you believe/agree that implementing MMC is effective on the duration of your construction projects regarding the following views or not? Please explain why?

- Project delay is reduced as a result of defects, snagging, and change of designs minimization
- Construction project scheduling and delivery is more reliable
- There is more confidence to anticipate shorter project completion time
- Delay due to a well-managed supply chain that provides a stable flow of goods and services is prevented

3. Do you believe/agree that implementing MMC is effective on the budget of your construction projects regarding the following views or not? Please explain why?

- Problems of construction projects are resolved effectively without changes on the amount of project budget
- Optimizes cheaper and easier cost on communication is and follows-up assigned tasks to construction project resources
- Increases profit
- Correction costs are lowered by realizing the defects earlier
- Expenses are reduced by well-managing the supply chain

4. Do you believe/agree that implementing MMC is effective on the quality of your construction projects regarding the following views or not? Please explain why?

- Matches project scope with project proposal and complies with contract specifications
- Decreases product defect rate
- Improves product and service quality
- Contributes to achieving defined quality objectives for the construction projects

5. Do you believe/agree that implementing MMC is effective on the customer satisfaction of your construction projects regarding the following views or not? Please explain why?

- Decreases clients' complaints
- Improves customers' relationship and communication
- Enhances reputation of the organization and quality image to justify to clients