



WALLAGA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

**INVESTIGATION OF CHALLENGES IN ADOPTING
MODULAR CONSTRUCTION WORKS IN THE CASE OF
EAST WALLAGA ZONE.**

MSc. Thesis

By

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JUNE, 2025

NEKEMTE, ETHIOPIA



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**INVESTIGATION OF CHALLENGES IN ADOPTING MODULAR
CONSTRUCTION WORKS IN THE CASE OF EAST WALLAGA
ZONE.**

**A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF
WOLLEGA UNIVERSITY IN PARTIAL FULFILLMENT OF THE
REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF
SCIENCE IN CONSTRUCTION TECHNOLOGY AND MANAGEMENT.**

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APPROVAL SHEET FOR ADVISORS

This is to certify that this thesis entitled “**Investigation Of Challenges In Adopting Modular Construction Works In The Case Of East Wallaga Zone.**” was accepted in partial fulfillment of the requirements for the award of the degree of master of science in construction technology and management by the school of graduate studies, Wollega University through the College of Engineering and Technology was done by **Danga Regasa** is frank work carried out him under my guidance. The matter embodied in this thesis work has not been submitted earlier for the award of any degree or diploma. The assistance and help received during this investigation have been accordingly acknowledged. Therefore, I recommend that it can be accepted as fulfilling the research thesis requirements.

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APPROVAL SHEET FOR SUBMITTING FINAL RESEARCH

As members of the board of examining of the final M.Sc. research open defense, we certify that we have read and evaluated the research prepared by DANGA REGASA under the title of “Investigation Of Challenges In Adopting Modular Construction Works In The Case Of East Wallaga Zone” and recommend that the research be accepted as fulfilling the research requirement for Masters in Construction Technology and Management in May 2025.

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STATEMENT OF THE AUTHOR

Ms. Danga Regasa, Hereby declare and affirm that the research entitled " Investigation of Challenges in Adopting Modular Construction Works In The Case Of East Wallaga Zone " is my work conducted under the supervision of Dr:-BAHIRU BEWKET (PhD) and ASHANAF OLANA (MSc.). I have followed all the ethical principles of scholarship in the preparation, data collection, data analysis, and completion of this thesis. All scholarly matter that is included in the thesis has been given recognition through citation. I have adequately cited and referenced all the sources. I also declare that I have adhered to all principles of academic honesty and integrity and I have not misrepresented, fabricated, or falsified any data source in my submission. This thesis is submitted in partial fulfilment of the requirement for a degree from the Post Graduate Studies at Wollega University. I further declare that this thesis has not been submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

I understand that any violation of the above will be Causes for disciplinary action by the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ACKNOWLEDGMENT

Overall, I thank the Almighty God for what he has done to me in my entire life and makes me strong and feel persistent in committing the research in awesome exertion to overcome different challenges and at long last come up with the achievement of this thesis. I am very grateful to express my deepest appreciation to my advisor, Dr:-BAHIRU BEWKET (PhD), and my co-advisor, ASHANAF OLANA (M.Sc.), for their concern and excellent advice which began from the inception of the research work. All my postgraduate teachers merit awesome much obliged, since their input is worthwhile.

I would like to express my appreciation to all organizations and individuals who contributed straightforwardly or by implication to this thesis and given the fundamental materials and background for the realization of this thesis. Particular obligations are sent to all respondents who sacrificed their valuable time in filling out the questionnaires.

I am deeply grateful to my family for encouraging me to finish the research. I am moreover incredibly obligated to all my companions who encouraged me in one way or another amid my M.Sc. programs.

LIST OF ACRONYMS AND ABBREVIATIONS

AMC: Adoption of Modular Construction

BIM: Building Information Modeling

GHG: Green House Gas

MC : Modular Construction

MiC: Modular integrated construction

MMC: Modern Methods of Construction

SPSS: Statistic package for social science

RII: Relative Importance Index Method

3D – Vm: Three Dimensional Volumetric Modules

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ABSTRACT

Modular construction is a construction procedure that involves the planning, designing, fabrication, and transportation of fabricated building items, and it's assembled on the site with great speed and a high degree of finish. In the East Wallaga zone, the modern method of construction work is not adopted. Because of this, construction time is delayed, poor quality, and high material wastage, so the aim of the study was to assess the challenges of adopting modern methods of construction work. The data analysis technique includes both quantitative and qualitative data. The major challenges affecting the adaptation of modular construction works were identified and grouped into eight major areas. The absence of targets for modular construction and unequal financial playing f due to government policies are the highest challenges. In terms of quality, time, and cost performance, modular construction methods the highest challenges cost scarce financial resources, when compared with conventional construction methods. The readiness for the future adaptation of modular construction in local building projects as stakeholders evaluate market acceptance are the uppermost challenges. Generally, modular construction methods are the highest quality and highest speed of construction and play a major role in the development of the country. So government bodies and all construction sectors in East Wallaga should pay attention to it.

Keywords: Modular construction, on-site Construction, Challenges, Adopting

CHAPTER ONE

1. INTRODUCTION

1.1. Background of Study

Modular construction is a generic term used to describe a building process which uses prefabrication and factory assembly as a fast way of delivering new buildings. It maximizes the efficient use of building materials, construction workforce and resources. The procedure involves the planning, designing, fabrication, and transportation of fabricated building items, and it's assembled on the site with great speed and a high degree of finish. Government of Jersey, 2022)

His degree of accuracy is distantly way better than on-site construction. Advantages of modular construction include shorter construction schedules, a greater degree of predictability in cost, reduced material waste, reduced carbon emissions due to transportation to and from site associated with on-site construction, reduced site disturbance, design customization and easier construction in tight urban areas, better management of timelines, higher quality, Safety, and A more sustainable approach to construction. Modular construction is considered ecologically ideal for on-site due to the controlled environment for arranging and generation some time recently gathering within the construction location (Fufa et al., 2023).

Modular construction offers a promising path towards more efficient and sustainable building practices. However, several challenges need to be addressed to fully embrace modular construction on a global scale:- Regulatory Changes, Skills Shortage, Training and Certification, Cost Considerations, Material Availability, Labor Shortages (Investigate et al., 2024).

The Ethiopian construction industry, like that in most creating nations, faces challenges that block its improvement. To ensure ceaseless enhancement within the development industry's execution, its challenges must be recognized so that coordinated arrangements that suit the setting can be created. The challenges facing the industry are to assess four categories, based on their sources: variables emanating from the role of government, resource-related variables, those related to the nature of the industry and factors exuding from the vision of the industry itself for its possessed advancement. The major challenges are delay in construction industry development policy implementation and corruption; weak capacity of contractors and consultants, lack of collaboration and professionalism; etc. Findings provide information that

stakeholders can use to make informed decisions and critical interventions for the effective development of the industry (Dosumu & Aigbavboa, 2020).

he study shows that in the Oromia regional state the challenges of adopting modular construction mainly depend on factors such as lack of suitable transportation, lack of a synergetic information platform, lack of practice and experience (Girma et al., 2020).

Generally, the modular construction development strategy is the foremost practical and compelling development within the industry in the world. In Ethiopia, particularly in Oromia, it is not implemented due to several challenges, so the study is to identify the challenges to adopting modular construction in the case of east Wollega zone oromia regional state.

1.2. Statement of the Problem

Modular construction is a construction procedure that involves the planning, designing, fabrication, and transportation of fabricated building items, and it's assembled on the site with great speed and a high degree of finish. This degree of precision is far better than on-site construction (Government of Jersey, 2022).

In the East Wallega zone, modular construction methods are not practiced because there are many challenges. According to previous studies, results are shown to mainly depend on factors such as the need for reasonable transportation, need for a synergetic data stage, need for a home and involvement. (Girma et al., 2020)

In the east Wallaga zone, the modular construction method is not adopted. Due to this, many construction projects are not succeeding as a goal that means delays in construction schedules, poor quality of construction, high wastage cost, and high material wastage. Therefore, the present study will aim to assess the challenges of adopting modern methods of construction work in the east Wallaga zone.

Over the previous years of history, performance has developed, but still, there is a great gap between improvements. Nowadays, in East Wallaga, many construction projects use conventional or traditional construction methods. For this reason, there are delays in construction schedules, poor quality of construction projects, high wastage of construction costs, and high

material wastage. To reduce such problems, modular construction is far better than traditional construction methods.

Therefore, to identify this limitation and to meet the required attention, the researcher should have to be initiated to identify the Challenges of Adopting Modern Methods of Construction Works in the case of the East Wallaga Zone, and it is also targeted to identifying and ranking the Challenges of Adopting Modular Construction Works the Case of East Wallaga Zone, and to recommended concerning body.

1.3. Research Question

- What are the challenges that hinder the implementation of modular construction?
- What are the benefits of adopting modular construction?
- What are the stakeholder perceptions of the future adoption of modular construction in local building projects?

1.4. Objective of Study

1.4.1. General Objective

This study is focused on identifying the challenges of adopting modular construction in the case of east wallaga zone.

1.4.2. Specific Objective

- to identify and rank the major challenges affecting the adoption of modular construction
- to compare modular construction with conventional construction methods in terms of quality time and cost performance based on stakeholder perception
- to evaluate stakeholder readiness for the future adoption of modular construction in local building projects.

1.5. Scope of study

The study focused on identifying and ranking the challenges of adopting modular construction work in the case of the East Wallaga zone. Delays in construction schedules, poor quality of construction, high waste cost, and high material wastage due to this, many construction projects are not succeeding as a goal.so the target studies are to identify which challenges are highly affecting the use of modular construction methods in the east Wallega zone.

From the viewpoints of the major parties in construction, namely contractors, consultants, clients, and regulatory authorities, to identify the major challenges of adopting modular construction in the construction industry and from stakeholders' perception to analysis of the results of studies.

1.6. Significance of study

The aim of the research is to investigate the major challenges of adopting modular construction and to suggest possible ways of minimizing the challenges of adopting modular construction and to suggest the benefits of adopting modular construction in the east Wallaga. The result of this research will help the overall construction industry and end users in East Wallaga.

It is expected that the findings of the study will be used:

- ✚ To recommend the benefits of modern modular construction methods.
- ✚ To recommend the concerned bodies to take the direction of corrective action in the construction industry.
- ✚ To educate the construction sector about the benefits of modular construction methods.
- ✚ In the future, to serve as a reference for students interested in pursuing related postgraduate studies.

1.7. Organization of the Paper

The research thesis is organized into four chapters. The first chapter defined the problem that the researcher searches for to investigate and specified how the research is going to be conducted. It provided an overview of the problem statement as well as the research questions and objectives.

The second chapter was exclusively devoted to reviewing related literature on the Challenges of Adopting Modular Construction Works in the Case of East Wallaga Zone. The third chapter discusses a general description of the research strategy implemented, as well as the justification of the methodology. It focused on the description of the study area, research design, population and sampling techniques, and data collection methods and method of data analysis. The fourth chapter provides the results of this research. And chapter five is the recommendation and conclusion.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Overview the challenges of adopting modular construction

Modular integrated development has as of late been advanced by the progressing nations as a viable arrangement to;- empower quick development, upgrade the reducing development efficiency, and back feasible improvement. The benefits and challenges of Modular integrated construction have pulled in a few analysts in later a long time. A few challenges exist within the around the world appropriation of Modular integrated construction, such as tall starting taking a toll, the instability of requests, troubles in accomplishing economies of scale, transportation of modules, troubles with coordination and planning, lack of codes, and lack of government support. The barriers are classified: knowledge, attitudinal, financial, technical, aesthetic, industry, process, and policy barriers. This study showed the hierarchical nature of Modular integrated construction challenges due to their diversification. It found challenges related to the technical advancements of MiC in terms of designs and materials, such as the lack of design guidelines, scarcity of skilled workers, and transportation problems.(Tsz Wai et al., 2023)

In Nepal, the study investigated and identified the top five significant opportunities and challenges in the modular construction market. The top five opportunities are: a) reduction in construction time, b) expanded labor efficiency, c) diminishment in revamp, d) improvement of more standardized and naturally economical items and e) better reasonableness for ventures with time and space imperatives. The top five challenges identified are: a) competition with ordinary development strategies, b) less data integration of measured development to society, c) the need for qualified specialists, d) less suitability for small projects because of design and cost, and e) limited market demand compared to conventional construction..(Kisi et al., 2019)

In Portugal, modular construction has a disruptive nature to traditional construction methods, and it defies the current way construction projects are planned, procured, delivered and managed. Construction partners must be effectively included within the few stages of the venture to guarantee its victory, from plan to development, operation and support stages. Secluded development can be a reasonable arrangement to extend efficiency in construction as well as other issues confronted within the industry. To study the reasons behind the low levels of usage of modular construction in European Union construction markets(Ribeiro et al., 2022)

In the United Kingdom, Modern Methods of Construction (MMC) has no all-around acknowledged definition but can be recognized as a collective term, utilized to depict a number of offbeat and new inventive development strategies. The main purpose of introducing MMC is to improve products and processes in terms of business efficiency, quality, customer satisfaction, environmental performance, sustainability and the delivery of the final product on time and within the constraints of the project environment. Tall quality MMC requires superior forms for the execution and conveyance of the item. The first wave of MMC struggled with negative reports, due to reasons such as the reliability of product, poor expertise, and durability was lacking and not quality assured. Since then, construction firms have learnt from the past. The new types of MMC are quality assured, but barriers are that the design time of projects is not frozen early enough to allow for lead manufacturing time of such products (Williamson et al., 2019)

The United Kingdom is seeing an advancement emergency supported by the failure of conventional development to overcome its ambiguities and complexities when overseeing multidisciplinary errands. Modern Methods of Construction by presumption in favor of outperforming traditional methods in meeting key industry goals. Despite the public construction sector's recognition of the benefits, MC uptake of this influential purchasing power is still far from satisfactory. Such low adoption rates have been linked to MC firms' business strategies contributing to public clients' indecision (Saad et al., 2023)

In the United Kingdom and China, modular construction offers many benefits. Cost-related issues are the most important barriers to implementing modern methods of construction, in spite of the fact that respondents from the two nations clearly oppose this idea because of the relative significance of distinctive components. Clients have agreement on the significance of fewer obstructions than temporary workers and experts, who are anticipated to assist, embrace advanced strategies of development. Expansive organizations show fewer consensuses than medium-sized organizations, which show fewer consensuses than small organizations. This was deciphered to assist the industry in embracing secluded developments, since bigger organizations control smaller organizations in most cases (Rahman, 2014)

In Bangladesh, the construction industry is extending at a quick pace and building development innovation has not been created. However, to that degree compared to other creating nations. As of late, Bangladesh has included completely different mega ventures as a lower center salary nation. But most of the development is based on labor-intensive, so the venture time and work are not useful. Utilization of cutting-edge apparatus and procedures is thought to beat generation speed, assurance, and productivity. The use of mechanical progression comes about a nation to ended up quickly forward and decreasing the hazards of human exercise by supplanting it with innovation (Abdilahi et al., 2023)

Modular construction endeavors to alter the advertising by presenting an inventive domestic plan that consolidates tall quality and energy-efficiency at a reasonable cost. This would possibly energize families to get to be home-owners instead of tenants due to more reasonable costs and lower utilities bills. Be that as it may, preparations come about uncovered that there are boundaries that anticipate the selection of measured development, such as nearby building codes, necessities, and measured confinement. The purpose of this study is to conduct a review to identify and assess the challenges faced by modular construction in the U.S. residential industry. Furthermore, this paper will introduce modular construction and other Smart and Industrialized Construction techniques that can be utilized in constructing affordable homes (Costin et al., 2019)

In Malaysia, modular construction is also known as volumetric construction, modular building system or modular system. Modular construction was created in the 1940s amid World War 2 as an arrangement for soldiers' convenience and after World War 2 due to the increment in lodging requests within the US. Modular development may be a development strategy to develop a building utilizing three-dimensional or secluded units, which are amassed and delivered in a manufacturing plant. The three-dimensional units utilized for modular development incorporate the calculated and gathering viewpoint, draining legitimate coordination through arranging and integration.(Musa et al., 2016)

In Vietnam, construction technology adoption is low when compared to other countries with similar gross domestic product per capita, resulting in lesser productivity. The most influential construction technology adoption barriers: Unknown impact on productivity, late implementation of software in construction projects, lack of understanding of importance and needs in the

construction industry, lack of funds during budget planning for technological advances and implementation, lack of experts required for technological change, and insufficient skills in the industry(Momade et al., 2022)

In Ethiopia, the major challenges identified are the nature of the industry and lack of awareness, weak capacity of companies and the regulatory instruments, inadequate tender duration and poor monitoring and controlling practice. The suggested improvement mechanisms are compelling coordination of the method and mindfulness creation, promoting technology and development within the acquirement preparation and innovation and development thought in development venture enrollment. Considering the suggested improvement mechanisms, an improvement framework is framed under three pillars: improving the regulatory framework, raising awareness and stakeholder engagement and continual monitoring and control of the practice. The effectiveness of construction industry improvement programs in developing countries is affected by the in appropriateness of the adopted implementation mechanisms. Understanding the operating environment, the enablers and barriers, and stakeholders' implementation capacity, is important for the success of any envisioned practice(Mengistu et al., 2023)

In Oromia, the prefabricated construction method is the most practical and effective construction in the industry today in the world. It is broadly considered a maintainable approach to the construction industry. In any case, in Ethiopia, especially in Oromia, it isn't encouraged development where the construction method is a conventional method. Lack of suitable transportation, lack of synergetic information platform, lack of practice and experience, and UN integrated industry chain were the major factor challenges to using prefabrication technology(Girma et al., 2020)

Generally the invention of the offsite fabrication approach, this technique was further adopted by developed and developing countries and is regarded as a modern construction technique. Modular construction is an emerging technology that uses light steel framing in factory-produced units that can be assembled on-site to form parts of, or even complete, residential and commercial buildings. Modular construction is the foremost progressive strategy of accessible off-site development, producing fully-fitted modules with up to 80% of the work completed in a controlled environment prior to their transportation and establishment on-site (Ribeiro et al., 2022)

2.2. Lack of adopting modular construction work consequence

Modular construction has generally been regarded as a more productive construction method, and digital technologies are considered to provide higher productivity and safety. Be that as it may, there's a need to investigate how advanced advances can be best utilized to realize the potential points of interest of off-site development. A little writing has made investigations in this region, whereas, to begin with, hand-to-hand examinations from the development industry are still uncommon. This study aims to distinguish the issues which can possibly be settled by receiving advanced in off-location development ventures, and explore the current home and possible approaches to improve technology utilization to achieve the goal. Practitioners, including designers, manufacturers and site engineers working on Chinese off-site construction projects (Wang et al., 2022)

The modular construction technique could be a better choice depending upon the building form factor, site location, and the client and planning requirements and some scenarios where it would be preferred over the traditional construction techniques include :- Regular or cellular building shapes with a high degree of repetition where the economy of scale in design and manufacturing can be achieved, Construction in congested cities, Construction sites where noise and other pollution need to be minimized during the construction, Extensions to existing buildings, and Construction projects where some degree of relocation or extension is envisioned in the future (Kisi et al., 2019)

Modular Construction (MC) has no universally accepted definition but can be recognized as a collective term, used to describe a number of unconventional and unfamiliar innovative construction methods. The main purpose of introducing MC is to improve products and processes in terms of business efficiency, quality, customer satisfaction, environmental performance, sustainability and the delivery of the final product on time and within the constraints of the project environment. High-quality MC requires better processes in the performance and delivery of the product (Williamson et al., 2019)

he trade-offs include favoring modular construction in specific when the sort of structure encompasses a degree of repeatability, a unit estimate that suits arriving transport, and an esteem thickness where the reserve funds for moving exercises to the plant outweigh the coordination fetched. Any building being fabricated has to be outlined for the fabricating handle and thus

oblige the number of distinctive varieties required. For illustration, reasonable lodging, understudy lodging, and inns are exceedingly standardized and repeatable. This doesn't cruel that all of these buildings presently have to be the same understanding the level of customization wanted by the conclusion client and what can be built into the fabricating handle could be a key element in developing the modular solution. In terms of unit size, narrow hotel rooms, for instance, are easier to pre-produce than wide lobby halls. And bathrooms with a high built value are more feasible for modularization than simple (Bertram et al., 2019)

Construction is the exhibit of gathering parts of a structure in an assembling procedure or another storing up location and moving add up to arrays or sub-gathering occasions to the improvement site where the structure is to be constructed. The pre-assembled development strategy is the foremost practical and viable development within the industry nowadays within the world. It is broadly considered a maintainable approach to the development industry.

In Ethiopia, especially in Oromia, it isn't encouraged to develop areas where the construction method may be a routine strategy. The challenges of utilizing construction innovation in the Oromia Territorial State basically depend on components such as the need for reasonable transportation, need for a synergetic data stage, need to hone and encounter. Generally, the research concluded that lack of suitable transportation, lack of synergetic information platform, lack of practice and experience, and an integrated industry chain were the major factor challenges of using prefabrication technology (Girma et al., 2020)

2.3. Modular construction with conventional ones in terms of quality, time, and cost

Modular integrated construction has as of late been advanced by progressive nations as a compelling arrangement to 1) empower quick development, 2) improve the decreasing development efficiency, and 3) back economic advancement (Tsz Wai et al., 2023)

Modern methods of construction offer a promising path toward more efficient and sustainable building practices. However, several challenges need to be addressed to fully embrace modern methods of construction on a global scale:

Regulatory changes or the adoption of modern methods of construction have been hindered by evolving regulations. Harmonizing regulations across countries and regions is essential to facilitate the widespread use of modern construction methods (Green, 2022).

Skills Shortage: Employers face difficulty recruiting workers with the necessary skills for modern methods of construction.(Assaad et al., 2023).

Training and Certification: Inadequate training and certification programs contribute to the slow uptake of modern method of construction Fostering education and certification in modern construction techniques is crucial.

Cost Considerations: While modern methods of construction can be cost-effective in the long term; initial implementation costs can be higher. Addressing cost concerns and demonstrating the long-term benefits are essential (Assaad et al., 2023) .

Material Availability: The choice of materials for engineering purposes in the construction industry is a time consuming and costly process. Ensuring a steady supply of materials suitable for modern methods of construction is critical. The industry must explore sustainable alternatives and efficient material management (Aghazadeh et al., 2019).

Labor Shortages: Both on-site and professional labor shortages cause delays. Modern methods of construction solutions that provide greater predictability and reduce reliance on manual labor are increasingly attractive (Assaad et al., 2023) .

A review of the literature appears that secluded development has numerous boundaries and challenges. Further, a modular construction project requires high startup costs, requires highly skilled labor, lacks design standardization, has smaller market demands, requires effective communication between parties involved, lacks experienced contractors in applying modularization concepts, requires early design and production of parts and modules, possesses high transportation costs to transport larger modules to the site (Kisi et al., 2019).

Social and economic benefits of pre-assembled development strategies were distant predominant to conventional construction methods. (Maqbool et al., 2023) Several advantages of prefabricated construction includes rapid installation on site, reduced overall construction costs, low self-weight leading to the structural saving, reduced disruption in the vicinity of the construction site, and better quality control.(Kisi et al., 2019)

(Modern construction) MC's application in construction projects has significant benefits regarding sustainability, time, cost, and quality assurance. Unfortunately, the presentation of MC

within the construction industry has different barriers that affect its execution, such as attitudinal barriers, information obstructions, specialized boundaries, and budgetary barriers. Fortunately, those barriers can be tackled through enablers that facilitate the accomplishment of the adoption of MC in residential projects in Egypt (B et al., 2023)

2.3.1. Quality performance

The progressions in modular construction, highlighting steel and concrete measured frameworks, near an imaginative lightweight and long-span steel-concrete composite approach. It emphasizes the constructability, quality, and vigor of these frameworks, with steel-measured frameworks leveraging lightweight properties for quick get-together and basic keenness through corner bolster frameworks, whereas concrete secluded frameworks prioritize strength and fire resistance utilizing composite basic divider frameworks. The integration of computerization and construction strategies revolutionizes development hones, upgrading efficiency, effectiveness, and quality (Liew & Chua, 2025)

Offsite construction technologies and strategies, to address the challenges of destitute efficiency, lack of talented labor, unsuitable extended execution, among other issues. In fact, offsite construction showed great potential to deal with the industry's epidemic problems. Offsite construction could create many opportunities for the workforce, including greater productivity, higher learning rates, better working conditions, enhanced worker quality, and improved safety and health, among others (Assaad et al., 2023)

The challenges of adopting modular construction verses due to quality performance;- uncertainty about component quality, potential for on-site assembly errors, workforce skills gap during construction, fragmented information flow, logistics expertise gap.

2.3.2. Time performance

Modular construction uses prefabricated elements for as many building components as possible such as everything from walls and mechanical systems to painting and carpet can be completed on the assembly line. The prefabricated elements are assembled on-site to either construct parts of or entire residential and commercial buildings. In comparison, conventional concrete development with brick dividers in Nepal takes a significant amount of development time and space because it requires a stockpile of crude materials on location and most of the work is done

on location. A few focal points of pre-assembled development incorporate fast establishment on location, decreased general development costs, more self-weight-driven structural savings, decreased disturbance within the region of the development location, and superior quality control (Kisi et al., 2019)

The challenges are adopting modular construction verses due to fastening performance, longer lead times in design & manufacturing, delays associated with component fabrication and construction, component lead times, prefabrication duration, limited capacity of modular construction providers, difficulties securing timely deliveries, Extended design phase due to the complexities of MC.

2.3.3. Cost performance

The construction sector is one of the biggest all-inclusive segments because it has a positive effect on countries' economies. Modular construction can be exorbitant. It is acknowledged by temporary workers for its capacity to decrease construction schedules and save costs. In any case, program delays, expertise holes, and decreased plan adaptability pose noteworthy challenges (Thurairajah et al., 2023). The creation of a sustainability-oriented approach to construction that simultaneously addresses economic, ecological, and equity considerations is essential. Civil engineers in particular are in a key position to influence these three angles given their wide parts, extending from planning to deconstructing the built environment (Marinelli et al., 2022). Generally, the challenges of the adoption of modular construction are due to cost performance, high upfront cost, difficulty achieving economics of scale, high initial investment cost, scarce financial resources, and high transportation costs.

Total cost estimates for both construction methods rely on the quantities from BIM and the rates associated with the material components. Such rates incorporate labor within them. Modular construction is on normal cheaper than ordinary strategies for this case illustration. The reason behind this is due to the fewer materials used, and the automated building process in modular construction, which permits economies of scale to be realized (Hammad & Akbarnezhad, 2017)

2.4. Comparative analysis of Modular and conventional construction methods

The utilization of modular construction methods for ventures offers noteworthy time and natural advancement relative to routine development strategies. Right now, there's a need for suitable evaluation approaches to capture the contrasts between modular and conventional construction. With the growing awareness of sustainable construction, many companies have shifted their focus to sustainable design. This is particularly important given the impact of the construction sector on the economy and on the environment. One way suggested improving the sustainability of the construction and building industries is through the use of modular construction.

This work presented a novel framework to compare the modular construction method against a conventional one. The framework focused on evaluating three main criteria, namely embodied carbon, productivity and monetary cost of the project. The effectiveness of the proposed framework was confirmed by its application to a practical construction project. Modular development was found to be more compelling in terms of lower encapsulated carbon, higher efficiency and lower development costs (Hammad & Akbarnezhad, 2017)

Modular construction technology (3D Volumetric Development) is one such construction innovation. Each year, both financial specialists and standard customers are appearing to be increasingly intrigued by measured homes, and it is rapidly getting to be a better approach in domestic building compared to conventional construction. This sort of development encompasses a number of points of interest against conventional construction, such as shorter construction time, higher quality and conceivably sparing a little cash (Endzelis & Daukšys, 2018)

Modular construction could be a novel strategy that has several advantages over conventional development strategies; be that as it may, alongside the benefits, there are confinements that make it challenging. Different perspectives of secluded development ought to be considered in-depth to progress the development handle. The most benefits and challenges related to measured development and will offer assistance extend partners select between this strategy and ordinary development strategies for their ventures (Karthik et al., 2020)

Modular construction endeavors to alter advertising by presenting an imaginative domestic plan that joins tall quality and energy-efficiency at a reasonable cost. This would possibly empower

families to end up being home-owners instead of leaseholders due to more reasonable costs and lower utility bills (Costin et al., 2019)

Modular construction (MC) plays a significant part in cultivating maintainable advancement. In any case, the advancement of MC in numerous ways has been burdened by its winning undeveloped supply chain. This think about points to efficiently investigating the drivers, openings, limitations, concerns, techniques, and measures with respect to upgrading the MC supply chain, utilizing the observational case of secluded coordinates development in Hong Kong and the supply chain within the more noteworthy Inlet Range of China (Zhang et al., 2024)

Nearby is an imaginative lightweight and long-span steel-concrete composite approach. It emphasizes the constructability, quality, and vigor of these frameworks, with steel secluded frameworks leveraging lightweight properties for quick get-together and basic keenness through corner bolster frameworks, whereas concrete secluded frameworks prioritize strength and fire resistance utilizing composite basic divider frameworks. The proposed lightweight steel-concrete composite framework coordinates the benefits of both materials: advertising amplified ranges, strength, adaptability, and ease of get-together. Strong quick-joining strategies coupled with lightweight steel fiber strengthened thin floor framework guarantee sped up establishment and worldwide soundness. The integration of robotization and construction methods revolutionized development phones, improving efficiency, proficiency, and quality. Also Measured development, pointing to progress, efficiency, proficiency, security, and maintainability inside the development industry (Liew & Chua, 2025)

The modular construction method could be a technique that uses pre-assembled modules/units, and it could be a strategy that has culminated in arrangements in inaccessible, country and urban zones where customary or conventional development may not be conceivable. Secluded development procedures ought to be embraced for the development of buildings such as church buildings, sanctuaries, mosques, restorative and healthcare offices and retail shops, quick nourishment joints, etc. Also, the measured construction techniques generate less squander on-site since building components are pre-assembled within the production line and after that transported to the location for their last establishment; hence, sparing time and cash. Subsequently, the secluded development procedure is much more effective and economical (Kantamneni et al., 2021)

explaining why they occur. Therefore, it is important to also adopt a qualitative research paradigm to compensate for the limitations of using the quantitative approach for a study. This research study was carried out within the prescribed timeframe as per the attached work schedule, from September 2024 to June 2025, and below shows the process of this research paper.

3.3. Data Source and Type

To conduct the research, the researcher used primary and secondary data. The primary data was obtained through open and closed questionnaires, and semi-structured interviews. The secondary data is collected from desk study, books, journal articles, reports, etc.

3.4. Methods of Data Collection

In this study, the data collection process will involve two stages. The first stage consisted of a literature search for information on the Challenges in Adopting Modular Construction Works in other countries and an interview with some experts involved in the implementation process.

The purpose of interviewing the experts will be essential to validate a preliminary set of Challenges in Adopting Modular Construction Works gleaned from the literature and to determine from their experience other Challenges in Adopting Modular Construction Works in the east wallaga. Based on this, questions develop and will be distributed to the respondents. The second stage is that semi-structured interviews were also conducted among contractors, consultants, clients, and government bodies for the qualitative study. The interview adopted an attitudinal approach which is used to subjectively evaluate the opinion of a person or group of people regarding a particular attribute, variable, factor or a question.

According to Singh(2007), quantitative data is a numerical record that results from a process of measurement on which basic mathematical operations can be done. The research method that was used for this study was a quantitative and qualitative method. The reason for choosing a quantitative research approach was since the data obtained by the ordinal Likert scale has been changed into numbers and analyzed through a statistical process. Furthermore, the qualitative method was used to analyze interview questionnaires which the researcher used to gather the required information from the respondents. Therefore, to obtain the required data from sample respondents regarding identifying the Challenges in Adopting Modular Construction Works, analyze the Challenges in Adopting Modular Construction Works and to rank the Challenges in

Adopting Modular Construction Works in the east Wallega Oromia region. The five types of Likert scale (1= Very Low (VL), 2= Low (L), 3 = Moderately (M), 4 = High (H), and 5= Very High (VH)). Questionnaires were used. Additionally, semi-structured interviews and case studies were used in-depth to investigate the particular occasions of the research problem.

3.5. Target Population.

The population refers to the total collection of elements that one would like to study or make inferences in Igella (2014). According to Amin (2005), a target population is a population to which the researcher ultimately wants to generalize the results. Therefore, the target population of this study was contractors, consultants, clients, and government bodies.

3.5.1. Population Study and Sample Size

Sampling is the method of selecting an actual agent test of people from the populace intrigued. Sampling is a vital device for investigating ponders, since the populace of intrigued more often than not comprises as well numerous people for any investigative extent to incorporate as members. A great test could be a factual representation of the population intrigued and is hugely sufficient to reply to the inquiry about the address (Majid, 2018)

Three categories of practitioners within the construction industry were chosen for the study, which included contractors, consultants, clients, and government bodies. The study design led to a choice of only practitioners who are members of their various participant professional bodies, thereby giving a research population of contractors, consultants, clients, and government bodies who are members of their respective professional bodies. So the sample for the study total by taking survey data form consultant, contractors, clients, and government body in east wallaga the population size of 50.

Stratified sampling procedures are applied to generate the sample for the study and the questionnaire survey uses will propose the formula of Yamane (1967) as follows; $n = \frac{N}{1 + N(e)^2}$, e =the standard error of sampling distribution, N =the total population size, n =is sample size. Sample Size practitioners and the assumed standard error of sampling distribution ($=0.013$), so $n=44.034$

3.6. Pilot study

Drafting a good questionnaire is highly specified work and prerequisites are great attention, skill, knowledge, efficiency, and experience. These intended questionnaires should be based on a carefully prepared set of questions piloted and sophisticated until the researcher is induced by their validity. Therefore, the pre-analysis is a substantial step in the questionnaire design process, preceding to confirming the questionnaire. It includes controlling the questionnaire to a regulated number of possible respondents and other knowledgeable societies to find and correct design weaknesses (Al-Najjar, 2008). The test was made by distributing five drafts of the questionnaire to experts in the construction industry. After checking the questionnaires, they agreed that the questionnaire is suitable to achieve the goals of the study, and they asked me to add some parameters and modifications to some parameters..

3.7. Data Quality Control

3.7.1. Data Reliability

Reliability estimates the degree of uniformity of the results obtained from repeated measurements. The reliability of an instrument or questionnaire is the degree of consistency with which it measures the attribute it is supposed to be measuring. Moreover, Humaidi & Said (2011) said that the higher reliability indicates less variation of the instruments.

The variables include dependent and independent variables. The independent variables include all the challenges in adopting modular construction work, such as: challenges due to supply chain and information systems, challenges due to the workforce or workers, negative challenges of client perception, challenges due to contractors, challenges due to construction design, challenges due to behind government body, barriers due to equipment availability, barriers due to construction site and standard of offsite, The dependent variables are the impacts of construction industry, delay of construction pried, lack of construction quality,

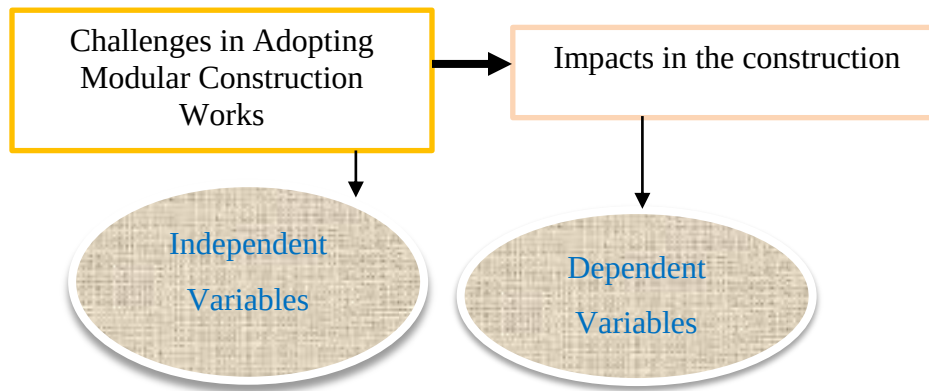


Figure 3.3. Conceptual Frame work

3.7.2. Data Validity

Validity is an exceptionally critical and valuable concept in all forms of investigative methodology. Its essential purpose is to extend the accuracy and convenience of discoveries by eliminating or controlling as numerous bewildering factors as conceivable, which allows for more prominent certainty within the discoveries of a given study (Graziano & Raulin, 2004). In this study, the researcher addressed the research validity through formulating objective questions, the review of related literature and adopting instruments used in previous studies. In order to measure how true the research results are and how the research instruments allow them to hit the bull's eye; of a research objective or construct an instrument or research question. To address the objective and research questions of this study, even researcher invited expertise to assure the content validity of the instrument or questioner. Based on the judgments and comments of the experts, the contents of the survey questionnaire and other qualitative data collection tools were revised and used for actual primary data collection purposes. In addition, data was collected from different people to obtain rich information for the purpose of the data. The Kruskal-Wallis test is less sensitive to outliers than the one-way ANOVA since it does not presuppose normality in the data. This test is used in order to check if there is any significant difference in the point of view of the respondents (contractors, consultant, client, and government body) regarding the level of each of the Challenges in Adopting Modular Construction Works and also used to validate the results of Kendall's coefficient of concordance. Ho: There is no statistically significant difference between the responses of contractors, consultants, clients, and government bodies.

H1: There is a significant difference between the responses of the contractors, consultants, clients, and government bodies (StatisticsSolutions, 2017)

3.8. Number of Questionnaires Distributed

Based on the selected sample, a questionnaire assessment was conducted to gather the requisite information and a total of 44 questionnaires were sent to the respondents, of which 22 were contractors, 9 consultants, 9 clients, and 4 government bodies.

3.9. Questionnaire Response Rate

From 44 distributed questionnaires, 40 questionnaires were returned. Two are not returned and Two of them did not fill in correctly.

Table 3.1. Result of Questionnaire Response Rate.

Respondents	Distributed	Returned	Un returned	Valid percent (%)
constructor	22	20	2	50.0
consultant	9	9	0	22.5
clients	9	7	2	17.5
government body	4	4	0	10
Total	44	40	4	100.0

This indicates that, from a total of 44 distributed questionnaires, 42 were returned. From the returned 42 questionnaires' 2 were not valid. Means that 40 returned questionnaire were valid.

3.10. Data Analysis Technique

The data Analysis Technique is included, quantitative data were analyzed using the Statistical Package for Social Sciences (SPSS) 25 version, Microsoft Excel software 2013, and the original pro 8.5 version for graphics. Two forms of statistical analysis were undertaken: Descriptive statistics such as percentages are used to summarize information from respondents and also inferential statistics such as the relative importance index method (RII) are used to determine constructors, consultants, clients, and government bodies' perceptions of the relative challenges adopted in modular construction work.

Ranking of the attributes in terms of their criticality as perceived by the respondents was done by the use of the Relative impact Index (RII) method. Also, (Ametepey & Ansah, 2014) and

(Enshassi et al., 2014) The RII method determines the relative challenges adopted in modular construction work in the construction industry. Therefore, the same method adopted in data analysis consists of the following. The relative importance index method is where W: is the weight given to each response, N: is the total number of respondents, A: is the highest weight, $\Sigma W =$ is the sum of weights given to each response. The relative importance index has values from 0 to 1. and the group index is the average of the relative importance index of the identified factors. The values of RII range from 0 to 1 (0 not inclusive); the higher the RII the more challenges adopting in modular construction. The RII value is ranked, and the results are shown using tables and text. The RII is then classified based on the RII classification as shown in the table according to (Akadiri, 2018).

Table 3.2. Classification of RII

Scale	Level of Importance	RII
1	very low impact	$0.0 < RII \leq 0.2$
2	low impact	$0.2 < RII \leq 0.4$
3	medium impact	$0.4 < RII \leq 0.6$
4	high impact	$0.6 < RII \leq 0.8$
5	very high impact	$0.8 < RII \leq 1.0$

Consequently, the study sponsors' level of agreement about the need to investigate challenges in adopting modular construction works in the case of East Wallaga Zone. To assess the major time, cost, and quality of construction work, and to rank the major challenges in adopting Modular Construction Works in the case of East Wallaga Zone. the relative importance index (RII) value of the response was computed based on the Likert scale and indicated the average agreement of respondents.

Accordingly, the higher the RII, the more challenges in adopting Modular Construction Works in construction affected time, cost and quality of construction. Therefore, the RII value is ranked, and the results are shown using tables. Also, the results were supported by interviews conducted in the East Wallaga zone. The discussions were on the top-ranked factors according to all responses which achieved the entire objectives of the research and answered the research questions.

3.11. Degree of freedom for all groups of respondents.

Kendall's coefficient of concordance was utilized to decide whether there's a critical degree of assertion among the four (4) groups of respondents (constructors, consultants, clients, and government bodies). Kendall's coefficient of concordance is used as a measure of agreement among raters. (Sheskin, 2003). Ho: there is no significant difference between the responses of the constructors, consultants, clients, and government bodies. H1: There is a significant difference between the responses of the constructors, consultants, clients, and government bodies.

For all the challenges adopted in modular construction groups, the P-values (Sig) are greater than $\alpha = 0.05$ (α is the level of significance). The null hypothesis, however, is rejected. Thus, it can be said that there is sufficient evidence to support the alternative hypothesis, H1. Therefore, there is a significant degree of agreement among the constructors, consultants, clients, and government bodies regarding the challenge adopted in modular construction in the east wallaga zone Kendall's coefficient of concordance Where w =the coefficient of concordance; D =the difference between the individual sum of ranks of the raters or judges and the average of the sum of ranks of the objective or individual, SD^2 =the sum of the squares of the difference, M = number of judges or raters N =number of objects or individuals being rated or ranked (Sheskin, 2003).

A Kruskal-Wallis test (also known as a "one-way ANOVA on ranks") may be a rank-based nonparametric test which will be utilized to see in the event that two or more groups of an independent variable on a ceaseless or ordinal subordinate variable have statistically significant differences. When the normality assumption is broken, this test is employed as a nonparametric counterpart to the one-way ANOVA (Ostertagová et al., 2014). The Kruskal-Wallis test is less sensitive to outliers than the one-way ANOVA since it does not presuppose normality in the data. This test is used in order to check out if there are any significant differences in the point of view of the respondents (constructors, consultants, clients, and government bodies) regarding the level of each of the challenges adopted in modular construction work ,and also used to validate the results of Kendall's coefficient of concordance.

Ho: there is no significant difference between the responses of the constructors, consultants, clients, and government bodies.

H1: There is a significant difference between the responses of the constructors, consultants, clients, and government bodies.

The Kruskal Wallis statistic test or Where Kw is Kruskal Wallis statistic, $H = (12 / (n * (n + 1))) * (\text{Sum of } (R_i^2 / n_i)) - 3 * (n + 1)$, n is the number of observations in the k samples, ni the number of observations in the sample and Ri the sum of the ranks in the sample (Monge, 2019).The interview data will be analyzed using conceptual content analysis which takes into account the appearance of a concept or the number of times (frequency) a particular concept appears in a text. Bordens and Abbott (2008) note that substance investigation may be a valuable procedure to assist in understanding behavior adopting a purely descriptive approach.

3.12. Ethical Considerations

Every step of the investigation handling must be guided by ethical principles. The quality of work and the code of ethics are closely related. In the event that analysts need their considerations to be effective, they must follow ethical standards. The moral standard helps the analyst in completing his or her work in an opportune and productive way (Hasan et al., n.d.).

Ethics in research is the expected rules, principles, and norms to be followed by researchers, respondents, and supporting organizations. Particularly about conduct with other people and organizations, aimed at causing no harm and providing confidential, honest, if possible, benefits to those involved in the research. To this end, the maximum effort was made by the researcher to follow the ethical codes of the research in terms of resource utilization, data collection, analysis, interpretation, and the way research reports are disclosed. Also, participants are told to give appropriate data that must be kept confidential to contribute to the great success of the study by the researcher.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1. Respondents' Background Characteristics

Findings related to respondents out of 40 total respondents in the survey, 22 were constructors, 9 were consultants, 7 clients, and 4 of the respondents were government bodies. It was also found that 22 of the total respondents worked with contractors, 9 worked with consultants, whilst 7 worked with clients, and 4 worked with the government. Also, the educational qualifications of the respondents showed that most of them held a B.Sc., while some of them held an M.Sc., and of the total number of respondents, none of them held a Ph.D. The table below shows the background information of the respondents.

Table 4.1. Result of the respondent's background information

variables	category	Frequency
Educational level	Non degree	10
	BSC degree holder	21
	MSc degree holder	9
	Ph.D. holder	0
Worked with	contractor	20
	consultant	9
	client	7
	Government body	4
Work experience	0 to 5 years	14
	5 to 10 years	15
	10 to 15 years	11

4.2. Identify the Challenges Adopting Modular Construction Works

The survey data, consisting of the seventy causes of Challenges in Adopting Modular Construction Works, was identified and grouped into eight major areas. The first group challenges in Adopting Modular Construction Works are challenges due to supply chain and information systems;- Fragmented communication & information flow, Unclear industry standards, Limited supplier options, Disrupted supply chain, Limited component options,

Logistics expertise gap, Intricate on-site coordination, Inexperienced logistics personnel, Limited information transparency, Disorganized supply chain management, Unreliable component availability. Group two challenges due to the workforce or workers; fear of workforce reduction, lack of qualified workers, up training the workforce can be costly, acquiring new skills can be a financial burden, and Limited availability of skilled personnel. Group of challenges due to negative client perception: - Increased client doubt and reluctance. Clients struggle to embrace the concept, public misunderstandings of modular construction; lack of awareness of the benefits of modular construction, Workforce lacks experience in both traditional and modular construction, Limited expertise in designing and managing inexperienced personnel in handling the unique demands of modular construction.

The fourth group are challenges due to contractors:- high upfront cost burden, uncertain return on initial investment, viability of the initial investment in modular construction, workforce lack of experience in modular construction, skill gap in overall project execution, shortage of integrated project delivery, shortage of qualified modular construction builders, limited skilled contractors. The group has five challenges due to construction design:-Complex designs that are difficult to modularize, Restricted design options, Challenges achieving desired architectural styles, Limited flexibility for customization, Uniform appearance often associated with modular construction, Limited adaptability of modular buildings, Challenges with on-site modifications, Design rigidity in modular construction, Sequencing challenges, Limited design flexibility, Upfront design commitment.

Six group challenges due to behind government bodies:-the unregulated modular construction industry, lack of standardized building codes, unfavorable government policies, inadequate standardization, local building codes not adapted to modular construction, challenging supply chain coordination, demanding logistics due to bulky components, need for specialized transportation and assembly, limited government support for modular building, Absence of targeted for modular construction, Unequal financial playing f due to government policies. Group seven barriers due to equipment availability;-Need for specialized lifting equipment, Limited lifting capacity on construction sites, Limited on-site handling capabilities, challenges with temporary storage solutions, Transportation and handling risks, Site preparation and foundation challenges, Transportation restrictions for large modules.

Group eight barriers due to construction site and standard of offsite standards; Limited adaptability during construction; Challenges with on-site adjustments; Inflexibility for last-minute design changes; Tight-fit requirements for component assembly; Minimal margin for error during construction; Challenges in identifying the best-fit projects for modular construction, Limited space for major construction projects, Constraints on developing large sites, Challenges adapting the site for modular construction Existing site conditions hindering modular construction implementations.

4.2.1. Assess the major challenges affecting the adoption of modular construction works.

The survey data consisted of the seventy factors Challenges in Adopting Modular Construction Works were analyzed and grouped into eight major areas: challenges due to supply chain and information system, challenges due to workforce or workers, challenges due to negative client perception, challenges due to constructor, challenges due to construction design, challenges due to behind government body, barriers due to equipment availability, and barriers due to construction site and standard of offsite.

The data analysis for Ranking of the attributes in terms of their criticality as perceived by the respondents was done by the use of the Relative impact Index (RII) method, where W : is the weight given to each response, N : is the total number of respondents, A : is the highest weight, ΣW = is the sum of weights given to each response. The relative importance index has values from 0 to 1. and the group index is the average of the relative importance index of the identified factors.

The results of the study provide an indication of the relative importance index and rank of challenges in adopting Modular Construction Works in the east Wallega zone, as presented in the table, according to the four parties. Table 4.2.1. It shows the relative importance index (RII) and rank of Challenges in Adopting Modular Construction Works according to the four groups of respondents.

Table 4.2 Relative importance index (RII) and rankings the overall challenges in adopting modular construction

S/N	factors	Contractor		Consultant		Client		Government Body		Over All	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Challenges Due To Supply Chain And Information System											
1	Fragmented communication & information flow	0.61	23	0.7	9	0.8	5	0.7	7	0.69	16
2	Unclear industry standards	0.65	19	0.7	9	0.77	6	0.7	7	0.7	15
3	Limited supplier options	0.68	16	0.7	8	0.86	3	0.65	8	0.72	13
4	Disrupted supply chain	0.68	16	0.7	7	0.86	3	0.65	8	0.72	13
5	Limited component options	0.7	14	0.7	7	0.86	3	0.65	8	0.73	12
6	Logistics expertise gap	0.64	20	0.7	8	0.8	5	0.65	8	0.69	16
7	Intricate on-site coordination	0.63	21	0.7	8	0.77	6	0.65	8	0.69	16
8	Inexperienced logistics personnel	0.65	19	0.7	7	0.74	7	0.65	8	0.69	16
9	Limited information transparency	0.65	19	0.7	9	0.91	1	0.65	8	0.72	13

S/N	factors	Contractor		Consultant		Client		Government Body		Over All	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
10	Disorganized supply chain management:	0.67	17	0.7	8	0.83	4	0.65	8	0.71	14
11	Unreliable component availability	0.68	16	0.7	9	0.83	4	0.65	8	0.71	14
Challenges Due To Manpower Or Workers											
12	Fear of workforce reduction	0.62	22	0.6	12	0.77	6	0.75	6	0.69	16
13	Lack of qualified workers	0.64	20	0.6	10	0.77	6	0.75	6	0.7	15
14	Up skilling the workforce can be costly	0.63	21	0.7	8	0.69	9	0.8	5	0.7	15
15	Acquiring new skills can be a financial burden.	0.64	20	0.7	7	0.71	8	0.8	5	0.72	13
16	Limited availability of skilled personnel	0.66	18	0.6	10	0.69	9	0.85	4	0.71	14

S/N	factors	Contractor		Consultant		Client		Government Body		Over All	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Challenges Due To Negative Client Perception											
17	Increased client doubt and reluctance	0.63	21	0.7	7	0.66	10	0.8	5	0.7	15
18	Clients struggle to embrace the concept	0.67	17	0.8	4	0.77	6	0.8	5	0.75	10
19	Public misunderstandings of modular construction	0.73	11	0.7	6	0.83	4	0.8	5	0.77	8
20	Lack of awareness of the benefits of modular construction	0.71	13	0.7	7	0.83	4	0.8	5	0.76	9
21	Workforce lacks experience in both traditional and modular construction	0.73	11	0.7	7	0.83	4	0.8	5	0.77	8
22	Limited expertise in designing and managing	0.74	10	0.7	8	0.77	6	0.8	5	0.75	10
23	Inexperienced personnel in handling the unique demands of modular construction	0.67	17	0.8	4	0.74	7	0.8	5	0.75	10
Challenges Due To Contractor											
24	High upfront cost burden	0.65	19	0.7	8	0.74	7	0.85	4	0.73	12
25	Uncertain return on initial investment	0.69	15	0.8	3	0.8	5	0.85	4	0.79	6
26	Viability of the initial investment in modular construction	0.69	15	0.8	3	0.83	4	0.85	4	0.79	6

S/N	factors	Contractor		Consultant		Client		Government Body		Over All	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
27	Workforce lacks experience in modular construction	0.7	14	0.7	9	0.83	4	0.85	4	0.76	9
28	Skill gap in overall project execution	0.69	15	0.8	5	0.71	8	0.85	4	0.75	10
29	Shortage of integrated project delivery	0.68	16	0.8	4	0.69	9	0.85	4	0.75	10
30	Shortage of qualified modular construction builders	0.55	27	0.8	5	0.69	9	0.85	4	0.71	14
31	Limited skilled contractors	0.78	6	0.8	3	0.8	5	0.85	4	0.81	4
Challenges Due To Construction Design											
32	Complex designs that are difficult to modularize	0.72	12	0.7	7	0.91	1	0.95	2	0.82	3
33	Restricted design options	0.74	10	0.7	6	0.83	4	0.95	2	0.81	4
34	Challenges achieving desired architectural styles	0.72	12	0.7	7	0.8	5	0.95	2	0.8	5
35	Limited flexibility for customization	0.72	12	0.8	5	0.86	3	0.95	2	0.82	3
36	Uniform appearance often associated with modular construction	0.71	13	0.7	8	0.8	5	0.95	2	0.79	6
37	Limited adaptability of modular buildings	0.74	10	0.7	8	0.8	5	0.95	2	0.79	6
38	Challenges with on-site modifications	0.78	6	0.8	5	0.77	6	0.95	2	0.81	4
39	Design rigidity in modular construction	0.77	7	0.6	11	0.89	2	0.9	3	0.79	6
40	Sequencing challenges	0.72	12	0.7	8	0.83	4	0.85	4	0.77	8
41	Limited design flexibility	0.71	13	0.6	10	0.71	8	0.8	5	0.72	13
42	Upfront design commitment	0.73	11	0.6	12	0.74	7	0.9	3	0.74	11

S/N	factors	Contractor		Consultant		Client		Government Body		Over All	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Challenges Due To Behind Government Body											
43	Unregulated modular construction industry	0.79	5	0.7	8	0.89	2	0.95	2	0.83	2
44	Lack of standardized building codes	0.75	9	0.8	5	0.86	3	0.95	2	0.83	2
45	Unfavorable government policies	0.71	13	0.8	5	0.71	8	0.95	2	0.78	7
46	Inadequate standardization	0.72	12	0.8	4	0.77	8	0.95	2	0.8	5
47	Local building codes not adapted to modular construction	0.76	8	0.7	6	0.86	3	0.95	2	0.83	2
48	Challenging supply chain coordination	0.73	11	0.7	7	0.74	7	0.95	2	0.78	7
49	Demanding logistics due to bulky components	0.73	11	0.8	5	0.74	7	0.95	2	0.79	6
50	Need for specialized transportation and assembly	0.75	9	0.8	4	0.71	8	0.95	2	0.8	5
51	Limited government support for modular building	0.75	9	0.8	1	0.8	5	0.9	3	0.82	3
52	Absence of targeted modular construction	0.75	9	0.8	4	0.89	2	0.95	2	0.84	1
53	Unequal financial playing f due to government policies	0.79	5	0.8	3	0.8	5	0.95	2	0.84	1
54	Need for specialized lifting equipment	0.75	9	0.8	3	0.86	3	0.85	4	0.81	4

S/N	factors	Contractor		Consultant		Client		Government Body		Over All	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Barriers Due To Equipment Availability											
55	Limited lifting capacity on construction sites	0.73	11	0.7	8	0.83	2	0.85	4	0.77	8
56	Limited on-site handling capabilities	0.71	13	0.7	7	0.8	5	0.85	4	0.77	8
57	Challenges with temporary storage solutions	0.66	18	0.7	8	0.89	2	0.85	4	0.77	8
58	Transportation and handling risks	0.71	13	0.7	8	0.86	2	0.85	4	0.78	7
59	Site preparation and foundation challenges	0.67	17	0.7	7	0.71	8	0.8	5	0.72	13
60	Transportation restrictions for large modules	0.69	15	0.7	6	0.8	5	0.85	4	0.77	8
Barriers Due To Construction Site And Standard Of Offsite											
61	Limited adaptability during construction	0.63	21	0.7	7	0.74	7	0.95	2	0.76	9
62	Challenges with on-site adjustments	0.6		0.7	8	0.71	8	0.95	2	0.74	11
63	Inflexibility for last-minute design changes	0.67	17	0.6	10	0.71	8	0.95	2	0.74	11
64	Tight fit requirements for component assembly	0.66	18	0.7	6	0.66	10	0.95	2	0.75	10
65	Minimal margin for error during construction	0.64	20	0.7	6	0.66	10	0.95	2	0.75	10
66	Challenge in identifying the best fit projects for modular construction	0.63	21	0.7	7	0.71	8	0.95	2	0.75	10

S/ N	factors	Contractor		Consultant		Client		Government Body		Over All	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
67	Limited space for major construction projects	0.61	23	0.6	10	0.8	5	0.9	3	0.74	11
68	Constraints on developing large sites	0.62	22	0.6	11	0.74	7	0.9	3	0.72	13
69	Challenges adapting the site for modular construction	0.66	18	0.7	9	0.71	8	0.85	4	0.72	13
70	Existing site conditions hindering modular construction implementations	0.66	18	0.7	8	0.69	9	0.9	3	0.73	12

4.2.1.1. The groups of challenges are due to the supply chain and information system.

Contractors, consultants, clients, and government bodies together under the challenges due to supply chain and information system groups: Fragmented communication & information flow, unclear industry standards, limited supplier options, disrupted supply chain, limited component options, Logistics expertise gap, intricate on-site coordination, inexperienced logistics personnel, Limited information transparency, Disorganized supply chain management, Unreliable component availability. From this group, Limited component options are the highest challenges (0.69, 0.7, 0.72, 0.72, 0.73, 0.69, 0.69, 0.69, 0.71, 0.71, 0.72) within the rank of 16,15,13,13,12,16,16,13,14,14, respectively and from over all ranks to assigned 13 and relative challenges of index RII IS 0.86. It is encouraging to note that contractors, consultants, clients, and government bodies interviewed also admitted that the barriers to the supply chain and information system are the greatest challenges in adopting Modular Construction Works.

All the respondents put together, the challenges due to the supply chain and information system were ranked twelve by all the respondents. Challenges due to the supply chain and information system were determined by all respondents under the challenges due to the supply chain and information system group of Challenges in Adopting Modular Construction Works rankings as the sixth Challenges in Adopting Modular Construction Works rankings in East Wallega Oromia national regional state.

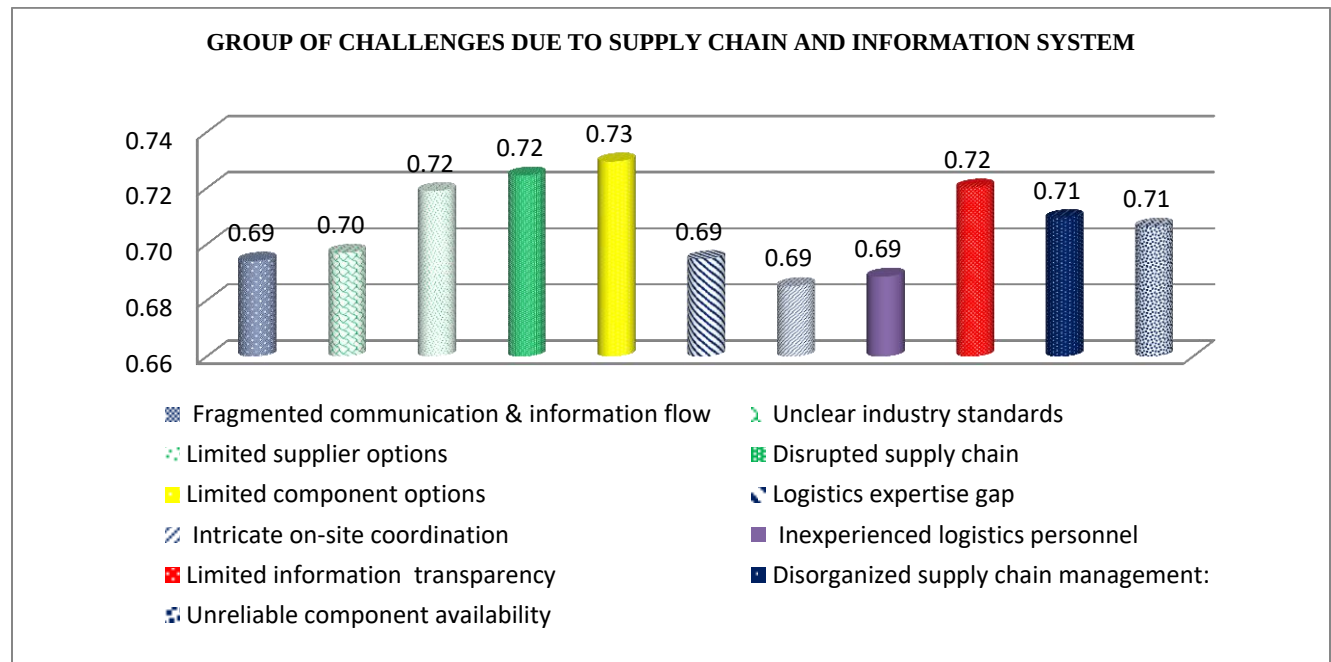


Figure 4.1. The groups of challenges due to supply chain and information systems

4.2.1.2. The Challenges Due To Man Power or Workers Groups

The above table reveals the respondents' rankings of the various challenges of adopting the modular construction method. The table shows that, with a relative challenges index method RII, fear of workforce reduction(0.69) with a rank of 16, lack of qualified workers(0.70)with a rank of 15, up training the workforce can be costly(0.70) with a rank of 15, acquiring new skills can be a financial burden(0.72) with rank of 13. Limited availability of skilled personnel (0.71) with a rank of 15.

According to this group of challenges, acquiring new skills can be a financial burden (0.72) with a rank of 14 is the highest challenge in adopting Modular Construction Works in east Wallega Oromia national regional state. It is encouraging to note that contractors, consultants, clients, and

government bodies interviewed also admitted that Man Power or Workers are the most challenges to adopting Modular Construction Works. Generally, the adoption of modular construction challenges due to workforce or workers is the seventh rank of all groups in East Wallaga.

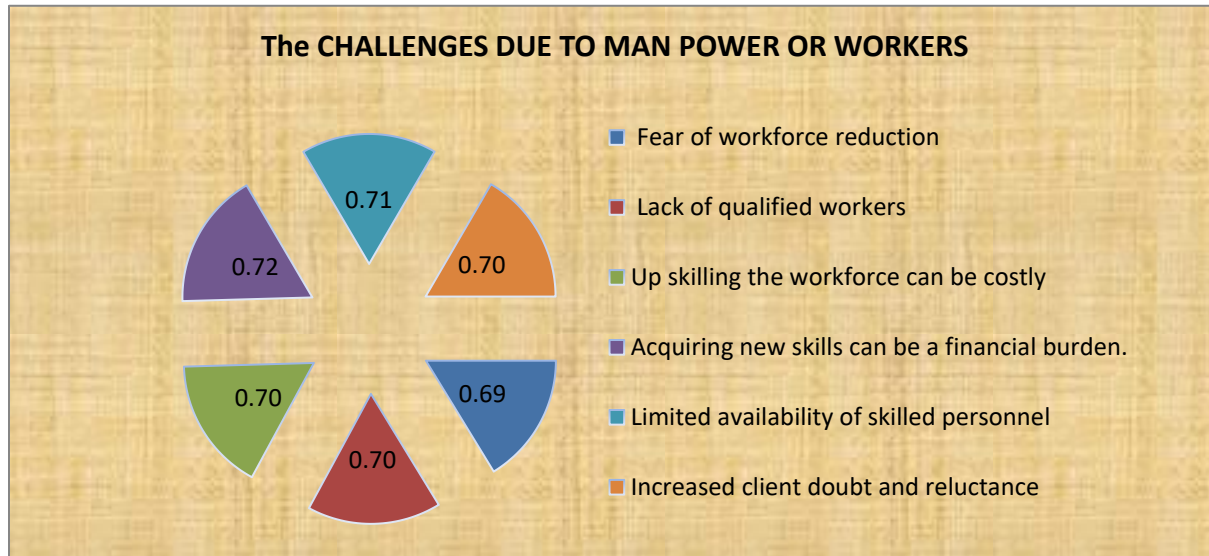


Figure 4.2. The challenges due to manpower or workers

4.2.1.3. Groups challenges due to negative client perception

Contractors, consultants, clients, and government bodies evaluated:- Increased client doubt and reluctance, public misunderstandings of modular construction. Clients struggle to embrace the concept. The workforce lacks experience in both traditional and lack of awareness of the benefits of modular construction. The workforce lacks experience in both traditional and modular construction, limited expertise in designing and managing inexperienced personnel in handling the unique demands of modular construction. Together, the ranking shows public misunderstandings of modular construction and the Workforce lacks experience in both traditional and modular construction (0.77,0.77). The similar rank of from above all challenges adopted in modular construction works, ranked 8, is more challenges in this group.

In this group, the second one is lack of awareness of the benefits of modular construction (0.76) with a rank of 9. It is encouraging to note that contractors, consultants, clients, and government bodies interviewed also admitted that negative client perception is the biggest challenge in adopting Modular Construction Works. Generally, the adoption of modular construction challenges due to negative client perception is the fourth rank of all groups in East Wallaga.

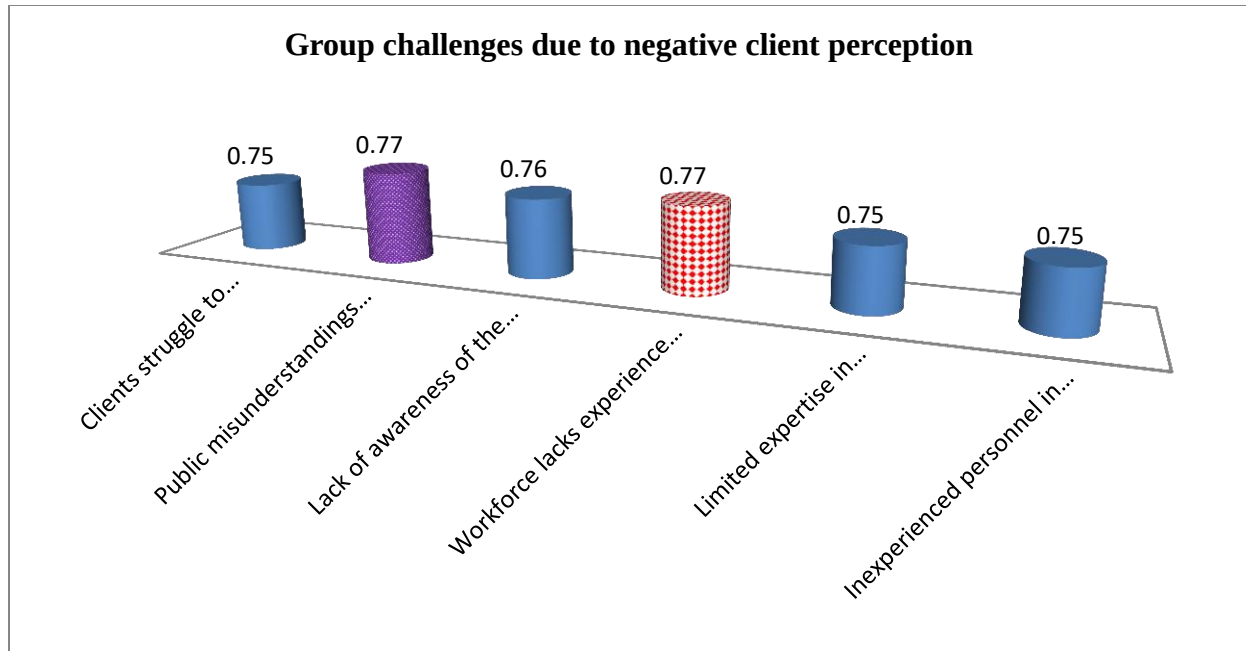


Figure 4.3. Groups challenges due to negative client perception

4.2.1.4. The groups of challenges due to contractor

The challenges due to constructors are high upfront cost burden, uncertain return on initial investment, viability of the initial investment in modular construction; workforce lacks experience in modular construction, skill gap in overall project execution, shortage of integrated project delivery, shortage of qualified modular construction builders, and limited skilled contractors. According to result shown above in table 4.2,

Limited skilled contractors, his highest challenge, with results RII -0.81 and rank 4 and viability of the initial investment in modular construction (0.79) and uncertain return on initial investment (0.79) is the second rank in this group to adopt the challenges of applying modular construction in East Wallega. It is encouraging to note that the contractors, consultants, clients, and government bodies interviewed also admitted that contractors have the most challenges in adopting Modular Construction Works. Overall, the group results are shown in the figures below. Generally adopting of modular construction challenges due to contractors are the third rank of all groups in East Wallaga.

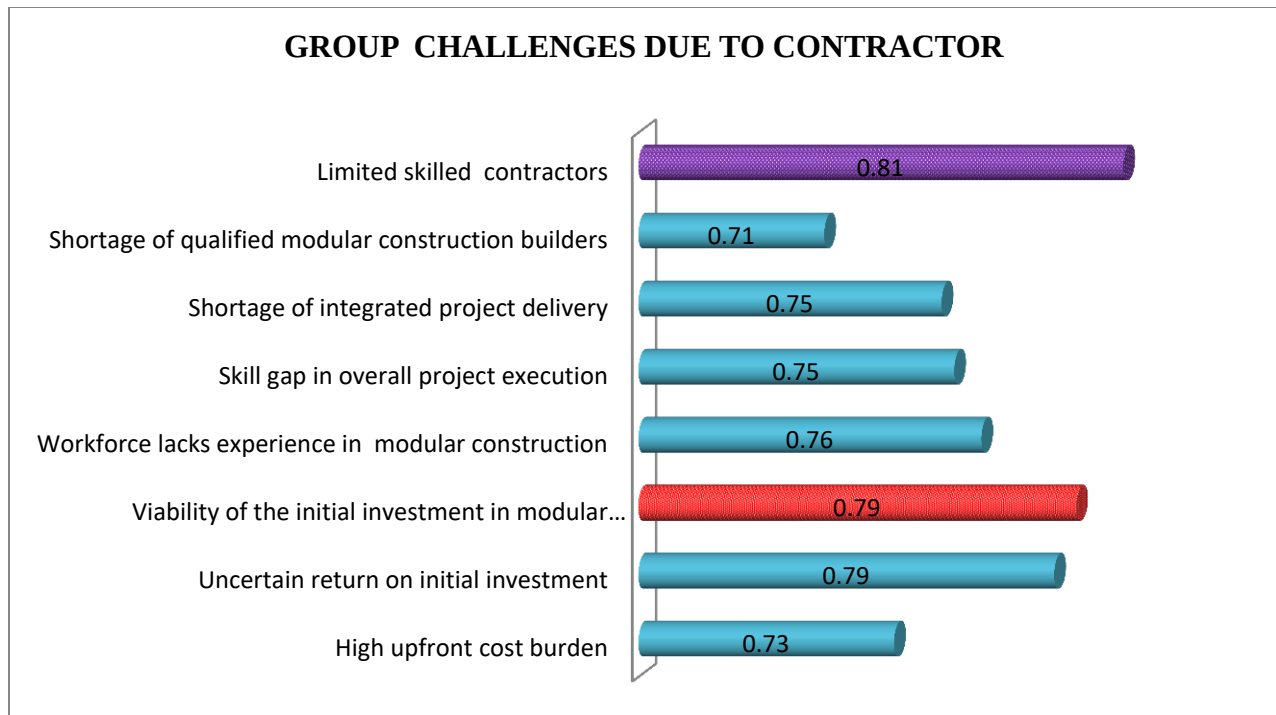


Figure 4.4. groups of challenges due to contractor

4.2.1.5. Challenges due to construction design

Contests implementing modular construction show, according to the result, limited flexibility for customization, and complex designs that are difficult to modularize, with relative challenges index result of 0.82 and ranking 3 in group challenges due to construction design. It is encouraging to note that contractors, consultants, clients, and government bodies interviewed also admitted that construction design is the biggest challenge in adopting Modular Construction Works.

Complex designs that are difficult to modularize, Restricted design options, Challenges achieving desired architectural styles, Limited flexibility for customization, uniform appearance often associated with modular construction, Limited adaptability to modular buildings, Challenges with on-site modifications, Design rigidity in modular construction, Sequencing challenges, Limited design flexibility, Upfront design commitment. The results of all groups adopting the challenges of applying modular construction are shown in the figures below. Generally, the adoption of modular construction challenges due to construction designs is the second rank among all groups in East Wallega.

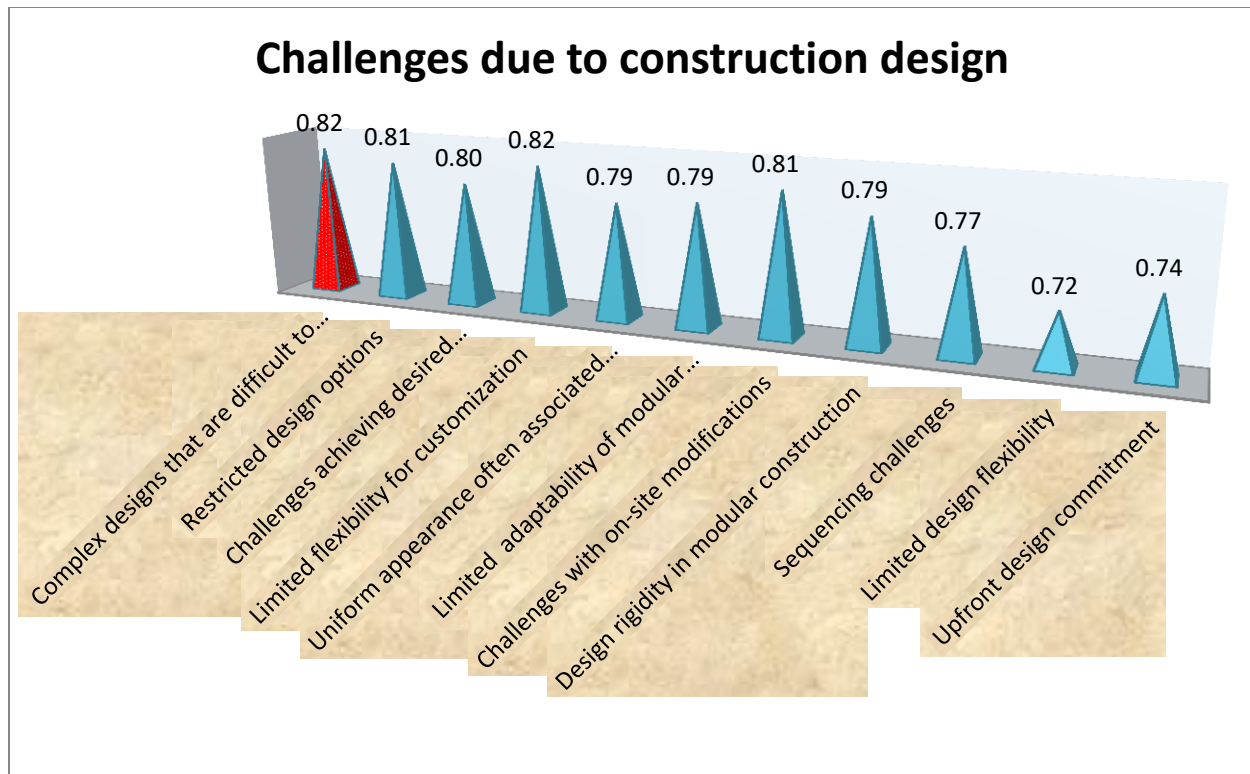


Figure 4. 5. Challenges due to construction design

4.2.1.6. Challenges due to behind government body

According to East Wallaga, research shows the barriers to adopting modular construction works that are assigned in this group Unregulated modular construction industry, lack of standardized building codes, unfavorable government policies, inadequate standardization, local building codes not adapted to modular construction, challenging supply chain coordination, demanding logistics due to bulky components, Need for specialized transportation and assembly, Limited government support for modular building, Absence of targeted for modular construction, Unequal financial playing f due to government policies. The results of all groups adopting the challenges of applying modular construction are shown in the figures below.

These challenges are due to government bodies, the absence of targets for modular construction and unequal financial playing off due to government policies showing the results of relative challenges index 0.84 with rank 1and this factor is the very highest challenge. It is encouraging to note that contractors, consultants, clients, and government bodies interviewed also admitted that, too, due to behind government bodies is the most Challenges in adopting Modular Construction Works. So challenges due to behind government body groups are assigned the first

rank from over all groups' challenges of adopting modular construction in the East Wallaga zone..

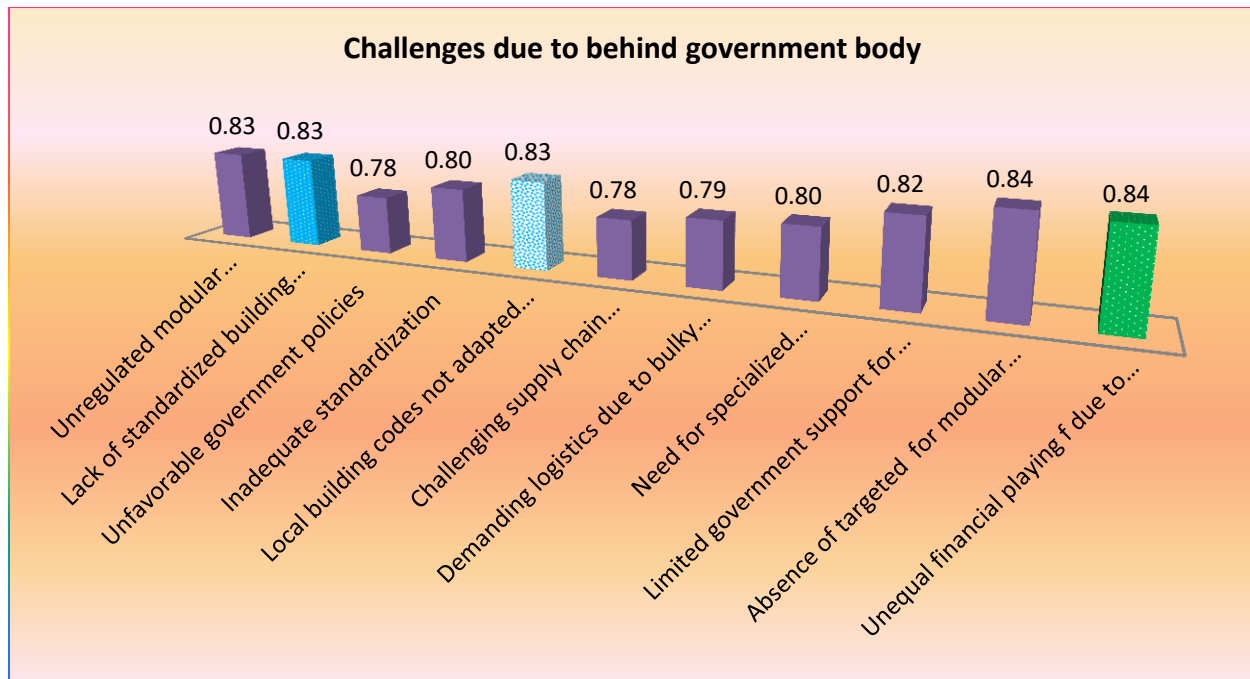


Figure 4.6.Challenges due to behind government body

4.2.1.7. Barriers due to equipment availability

In East Wallega zone barriers due to equipment availability is one challenge of adopting modular construction. in this group, the challenges are:- the need for specialized lifting equipment, limited lifting capacity on construction sites, limited on-site handling capabilities, challenges with temporary storage solutions, transportation and handling risks, site preparation and foundation challenges, Transportation restrictions for large modules. Contractors, consultants, clients, and government bodies together ranked the result over all groups adopting the challenges of applying modular construction. The results are shown below the figures.

Under the challenges due to equipment availability, the need for specialized lifting equipment is very challenging according to this group. The results of the relative challenges index show 0.81 with rank four. It is encouraging to note that the contractors, consultants, clients, and government bodies interviewed also admitted that too due to equipment availability is the most challenges in adopting Modular Construction Work. So Challenges due to Barriers due to equipment

availability group are assigned the third rank from over all groups' challenges of adopting modular construction in the East Wallega zone.

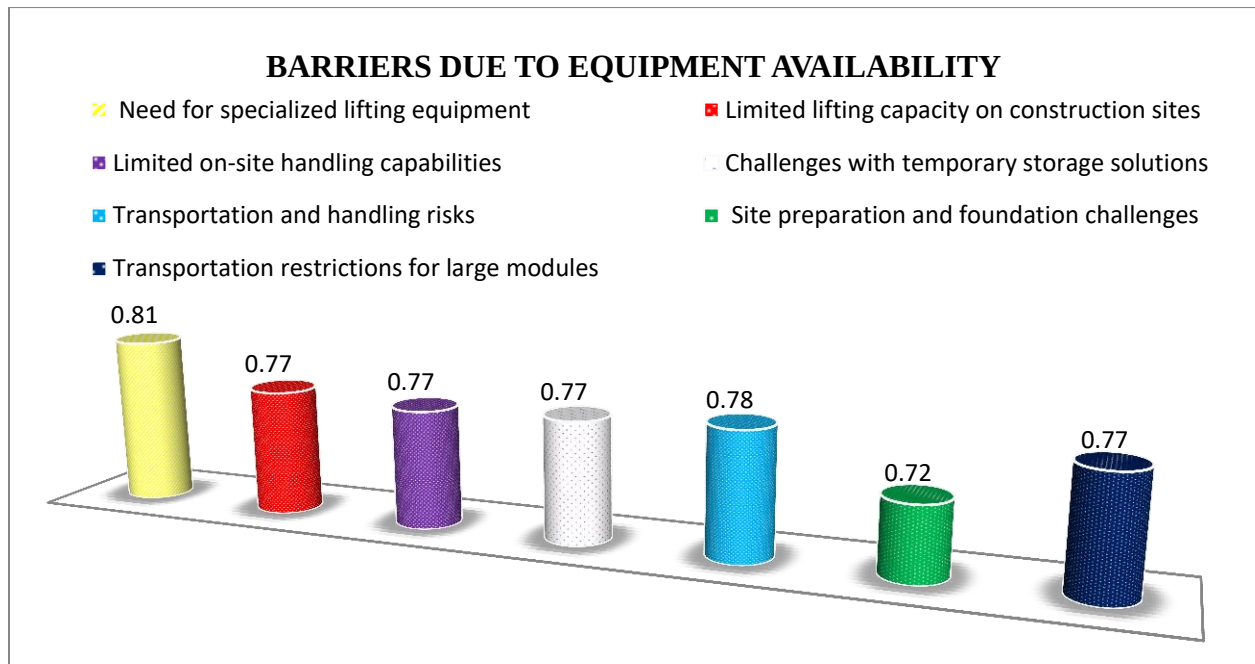


Figure 4.7.challenges due to equipment availability

4.2.1.8. Barriers due to construction site and standard of offsite

Under this group:- Limited adaptability during construction, Challenges with on-site adjustments, Inflexibility for last-minute design changes, Tight fit requirements for component assembly, Minimal margin for error during construction, Challenges in identifying the best fit projects for modular construction, Limited space for major construction projects, Constraints on developing large sites, Challenges adapting the site for modular construction Existing site conditions hindering modular construction implementations.

From these groups of challenges, limited adaptability during construction is high challenges, according to the results 0.76 with rank 9. The results of all groups adopting the challenges of applying modular construction are shown in the figures below, and it is encouraging to note that the contractors, consultants, clients, and government bodies interviewed also admitted that barriers due to construction site and standard of offsite are the greatest challenges in adopting Modular Construction Work. Barriers due to construction site and standard of offsite group are

assigned the fifth rank of from over all groups' challenges of adopting modular construction in the east Wallega zone.



Figure 4.8. Barriers due to construction site and standard of offsite

4.2.2. Ranking the challenges adopting modular construction in east wallega zone.

Table 4.2 also shows the average challenges of adopting and respondents' rankings of challenges adopting modular construction methods consequences. All major stakeholders agreed on the top three most significant challenges of adopting modular construction methods in the East Wallaga zone. Oromia's national and regional states are as follows: the groups of challenges due to behind of government bodies, challenges due to construction design, and barriers due to equipment availability and contractors are the top three groups' challenges. From over factors challenges adopting modular construction in the East Wallega zone, the first rank results of relative challenges show the absence of targets for modular construction, unequal financial playing of due to government policies(0.84,0.84) respectively. The second rank: Local building codes not adapted to modular construction, lack of standardized building codes, and unregulated modular construction industry (0.83, 0.83, and 0.83) respectively. Third rank: Complex designs that are difficult to modularize, limited flexibility for customization, and limited government support for modular building (0.82, 0.82, and 0.82) respectively.

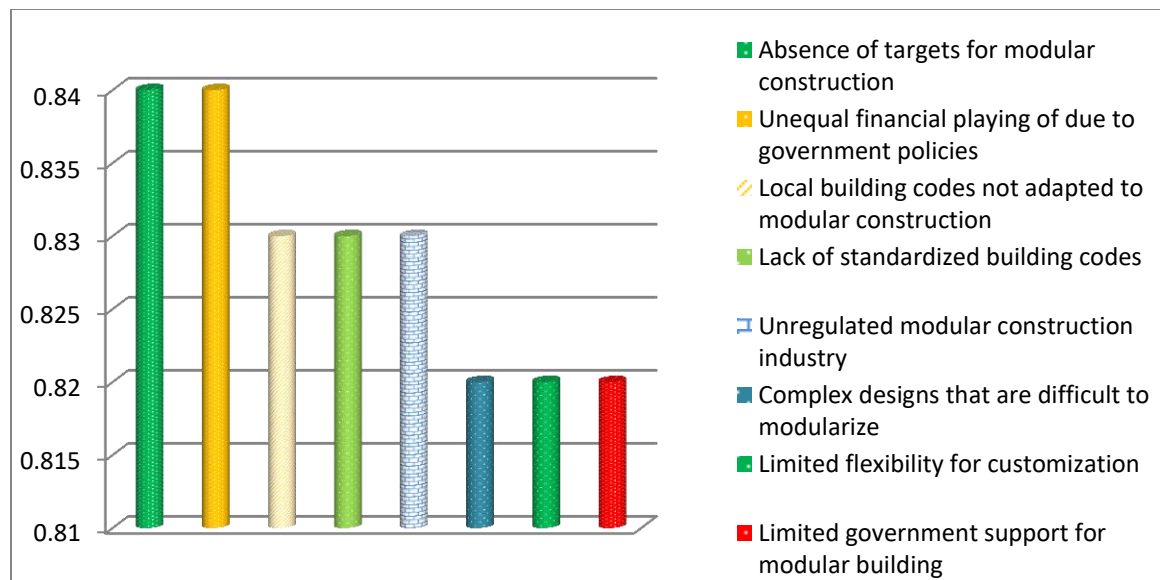


Figure 4.9. Ranking the challenges adopting modular construction in east wallega zone.

4.2.3. The degree of agreement between all groups about the challenges of adopting modular construction in East Wallega zone

As a measure of agreement among raters, Kendall's coefficient of concordance is used as a measure of agreement among raters to see if there is a significant degree of agreement among the three groups (contractor, consultant, client, and government body). Ho: There is no significant difference between the responses of the contractor, consultant, client, and government body. H1: There is a significant difference between the responses of the contractor, consultant, client, and government bodies. The table summarizes the results of group challenges of adopting modular construction methods.

Table 4.3. Kendall's coefficient of concordance for group challenges of adopting modular construction methods

Factors the challenges of adopting modular construction methods	W	Chi-square	P-value (asympt.sig.)	Df	Decision
Challenges due to supply chain and information systems	0.022	8.796	0.552	10	Retain the null hypothesis
Challenges due to manpower or workers	0.018	2.957	0.565	4	Retain the null hypothesis
Negative challenges of client perception	0.045	10.776	0.096	6	Retain the null hypothesis
Challenges due to contractor	0.062	17.265	0.016	7	Reject the null hypothesis
Challenges due to construction design	0.041	16.455	0.087	10	Retain the null hypothesis
Challenges due to behind government body	0.026	10.368	0.409	10	Retain the null hypothesis
Barriers due to equipment availability	0.39	9.339	0.155	6	Retain the null hypothesis
Barriers due to construction site and standard of off- site	0.009	3.334	0.950	9	Retain the null hypothesis

* The agreement is significant at level of $\alpha = 0.05$

According to Kendall's coefficient of concordance result related to samples of groups (contractor, consultant, client, and government body), the null hypothesis distribution is the same. So the decision excludes a group of challenges due to the contractor's p-value being greater than α or the significance of it, so the conclusion is that there is no significant difference between the groups. Thus, it can be said that there is sufficient evidence to support the null hypothesis. Therefore, there is a significant degree of agreement among the contractors, consultants, clients, and government bodies regarding the challenges of adopting modular construction methods in east Wollega zone, Oromia regional state.

A Kruskal-Wallis test is a rank-based nonparametric test that may be used to see if two or more groups of an independent variable on a continuous or ordinal dependent variable have statistically significant differences. The Kruskal-Wallis (KW) test was used to validate the result of the Kendall's coefficient of concordance test.

The KW test is a statistical test that is used to compare the rank means between two or more samples. This test is used in order to check if there are any significant differences in the points of view of the respondents (contractor, consultant, client, and government body) regarding the levels of each of the challenges of adopting modular construction methods in East Wollega zone oromia regional state. H0: There is no significant difference between the responses of contractors, consultants, clients, and government bodies. H1: There is a significant difference between the responses of the contractor, consultant, client, and government bodies. The results are presented in table 4.2.4. The Kruskal Wallis statistic test or Where Kw is Kruskal Wallis statistic, $H = (12 / (n * (n + 1))) * (\text{Sum of } (R_i^2 / n_i)) - 3 * (n + 1)$, n is the number of observations in the k samples, ni the number of observations in the sample and Ri the sum of the ranks in the sample (Monge, 2019)

Table 4.4.the results of the Kruskal-Wallis test or one-way ANOVA for group challenges of adopting modular construction methods

Factors the challenges of adopting modular construction methods	Kruskal-Wallis H	Sig.	Df	Decision
Challenges due to supply chain and information systems	29.302	.000	3	Reject the null hypothesis
Challenges due to manpower or workers	16.162	0.001	3	Reject the null hypothesis
Negative challenges of client perception	16.34	0.001	3	Reject the null hypothesis
Challenges due to contractor	19.705	0.000	3	Reject the null hypothesis
Challenges due to construction design	31.473	0.000	3	Reject the null hypothesis
Challenges due to behind government body	28.297	0.000	3	Reject the null hypothesis
Barriers due to equipment availability	19.230	0.000	3	Reject the null hypothesis
Barriers due to construction site and standard of off- site	32.12	0.000	3	Reject the null hypothesis

*the agreement is significant at level of $\alpha = 0.05$, * Df: degree of freedom

For all the challenges of adopting modular construction groups, as presented in table 4.2,3, the P-values (Sig) for further groups are less than $\alpha = 0.05$ (an is the level of significance). Hence, the null hypothesis, Ho, is rejected, so there is sufficient evidence to support the null hypothesis.

Hence, it can be concluded that there is a significant difference between the four groups of practitioners' responses regarding the challenges of adopting modular construction groups.

This result validates the previous result (Kendall's coefficient of concordance test). Therefore, it can be reliably stated that the four groups of respondents agree with each other in terms of their perception of the challenges of adopting modular construction groups in the east wallage zone oromia national regional state.

According to the results of interviews with contractors, consultants, clients, and government bodies, the results show that under the group of challenges to adopting modular construction proposing absence of targets for modular construction, unequal financial playing f due to government policies, the group's challenges due to behind government bodies and from over all challenges the first rank In east wallega. The second rank: Local building codes not adapted to modular construction, lack of standardized building codes, and unregulated modular construction industry. From the groups' challenges due to behind government bodies and from above all challenges, the first rank in East Wallega. Third rank: Complex designs that are difficult to modularize, limited flexibility for customization, and limited government support for modular building. From the group's challenges due to construction design in East Wallega, western Oromia national regional state.

Above, the quantitative data results show that the absence of targeted for modular construction, unequal financial playing f due to government policies, challenges are the first ranks among all challenges adopting modular construction groups due to the implementation of this method. So the result of the qualitative data analysis by conceptual and quantitative data analysis by RII methods, the absence of targets for modular construction, and unequal financial playing f due to government policies, are challenges adopting modular construction method groups are assigned first rank and the tables 4.5 show all the results groups of challenges to adopting modular construction.

Table 4.5.interview results the group challenges major affecting of the adoption of modular construction works.

Group Challenges Factors	Frequency
challenges due to supply chain and information system	4
challenges due to manpower or workers	2
challenges due to negative client perception	5
challenges due to contractor	6
challenges due to construction design	7
challenges due to behind government body	8
barriers due to equipment availability	6
barriers due to construction site and standard of offsite	2

4.3. Assess the comparative modular construction with conventional construction methods in terms of quality time and cost performance based on stakeholder perception

Seventeen survey data, consisting of conducting a comparative analysis of modular construction work with conventional ones in terms of quality, time, and cost performance, were identified and grouped. The first group is challenges due to construction time;- Longer lead times in design and manufacturing, delays associated with component fabrication and construction, component lead times, prefabrication duration, limited capacity of modular construction providers, difficulties securing timely deliveries, Extended design phase due to complexities of MC. Group nine challenges due construction cost;-High upfront costs, Difficulty achieving economies of scale, High initial investment costs, Scarce financial resources, High transportation costs. Group three challenges due construction quality;- Uncertainty about component quality, Potential for on-site assembly errors, Workforce skills gap during construction, Fragmented information flow, Logistics expertise gap.

Challenges due to construction time, construction cost, and construction quality, and the results of the study provide an indication of the relative importance index and rank of Challenges in Adopting Modular Construction with conventional ones in terms of quality, time, and cost performance in east wallega zone as presented in the table according to the four parties. Table 4.3 shows the relative importance index (RII) and ranks Challenges in Adopting Modular

Construction with conventional ones in terms of quality, time, and cost performance in the East Wallega zone.

Table 4.5 Relative importance index (RII) and rankings the overall challenges in adopting modular construction in terms of time, cost, and quality.

S/N	factors	Contractor		Consultant		Client		Government Body		Over All	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Time											
1	Longer lead times in design & manufacturing	0.62	22	0.53	14	0.69	9	0.85	4	0.67	8
2	Delays associated with component fabrication and construction	0.58	25	0.56	13	0.6	12	0.85	4	0.65	10
3	Component lead times	0.56	26	0.6	12	0.54	14	0.85	4	0.64	11
4	Prefabrication duration	0.53	28	0.6	12	0.54	14	0.85	4	0.63	12
5	Limited capacity of modular construction providers	0.55	27	0.56	13	0.63	11	0.85	4	0.65	10
6	Difficulties securing timely deliveries	0.55	27	0.62	11	0.63	11	0.85	4	0.66	9
7	Extended design phase due to complexities of MC	0.61	23	0.64	10	0.6	12	0.85	4	0.68	7
Cost											
8	High upfront costs	0.62	22	0.76	5	0.57	13	0.8	5	0.69	6
9	Difficulty achieving economies of scale	0.72	12	0.73	6	0.71	8	0.85	4	0.75	3

S/N	factors	Contractor		Consultant		Client		Government Body		Over All	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
10	High initial investment costs	0.71	13	0.73	6	0.71	8	0.85	4	0.75	3
11	Scarce financial resources	0.73	11	0.69	8	0.8	5	0.85	4	0.77	1
12	High transportation costs	0.66	18	0.6	12	0.8	5	0.85	4	0.73	5
Quality											
13	Uncertainty about component quality	0.7	14	0.6	12	0.8	5	0.95	2	0.76	2
14	Potential for on-site assembly errors	0.64	20	0.6	12	0.63	11	0.9	3	0.69	6
15	Workforce skills gap during construction	0.62	22	0.71	7	0.63	11	0.8	5	0.69	6
16	Fragmented information flow	0.8	4	0.67	9	0.69	9	0.8	5	0.74	4
17	Logistics expertise gap	0.62	22	0.67	9	0.57	13	0.8	5	0.66	9

4.3.1. Challenges of adopting modular construction methods versus due construction time

The challenges due to modular construction time comparatively related to traditional construction time are:- Longer lead times in design & manufacturing, delays associated with component fabrication and construction, Component lead times, prefabrication duration, limited capacity of modular construction providers, difficulties securing timely deliveries, extended design phases due to complexities of MC.

Contractors, consultants, clients, and government bodies put together ranked extended design phase due to the complexities of MC. The highest one the results is 0.68 from relative challenges with rank 7. It is encouraging to note that the contractors, consultants, clients, and government bodies interviewed also admitted to comparative challenges of adopting modular construction with conventional ones in terms of quality, time, and cost. So comparative Challenges Adopting Modular Construction with conventional ones in terms of quality, time, and cost groups;- construction time has assigned to the third group according to the results shown in the east wallega zone.

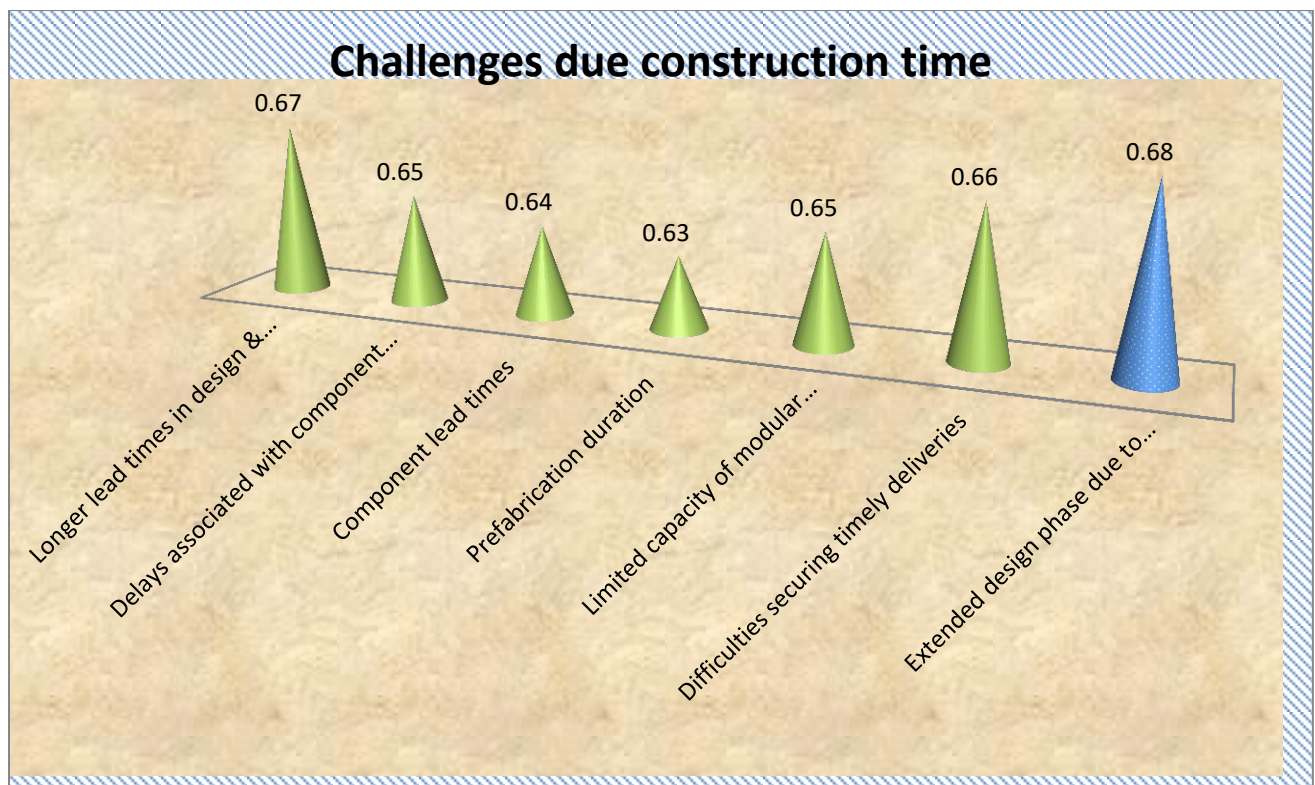


Figure 4.10. Challenges due construction time

4.3.2. Challenges of adopting modular construction methods verses due to construction cost

Relatively the modular construction to traditional construction work costs; - high upfront costs, difficulty achieving economies of scale, high initial investment costs, scarce financial resources, high transportation costs. Contractors, consultants, clients, and government bodies put together ranked scarce financial resources. The highest of the results is 0.77 from relative challenges with rank 1. It is encouraging to note that the contractors, consultants, clients, and government bodies interviewed also admitted to comparative challenges in adopting modular construction with conventional ones in terms of quality, time, and cost performance. So, challenges of adopting modular construction methods verses due to construction time group are assigned the construction cost first rank comparative challenges in Adopting Modular Construction with conventional ones in terms of quality, time, and cost groups in the east Wallega zone.

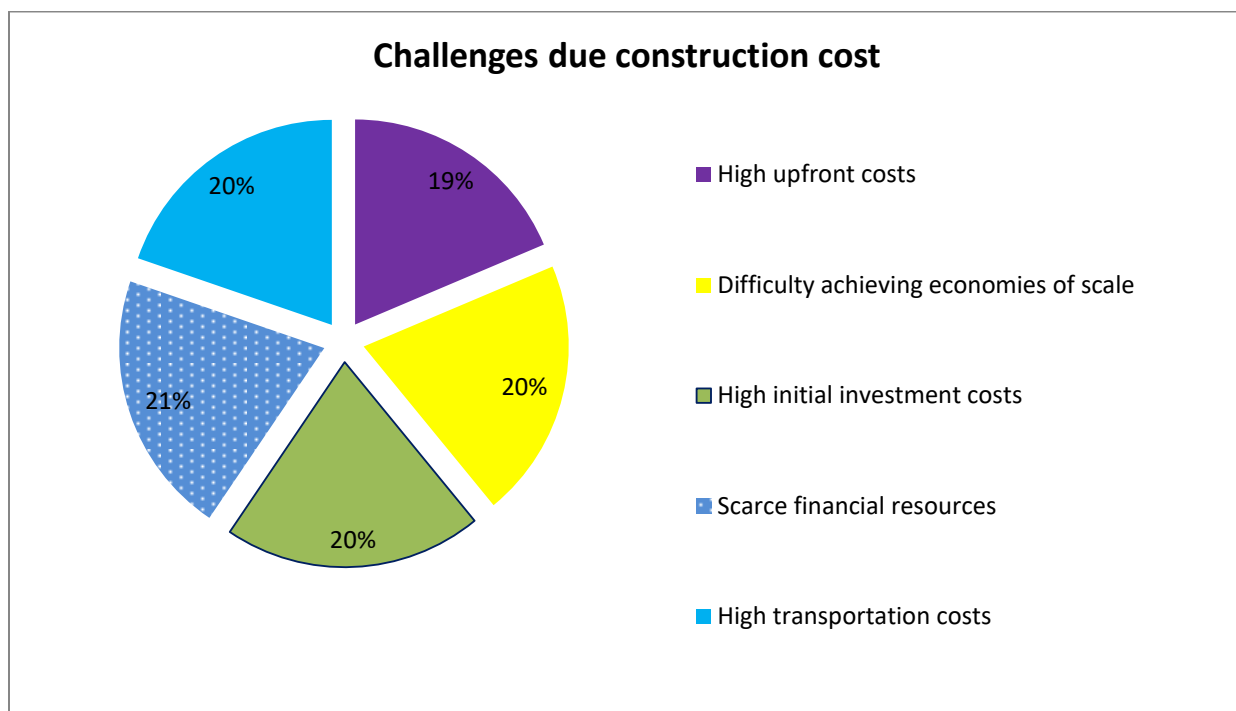


Figure 4.11. Challenges due construction cost

4.3.3. Challenges of adopting modular construction methods verses construction quality

Group three challenges due construction quality; - Uncertainty about component quality, Potential for on-site assembly errors, Workforce skills gap during construction, Fragmented information flow, Logistics expertise gap.

Contractors, consultants, clients, and government bodies put together ranked uncertainty about component quality. The highest of the results is 0.76 from relative challenges with rank 2. It is encouraging to note that the contractors, consultants, clients, and government bodies interviewed also admitted to comparative challenges in adopting modular construction with conventional ones in terms of quality, time, and cost performance. So, challenges of adopting modular construction methods verses due to construction time groups are assigned the second rank from comparative Challenges in Adopting Modular Construction with conventional ones in terms of quality, time, and cost groups in the East Wallega zone.

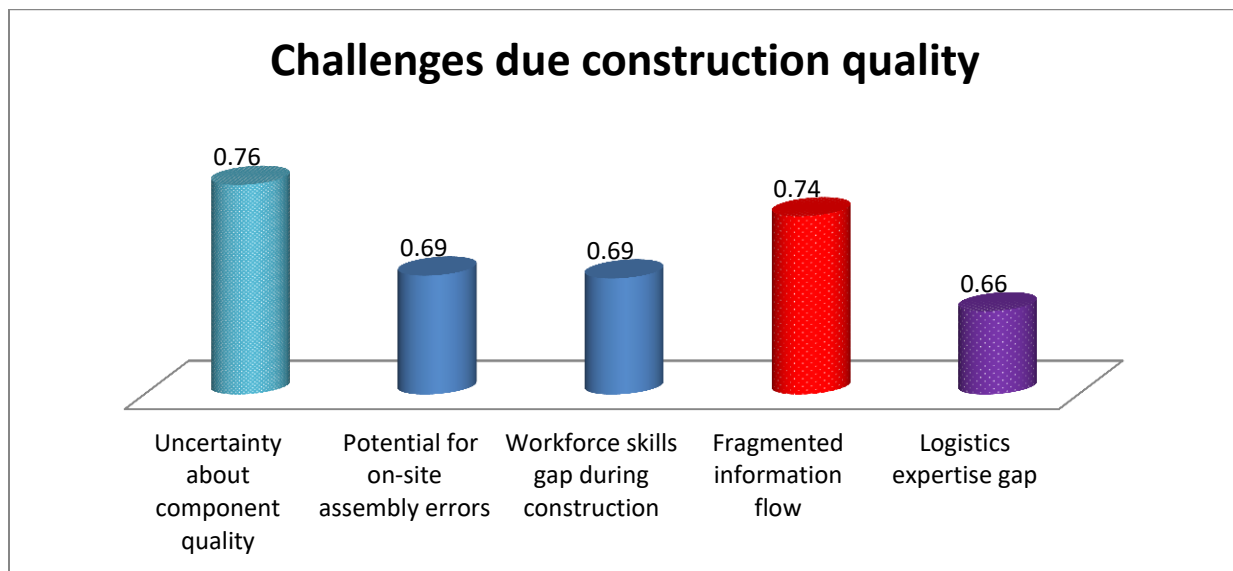


Figure 4.12. Challenges due construction quality

4.3.4. Ranking the challenges adopting modular construction methods versus. cost, time and quality

Table 4.3 also shows the average relative relevance index or average challenges of adopting and respondents' rankings of challenges adopting modular construction methods vs. cost, time and quality consequences. All major stakeholders agreed that the three groups with the most significant challenges adopting modular construction methods in East Wallaga zone Oromia national regional state are as follows: (1) Scarce financial resources, (2) Uncertainty about component quality, (3) High initial investment costs, and Difficulty achieving economies of scale are top three respectively

4.3.5. The degree of agreement for the groups challenges adopting modular construction methods versus. Cost, time and quality

As a measure of agreement among raters, Kendall's coefficient of concordance is used as a measure of agreement among raters to see if there is a significant degree of agreement among the three groups (contractor, consultant, client, and government body). Ho: There is no significant difference between the responses of the contractor, consultant, client, and government body. H1: There is a significant difference between the responses of the contractor, consultant, client, and government bodies. The table summarizes the results

Table 4.6. The results of Kendall's Coefficient of Concordance group challenges of modular construction in termes of cost, time, and quality.

Factors the challenges of adopting modular construction methods vs. cost, time and quality	W	Chi-square	P-value (asyp.sig,)	Df	Decision
Challenges due to construction time	0.019	4.513	0.608	6	Retain the null hypothesis
Challenges due to construction cost	0.067	10.743	0.03	4	Reject the null hypothesis
Challenges due to construction quality	0.3	4.784	0.31	4	Retain the null hypothesis

* The agreement is significant at level of $\alpha = 0.05$

According to Kendall's coefficient of concordance result related to samples of groups (contractor, consultant, client, and government body), the null hypothesis distribution is the same. So the decision excludes a group of challenges due to contractor and challenges due to construction costs the p-value is greater than α or the significance of it, so the conclusion is that there is no significant difference between the groups. Thus, it can be said that there is sufficient evidence to support the null hypothesis. Therefore, there is a significant degree of agreement between contractors, consultants, clients, and government bodies regarding the challenges of adopting modular construction methods vs. cost, time and quality in east Wollega zone oromia regional state. The Kruskal-Wallis (KW) test was used to validate the result of the Kendall's coefficient of concordance test. The Kruskal Wallis statistic test or Where Kw is Kruskal Wallis

statistic, $H = (12 / (n * (n + 1))) * (\text{Sum of } (R_i^2 / n_i)) - 3 * (n + 1)$, n is the number of observations in the k samples, n_i the number of observations in the sample and R_i the sum of the ranks in the sample (Monge, 2019).

This test is used in order to check if there are any significant differences in the points of view of the respondents (contractor, consultant, client, and government body) regarding the levels of each of the challenges adopting modular construction methods vs. cost, time and quality in east Wollega zone oromia regional state. H_0 : There is no significant difference between the responses of contractors, consultants, clients, and government bodies. H_1 : There is a significant difference between the responses of the contractor, consultant, client, and government bodies. The results are presented in table 4.6.

.Table 4.7. kruskal-wallis test or one-way ANOVA for group challenges adopting modular construction methods versus. Cost, time and quality.

Factors the challenges of adopting modular construction methods vs. cost, time and quality	Kruskal-Wallis H	Sig.	Df	Decision
Challenges due to construction time	29.822	0	3	Reject the null hypothesis
Challenges due to construction cost	20.74	0	3	Reject the null hypothesis
Challenges due to construction quality	9.988	0.04	3	Reject the null hypothesis

*the agreement is significant at level of $\alpha = 0.05$, * Df: degree of freedom

For all the challenges of adopting modular construction groups, as presented in table 4.7, the P-values (Sig) for further groups are less than $\alpha = 0.05$ (an is the level of significance). Hence, the null hypothesis, H_0 , is rejected, so there is sufficient evidence to support the hypothesis. Hence, it can be concluded that there is a significant difference between the four groups of practitioners' responses regarding the challenges of adopting modular construction groups vs. cost, time and quality. This result validates the previous result (Kendall's coefficient of concordance test). Therefore, it can be reliably stated that the four groups of respondents agree with each other in terms of their perception of the challenges of adopting modular construction groups in the East Wallage zone oromia national regional state.

According to the results of interviews with contractors, consultants, clients, and government bodies, the results show that under the group of challenges of adopting modular construction methods vs. cost, time and quality ;Scarce financial resources, uncertainty about component quality, high initial investment costs, and Difficulty achieving economies of scale are top three respectively under the group challenges adopting to modular construction challenges vs. cost, time and quality In east wallega western Oromia national regional state.

Table 4.8.interview results methods in terms of quality time and cost performance based on stakeholder perception

Group Challenges Factors	Frequency
Versus. cost, time and quality	
cost,	17
time	8
quality	15

4.4. Evaluate stakeholder readiness for the future adoption of modular construction in local building projects.

The survey data consisting of the four factors challenges for proposing modular construction techniques for future building projects were analyzed. The results of the study provide an indication of the relative importance index and rank of challenges for proposing modular construction techniques for future building projects. Challenges in Adopting Modular Construction Works in East Wallega zone as presented in the table according to the four parties' response. Table 4.8 shows the relative importance index (RII) and rank of Challenges in Adopting Modular Construction Works according to the four groups.

Table 4.8 relative importance index (RII) and rankings the overall evaluate stakeholder readiness for the future adoption of modular construction in local building projects.

S/N	factors	Contractor		Consultant		Client		Government Body	Over All		
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Economic challenges	0.8	4	0.8	3	0.86	2	0.85	4	0.83	3
2	Technical challenges	0.84	3	0.73	6	0.74	7	0.85	4	0.79	4
3	Market acceptance challenges	0.88	2	0.82	2	0.8	5	1	1	0.88	1
4	Regulatory and policy challenges	0.89	1	0.82	2	0.83	4	0.85	4	0.85	2

4.4.1. Challenges for proposing the modular construction technique for the future buildings

The challenges for proposing the modular construction technique for future buildings are: - Economic challenges, technical challenges, market acceptance challenges, regulatory and policy challenges.

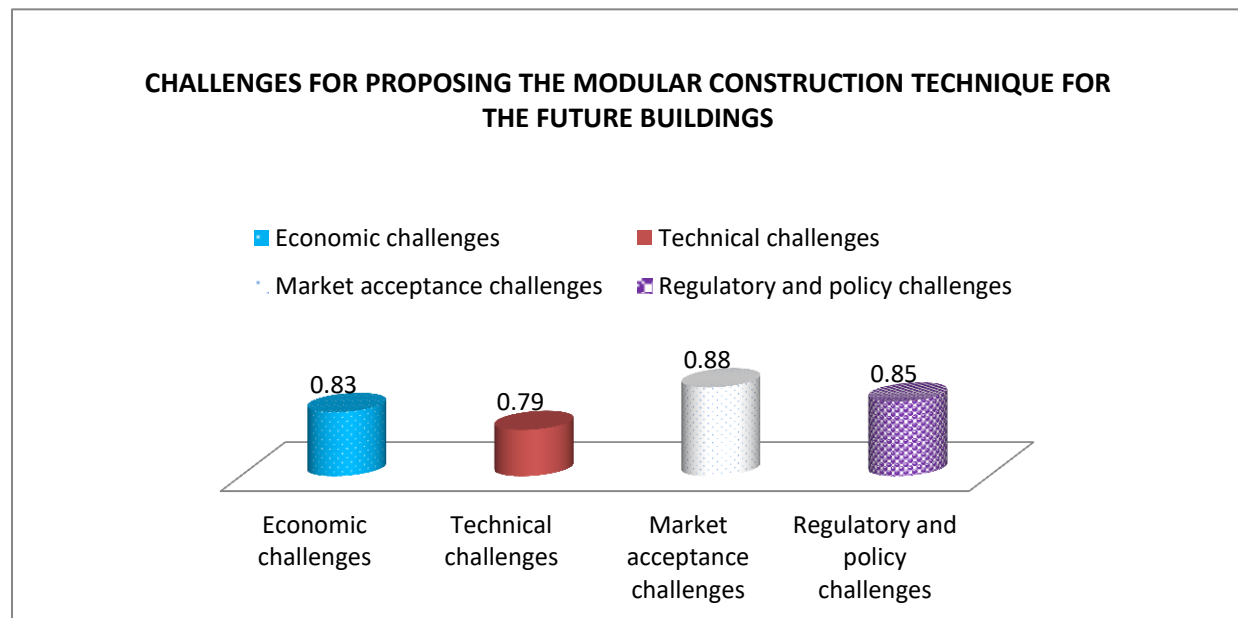


Figure 4.13. Challenges for proposing the modular construction technique for the future buildings

4.4.2. Ranking the Challenges to evaluate stakeholder readiness for the future adoption of modular construction in local building projects.

Table 4.8. It also shows the average relative relevance index or average challenges of adopting and respondents' rankings of challenges for proposing modular construction techniques future building projects adopting modular construction methods consequences. In general, all major stakeholders agreed that the three most significant challenges to adopting modular construction methods in East Wallaga zone, Oromia national regional state, are as follows: Market acceptance challenges are the first rank, regulatory and policy challenges are the second rank and economic challenges are the third rank.

Contractors, consultants, clients, and government bodies put together ranked market acceptance challenges the highest one. The results are 0.88 from relative challenges with rank 1. It is encouraging to note that contractors, consultants, clients, and government bodies interviewed also admitted to the challenges of proposing the modular construction technique for future buildings. Highly Market acceptance challenges in the East Wallega zone according to the results.

4.4.3. The degree of agreement for groups Challenges for proposing the modular construction technique for the future buildings

As a measure of agreement among raters, Kendall's coefficient of concordance is used as a measure of agreement among raters to see if there is a significant degree of agreement among the three groups (contractor, consultant, client, and government body). Ho: There is no significant difference between the responses of the contractor, consultant, client, and government body. H1: There is a significant difference between the responses of the contractor, consultant, client, and government bodies. The table summarizes the results.

Table 4.9. kendall's coefficient of concordance results to evaluate stakeholder readiness for the future adoption of modular construction in local building projects.

Factors the challenges of adopting modular construction methods	W	Chi-square	P-value (asympt.sig,)	Df	Decision
Factors the challenges for proposing the modular construction technique for future buildings	0.057	6.618	0.085	3	Retain the null hypothesis

* The agreement is significant at level of $\alpha = 0.05$

According to Kendall's coefficient of concordance result related to samples of groups (contractor, consultant, client, and government body), the null hypothesis distribution is the same. So the decision challenges for proposing the modular construction technique for future buildings the p-value is greater than α or the significance of it, so the conclusion is that there is no significant difference between groups. Thus, it can be said that there is sufficient evidence to support the null hypothesis. Therefore, there is a significant degree of agreement among the contractors, consultants, clients, and government bodies regarding the challenges of adopting modular construction methods in east Wollega zone, Oromia regional state.

The Kruskal-Wallis (KW) test was utilized to validate the result of the Kendall's coefficient of concordance test. The KW test is a statistical test that is used to compare the rank means between two or more samples. The Kruskal Wallis statistic test or Where Kw is Kruskal Wallis statistic, $H = (12 / (n * (n + 1))) * (\text{Sum of } (R_i^2 / n_i)) - 3 * (n + 1)$, n is the number of observations in the k samples, n_i the number of observations in the sample and R_i the sum of the ranks in the sample (Monge, 2019)

This test is used in order to check if there are any significant differences in the points of view of the respondents (contractor, consultant, client, and government body) regarding the levels of each of the challenges of adopting modular construction methods in East Wollega zone oromia regional state. H0: There is no significant difference between the responses of contractors, consultants, clients, and government bodies. H1: There is a significant difference between the

responses of the contractor, consultant, client, and government bodies. The results are presented in table 4.9

table 4.10. kruskal-wallis test or one way ANOVA results Evaluate stakeholder readiness for the future adoption of modular construction in local building projects.

Factors the challenges of adopting modular construction methods	Kruskal-Wallis H	Sig.	Df	Decision
Factors the challenges for proposing the modular construction technique for future buildings	2.650	0.449	3	Retain the null hypothesis

*the agreement is significant at level of $\alpha = 0.05$, * Df: degree of freedom

For all the challenges of adopting and proposing the modular construction technique for future building groups, as presented in table 4.10. The P-values (Sig) for groups are greater than $\alpha = 0.05$ (α is the level of significance. Hence, the null hypothesis, H_0 , is not rejected, so there is sufficient evidence to support the null hypothesis. Hence, it can be concluded that there is no significant difference between the four groups of practitioners' responses regarding the challenges of proposing the modular construction technique for future building groups. This result validates the previous result (Kendall's coefficient of concordance test). Therefore, it can be reliably stated that the four groups of respondents agree with each other in terms of their perception of the challenges for proposing the modular construction technique for future building groups in the east wallage zone oromia national regional state.

According to the results of interviews with contractors, consultants, clients, and government bodies, the results show that under the group challenges for proposing the modular construction technique for future buildings;- (1) Market acceptance challenges are the first rank; (2)Regulatory and policy challenges are the second rank and (3) Economic challenges is the third rank In east wallega. The result of the qualitative data analysis by conceptual and quantitative data analysis by RII methods challenges for proposing the modular construction technique for future buildings groups are assigned (1) Market acceptance challenges are the first rank, (2)

Regulatory and policy challenges are a second rank and (3) Economic challenges are the third rank In east wallega and the table 4.11 show the result of interview for qualitative data.

Table 4.11 the result of interview to proposing group challenges of modular construction techniques

Group Challenges Factors	Frequency
proposing modular construction techniques	
economic challenges	7
technical challenges	7
market acceptance challenges	14
regulatory and policy challenges	12

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1. CONCLUSION

Modular construction is a generic term used to describe a building process which uses prefabrication and factory assembly as a fast way of delivering new buildings. It maximizes the efficient use of building materials, construction workforce and resources. In the East Wallaga zone, the modular method of construction work is not adopted, and the study aims to assess the challenges of adopting modern methods of construction work in the East Wallaga zone.

According to the East Wallaga zone study, the survey data, consisting of the seventy causes of major Challenges in Adopting Modular Construction Works, was identified and ranked those are grouped into eight major areas. All major stakeholders agreed on the three most significant challenges of adopting modular construction methods in the East Wallaga zone. Oromia's national regional states the challenges due to behind of government bodies, challenges due to construction design, and barriers due to equipment availability and contractors are the top three groups' challenges, and From seventeen, the survey data, consisting of conducting to compare modular construction with conventional construction methods in terms of quality, time, and cost performance based on stakeholder perception group was identified analysis the costs scarce financial resources are the highest challenges.

The survey data consisted of four factors: stakeholder readiness for the future adoption of modular construction in local building projects; evaluation results were identified and analyzed. The results show Highly Market acceptance challenges in the East Wallega zone.

The findings also show that the challenges due to behind of government bodies, challenges due to construction design, and barriers due to equipment availability, and contractors are the top three groups' challenges. Generally, recommending Modular Construction is the method of quality and speed of the highest construction and plays a major role in the development of the country. So government bodies and all construction sectors in East Wallaga should pay attention to it.

5.2. RECOMMENDATIONS

Modular construction methods are those that provide greater efficiency in the construction process, resulting in increased production, better quality, in less time and with less waste, so reducing the environmental impact. Modern construction methods are a process for producing more, better quality homes in less time.

According to the East Wallaga zone study, the survey data, consisting of the seventy causes of Challenges in Adopting Modular Construction Works, was identified and grouped into eight major areas. All major stakeholders agreed on the three most significant challenges of adopting modular construction methods in East Wallaga zone, Oromia national regional states. The challenges due to behind of government bodies, challenges due to construction design, and barriers due to equipment availability and contractors are the top three group's challenges.

To compare modular construction with conventional construction methods in terms of quality, time, and cost performance based on stakeholder perception group was identified analysis the costs scarce financial resources are the highest challenges in the East Wallega zone. The stakeholder readiness for the future adoption of modular construction in local building projects; evaluation results were identified and analyzed. The results show Highly Market acceptance challenges in the East Wallega zone. So According to the results recommended by government bodies, construction designer, supply chain, and a contractors.

To government body

From the groups of challenges Adopting Modular Construction Works in East Wallega zone, all major stakeholders agreed to the challenges due to behind government bodies are the first rank. Under this group, the absence of targets for modular construction and unequal financial playing off due to government policies are the highest challenges. So government bodies and all construction sector leaders in East Wallaga should pay attention to it. Because modern construction technology and its materials throughout the world for minimal use of natural resources and to save it for future generations. "Over the next few years, I expect to see the majority of our programs done offsite".

To Construction designer

Applying modern methods of construction requires accurate design. Because there is a need for a more upfront design at the outset; once designed, the system is not as flexible for late changes as traditional construction. In East Wollega, all major stakeholders agreed to the Adopting Modular Construction Works challenges because construction design is the second rank under this Complex designs that are difficult to modularize and limited flexibility for customization are the highest challenges, so the designer must be considered too designed to apply modular construction methods.

To Supply chain.

A systematic framework with foremost drivers, opportunities, constraints, concerns, strategies, and measures is proposed for guiding modern construction supply chain enhancement from technical, political and regulatory, socio-economic, and geographical perspectives. The findings contribute to a better understanding of the complexity and dynamics of the advanced development strategy supply chain and direct partners to work collaboratively for supply chain enhancement. Limited information transparency, disrupted supply chain, limited supplier options, and limited component options are the highest challenges, so construction sectors and the supply chain. Leaders must be considered for future buildings.

To contractor

The effective implementation of modular construction within the region is unexpected because of the accessibility of temporary workers with specialized information and experience in this region. The lack of collaboration among experts is additionally vital to overcoming design issues. Transportation poses imperatives for contractors, requiring careful thought of measured construction potential benefits and drawbacks. Limited skilled contractors, Workforce lacks experience in modular construction, the viability of the initial investment in modular construction, and uncertain return on initial investment are same greatest challenges in the East Wollega zone. For a modular construction to extend to total with a great result, appropriate arranging, coordination and communication must exist between different important parties, including from the early stage of the venture. Participation of the client, consultants, manufacturer, contractor and supplier at the beginning stage of a modular construction method project is crucial.

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7. APPENDIX

7.1. Appendix Table I the challenges of adopting modular construction methods Results from contractors

S/N	factors the challenges of adopting modular construction methods	RII	RANK
1	Fragmented communication & information flow	0.61	19
2	Unclear industry standards	0.65	15
3	Limited supplier options	0.68	12
4	Disrupted supply chain	0.68	12
5	Limited component options	0.7	10
6	Logistics expertise gap	0.64	20
7	Intricate on-site coordination	0.63	21
8	Inexperienced logistics personnel	0.65	15
9	Limited information transparency	0.65	15
10	Disorganized supply chain management:	0.67	13
11	Unreliable component availability	0.68	12
12	Fear of workforce reduction	0.62	22
13	Lack of qualified workers	0.64	20
14	Up skilling the workforce can be costly	0.63	21
15	Acquiring new skills can be a financial burden.	0.64	20
16	Limited availability of skilled personnel	0.66	18
17	Increased client doubt and reluctance	0.63	21
18	Clients struggle to embrace the concept	0.67	13
19	Public misunderstandings of modular construction	0.73	7
20	Lack of awareness of the benefits of modular construction	0.71	13
21	Workforce lacks experience in both traditional and modular construction	0.73	7
22	Limited expertise in designing and managing	0.74	10
23	Inexperienced personnel in handling the unique demands of modular construction	0.67	17
24	High upfront cost burden	0.65	19
25	Uncertain return on initial investment	0.69	15
26	Viability of the initial investment in modular construction	0.69	15
27	Workforce lacks experience in modular construction	0.7	10

28	Skill gap in overall project execution	0.69	11
29	Shortage of integrated project delivery	0.68	12
30	Shortage of qualified modular construction builders	0.55	27
31	Limited skilled contractors	0.78	6
32	Complex designs that are difficult to modularize	0.72	12
33	Restricted design options	0.74	10
34	Challenges achieving desired architectural styles	0.72	12
35	Limited flexibility for customization	0.72	12
36	Uniform appearance often associated with modular construction	0.71	13
37	Limited adaptability of modular buildings	0.74	10
38	Challenges with on-site modifications	0.78	6
39	Design rigidity in modular construction	0.77	7
40	Sequencing challenges	0.72	12
41	Limited design flexibility	0.71	13
42	Upfront design commitment	0.73	7
43	Unregulated modular construction industry	0.79	5
44	Lack of standardized building codes	0.75	9
45	Unfavorable government policies	0.71	13
46	Inadequate standardization	0.72	12
47	Local building codes not adapted to modular construction	0.76	8
48	Challenging supply chain coordination	0.73	11
49	Demanding logistics due to bulky components	0.73	11
50	Need for specialized transportation and assembly	0.75	9
51	Limited government support for modular building	0.75	9
52	Absence of targeted for modular construction	0.75	9
53	Unequal financial playing f due to government policies	0.79	5
54	Need for specialized lifting equipment	0.75	9
55	Limited lifting capacity on construction sites	0.73	7
56	Limited on-site handling capabilities	0.71	9
57	Challenges with temporary storage solutions	0.66	14
58	Transportation and handling risks	0.71	9
59	Site preparation and foundation challenges	0.67	13
60	Transportation restrictions for large modules	0.69	11

61	Limited adaptability during construction	0.63	17
62	Challenges with on-site adjustments	0.6	20
63	Inflexibility for last-minute design changes	0.67	13
64	Tight fit requirements for component assembly	0.66	14
65	Minimal margin for error during construction	0.64	16
66	Challenge in identifying the best fit projects for modular construction	0.63	17
67	Limited space for major construction projects	0.61	19
68	Constraints on developing large sites	0.62	18
69	Challenges adapting the site for modular construction	0.66	14
70	Existing site conditions hindering modular construction implementations	0.66	14

7.2. Appendix Table II the challenges in adopting modular construction with conventional one in terms of quality, time, and cost performance results from contractors

S/N	factors the challenges of adopting modular construction methods	RII	RANK
1	Longer lead times in design & manufacturing	0.62	8
2	Delays associated with component fabrication and construction	0.58	13
3	Component lead times	0.56	14
4	Prefabrication duration	0.53	17
5	Limited capacity of modular construction providers	0.55	16
6	Difficulties securing timely deliveries	0.55	15
7	Extended design phase due to complexities of MC	0.61	9
8	High upfront costs	0.62	8
9	Difficulty achieving economies of scale	0.72	3
10	High initial investment costs	0.71	4
11	Scarce financial resources	0.73	2
12	High transportation costs	0.66	6
13	Uncertainty about component quality	0.7	5
14	Potential for on-site assembly errors	0.64	7
15	Workforce skills gap during construction	0.62	8
16	Fragmented information flow	0.8	1
17	Logistics expertise gap	0.62	8

7.3. Appendix Table III the Challenges for proposing modular construction techniques future for building projects Results from contractors

S/N	factors the challenges of adopting modular construction methods	RII	RANK
1	Economic challenges	0.8	4
2	Technical challenges	0.84	3
3	Market acceptance challenges	0.88	2
4	Regulatory and policy challenges	0.89	1

7.4. Appendix Table IV the challenges of adopting modular construction methods Results from consultant

S/N	factors the challenges of adopting modular construction methods	RII	RANK
1	Fragmented communication & information flow	0.67	8
2	Unclear industry standards	0.67	8
3	Limited supplier options	0.69	7
4	Disrupted supply chain	0.71	6
5	Limited component options	0.71	6
6	Logistics expertise gap	0.69	7
7	Intricate on-site coordination	0.69	7
8	Inexperienced logistics personnel	0.71	6
9	Limited information transparency	0.67	8
10	Disorganized supply chain management:	0.69	7
11	Unreliable component availability	0.67	8
12	Fear of workforce reduction	0.6	11
13	Lack of qualified workers	0.64	9
14	Up skilling the workforce can be costly	0.69	7
15	Acquiring new skills can be a financial burden.	0.71	6
16	Limited availability of skilled personnel	0.64	9
17	Increased client doubt and reluctance	0.71	7
18	Clients struggle to embrace the concept	0.78	3
19	Public misunderstandings of modular construction	0.73	5
20	Lack of awareness of the benefits of modular construction	0.71	6
21	Workforce lacks experience in both traditional and modular construction	0.71	6
22	Limited expertise in designing and managing	0.69	7
23	Inexperienced personnel in handling the unique demands of modular construction	0.78	3

24	High upfront cost burden	0.69	7
25	Uncertain return on initial investment	0.8	2
26	Viability of the initial investment in modular construction	0.8	2
27	Workforce lacks experience in modular construction	0.67	8
28	Skill gap in overall project execution	0.76	4
29	Shortage of integrated project delivery	0.78	3
30	Shortage of qualified modular construction builders	0.76	4
31	Limited skilled contractors	0.8	3
32	Complex designs that are difficult to modularize	0.71	6
33	Restricted design options	0.73	6
34	Challenges achieving desired architectural styles	0.71	6
35	Limited flexibility for customization	0.76	4
36	Uniform appearance often associated with modular construction	0.69	7
37	Limited adaptability of modular buildings	0.69	7
38	Challenges with on-site modifications	0.76	5
39	Design rigidity in modular construction	0.62	10
40	Sequencing challenges	0.69	8
41	Limited design flexibility	0.64	9
42	Upfront design commitment	0.6	11
43	Unregulated modular construction industry	0.69	7
44	Lack of standardized building codes	0.76	5
45	Unfavorable government policies	0.76	5
46	Inadequate standardization	0.78	4
47	Local building codes not adapted to modular construction	0.73	5
48	Challenging supply chain coordination	0.71	6
49	Demanding logistics due to bulky components	0.76	5
50	Need for specialized transportation and assembly	0.78	4
51	Limited government support for modular building	0.84	1
52	Absence of targeted for modular construction	0.78	4
53	Unequal financial playing f due to government policies	0.8	2
54	Need for specialized lifting equipment	0.8	2
55	Limited lifting capacity on construction sites	0.69	8
56	Limited on-site handling capabilities	0.71	6
57	Challenges with temporary storage solutions	0.69	7
58	Transportation and handling risks	0.69	7
59	Site preparation and foundation challenges	0.71	7
60	Transportation restrictions for large modules	0.73	6

61	Limited adaptability during construction	0.71	6
62	Challenges with on-site adjustments	0.69	8
63	Inflexibility for last-minute design changes	0.64	9
64	Tight fit requirements for component assembly	0.73	5
65	Minimal margin for error during construction	0.73	5
66	Challenge in identifying the best fit projects for modular construction	0.71	6
67	Limited space for major construction projects	0.64	9
68	Constraints on developing large sites	0.62	10
69	Challenges adapting the site for modular construction	0.67	8
70	Existing site conditions hindering modular construction implementations	0.69	8

7.5. Appendix Table V the challenges in adopting modular construction with conventional one in terms of quality, time, and cost performance results from consultant

S/N	factors the challenges of adopting modular construction methods	RII	RANK
1	Longer lead times in design & manufacturing	0.53	11
2	Delays associated with component fabrication and construction	0.56	10
3	Component lead times	0.6	9
4	Prefabrication duration	0.6	12
5	Limited capacity of modular construction providers	0.56	10
6	Difficulties securing timely deliveries	0.62	8
7	Extended design phase due to complexities of MC	0.64	7
8	High upfront costs	0.76	1
9	Difficulty achieving economies of scale	0.73	2
10	High initial investment costs	0.73	2
11	Scarce financial resources	0.69	5
12	High transportation costs	0.6	9
13	Uncertainty about component quality	0.6	9
14	Potential for on-site assembly errors	0.6	9
15	Workforce skills gap during construction	0.71	4
16	Fragmented information flow	0.67	6
17	Logistics expertise gap	0.67	6

7.6. Appendix Table VI the Challenges for proposing modular construction techniques future for building projects Results from contractor's consultant

S/N	factors the challenges of adopting modular construction methods	RII	RANK
1	Economic challenges	0.8	2
2	Technical challenges	0.73	3
3	Market acceptance challenges	0.82	1
4	Regulatory and policy challenges	0.82	1

7.7. Appendix Table VII the challenges of adopting modular construction methods Results from client

S/N	factors the challenges of adopting modular construction methods	RII	RANK
1	Fragmented communication & information flow	0.8	5
2	Unclear industry standards	0.77	6
3	Limited supplier options	0.86	3
4	Disrupted supply chain	0.86	3
5	Limited component options	0.86	3
6	Logistics expertise gap	0.8	5
7	Intricate on-site coordination	0.77	6
8	Inexperienced logistics personnel	0.74	7
9	Limited information transparency	0.91	1
10	Disorganized supply chain management:	0.83	4
11	Unreliable component availability	0.83	4
12	Fear of workforce reduction	0.77	6
13	Lack of qualified workers	0.77	6
14	Up skilling the workforce can be costly	0.69	9
15	Acquiring new skills can be a financial burden.	0.71	8
16	Limited availability of skilled personnel	0.69	9
17	Increased client doubt and reluctance	0.66	10
18	Clients struggle to embrace the concept	0.77	6
19	Public misunderstandings of modular construction	0.83	4
20	Lack of awareness of the benefits of modular construction	0.83	4
21	Workforce lacks experience in both traditional and modular construction	0.83	4
22	Limited expertise in designing and managing	0.77	6
23	Inexperienced personnel in handling the unique demands of modular construction	0.74	7

24	High upfront cost burden	0.74	7
25	Uncertain return on initial investment	0.8	5
26	Viability of the initial investment in modular construction	0.83	4
27	Workforce lacks experience in modular construction	0.83	4
28	Skill gap in overall project execution	0.71	8
29	Shortage of integrated project delivery	0.69	9
30	Shortage of qualified modular construction builders	0.69	9
31	Limited skilled contractors	0.8	5
32	Complex designs that are difficult to modularize	0.91	1
33	Restricted design options	0.83	4
34	Challenges achieving desired architectural styles	0.8	5
35	Limited flexibility for customization	0.86	3
36	Uniform appearance often associated with modular construction	0.8	5
37	Limited adaptability of modular buildings	0.8	5
38	Challenges with on-site modifications	0.77	6
39	Design rigidity in modular construction	0.89	2
40	Sequencing challenges	0.83	4
41	Limited design flexibility	0.71	8
42	Upfront design commitment	0.74	7
43	Unregulated modular construction industry	0.89	2
44	Lack of standardized building codes	0.86	3
45	Unfavorable government policies	0.71	8
46	Inadequate standardization	0.77	8
47	Local building codes not adapted to modular construction	0.86	3
48	Challenging supply chain coordination	0.74	7
49	Demanding logistics due to bulky components	0.74	7
50	Need for specialized transportation and assembly	0.71	8
51	Limited government support for modular building	0.8	5
52	Absence of targeted for modular construction	0.89	2
53	Unequal financial playing f due to government policies	0.8	5
54	Need for specialized lifting equipment	0.86	3
55	Limited lifting capacity on construction sites	0.83	2
56	Limited on-site handling capabilities	0.8	5
57	Challenges with temporary storage solutions	0.89	2
58	Transportation and handling risks	0.86	2
59	Site preparation and foundation challenges	0.71	8
60	Transportation restrictions for large modules	0.8	5

61	Limited adaptability during construction	0.74	7
62	Challenges with on-site adjustments	0.71	8
63	Inflexibility for last-minute design changes	0.71	8
64	Tight fit requirements for component assembly	0.66	10
65	Minimal margin for error during construction	0.66	10
66	Challenge in identifying the best fit projects for modular construction	0.71	8
67	Limited space for major construction projects	0.8	5
68	Constraints on developing large sites	0.74	7
69	Challenges adapting the site for modular construction	0.71	8
70	Existing site conditions hindering modular construction implementations	0.69	9

7.8. Appendix Table VIII the challenges in adopting modular construction with conventional one in terms of quality, time, and cost performance results from client

S/N	factors the challenges of adopting modular construction methods	RII	RANK
1	Longer lead times in design & manufacturing	0.69	3
2	Delays associated with component fabrication and construction	0.6	5
3	Component lead times	0.54	7
4	Prefabrication duration	0.54	7
5	Limited capacity of modular construction providers	0.63	4
6	Difficulties securing timely deliveries	0.63	4
7	Extended design phase due to complexities of MC	0.6	5
8	High upfront costs	0.57	6
9	Difficulty achieving economies of scale	0.71	2
10	High initial investment costs	0.71	2
11	Scarce financial resources	0.8	1
12	High transportation costs	0.8	1
13	Uncertainty about component quality	0.8	1
14	Potential for on-site assembly errors	0.63	4
15	Workforce skills gap during construction	0.63	4
16	Fragmented information flow	0.69	3
17	Logistics expertise gap	0.57	6

7.9. Appendix Table IX the Challenges for proposing modular construction techniques future for building projects Results from contractor's client

S/N	factors the challenges of adopting modular construction methods	RII	RANK
1	Economic challenges	0.86	1
2	Technical challenges	0.74	4
3	Market acceptance challenges	0.8	3
4	Regulatory and policy challenges	0.83	2

7.10 Appendix Table X the challenges of adopting modular construction methods Results from government body

S/N	factors the challenges of adopting modular construction methods	RII	RANK
1	Fragmented communication & information flow	0.7	6
2	Unclear industry standards	0.7	6
3	Limited supplier options	0.65	7
4	Disrupted supply chain	0.65	7
5	Limited component options	0.65	7
6	Logistics expertise gap	0.65	7
7	Intricate on-site coordination	0.65	7
8	Inexperienced logistics personnel	0.65	7
9	Limited information transparency	0.65	7
10	Disorganized supply chain management:	0.65	7
11	Unreliable component availability	0.65	7
12	Fear of workforce reduction	0.75	5
13	Lack of qualified workers	0.75	5
14	Up skilling the workforce can be costly	0.8	4
15	Acquiring new skills can be a financial burden.	0.8	4
16	Limited availability of skilled personnel	0.85	3
17	Increased client doubt and reluctance	0.8	4
18	Clients struggle to embrace the concept	0.8	4
19	Public misunderstandings of modular construction	0.8	4
20	Lack of awareness of the benefits of modular construction	0.8	4
21	Workforce lacks experience in both traditional and modular construction	0.8	4
22	Limited expertise in designing and managing	0.8	4

23	Inexperienced personnel in handling the unique demands of modular construction	0.8	4
24	High upfront cost burden	0.85	3
25	Uncertain return on initial investment	0.85	3
26	Viability of the initial investment in modular construction	0.85	3
27	Workforce lacks experience in modular construction	0.85	3
28	Skill gap in overall project execution	0.85	3
29	Shortage of integrated project delivery	0.85	3
30	Shortage of qualified modular construction builders	0.85	3
31	Limited skilled contractors	0.85	3
32	Complex designs that are difficult to modularize	0.95	1
33	Restricted design options	0.95	1
34	Challenges achieving desired architectural styles	0.95	1
35	Limited flexibility for customization	0.95	1
36	Uniform appearance often associated with modular construction	0.95	1
37	Limited adaptability of modular buildings	0.95	1
38	Challenges with on-site modifications	0.95	1
39	Design rigidity in modular construction	0.9	2
40	Sequencing challenges	0.85	3
41	Limited design flexibility	0.8	4
42	Upfront design commitment	0.9	2
43	Unregulated modular construction industry	0.95	1
44	Lack of standardized building codes	0.95	1
45	Unfavorable government policies	0.95	1
46	Inadequate standardization	0.95	1
47	Local building codes not adapted to modular construction	0.95	1
48	Challenging supply chain coordination	0.95	1
49	Demanding logistics due to bulky components	0.95	1
50	Need for specialized transportation and assembly	0.95	1
51	Limited government support for modular building	0.9	2
52	Absence of targeted for modular construction	0.95	1
53	Unequal financial playing f due to government policies	0.95	1
54	Need for specialized lifting equipment	0.85	3
55	Limited lifting capacity on construction sites	0.85	3
56	Limited on-site handling capabilities	0.85	3

57	Challenges with temporary storage solutions	0.85	3
58	Transportation and handling risks	0.85	3
59	Site preparation and foundation challenges	0.8	4
60	Transportation restrictions for large modules	0.85	3
61	Limited adaptability during construction	0.95	1
62	Challenges with on-site adjustments	0.95	1
63	Inflexibility for last-minute design changes	0.95	1
64	Tight fit requirements for component assembly	0.95	1
65	Minimal margin for error during construction	0.95	1
66	Challenge in identifying the best fit projects for modular construction	0.95	1
67	Limited space for major construction projects	0.9	2
68	Constraints on developing large sites	0.9	2
69	Challenges adapting the site for modular construction	0.85	3
70	Existing site conditions hindering modular construction implementations	0.9	2

7.11 Appendix Table XI the challenges in adopting modular construction with conventional one in terms of quality, time, and cost performance results from government body

S/N	factors the challenges of adopting modular construction methods	RII	RANK
71	Longer lead times in design & manufacturing	0.85	3
72	Delays associated with component fabrication and construction	0.85	3
73	Component lead times	0.85	3
74	Prefabrication duration	0.85	3
75	Limited capacity of modular construction providers	0.85	3
76	Difficulties securing timely deliveries	0.85	3
77	Extended design phase due to complexities of MC	0.85	3
78	High upfront costs	0.8	4
79	Difficulty achieving economies of scale	0.85	3
80	High initial investment costs	0.85	3
81	Scarce financial resources	0.85	3
82	High transportation costs	0.85	3
83	Uncertainty about component quality	0.95	1
84	Potential for on-site assembly errors	0.9	2
85	Workforce skills gap during construction	0.8	4
86	Fragmented information flow	0.8	4
87	Logistics expertise gap	0.8	4

7.12. Appendix Table XII the Challenges for proposing modular construction techniques future for building projects Results from contractor's government body

S/N	factors the challenges of adopting modular construction methods	RII	RANK
88	Economic challenges	0.85	2
89	Technical challenges	0.85	3
90	Market acceptance challenges	1	1
91	Regulatory and policy challenges	0.85	2

7.13. Appendix Table XIII Overall Results from group respondents the challenges of adopting modular construction methods

S/N	factors	Contractor		Consultant		Client		Government Body		Over All	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Fragmented communication & information flow	0.61	23	0.7	9	0.8	5	0.7	7	0.69	16
2	Unclear industry standards	0.65	19	0.7	9	0.77	6	0.7	7	0.7	15
3	Limited supplier options	0.68	16	0.7	8	0.86	3	0.65	8	0.72	13
4	Disrupted supply chain	0.68	16	0.7	7	0.86	3	0.65	8	0.72	13
5	Limited component options	0.7	14	0.7	7	0.86	3	0.65	8	0.73	12
6	Logistics expertise gap	0.64	20	0.7	8	0.8	5	0.65	8	0.69	16
7	Intricate on-site coordination	0.63	21	0.7	8	0.77	6	0.65	8	0.69	16
8	Inexperienced logistics personnel	0.65	19	0.7	7	0.74	7	0.65	8	0.69	16
9	Limited information transparency	0.65	19	0.7	9	0.91	1	0.65	8	0.72	13
10	Disorganized supply chain management:	0.67	17	0.7	8	0.83	4	0.65	8	0.71	14
11	Unreliable component availability	0.68	16	0.7	9	0.83	4	0.65	8	0.71	14
12	Fear of workforce reduction	0.62	22	0.6	12	0.77	6	0.75	6	0.69	16

13	Lack of qualified workers	0.64	20	0.6	10	0.77	6	0.75	6	0.7	15
14	Up skilling the workforce can be costly	0.63	21	0.7	8	0.69	9	0.8	5	0.7	15
15	Acquiring new skills can be a financial burden.	0.64	20	0.7	7	0.71	8	0.8	5	0.72	13
16	Limited availability of skilled personnel	0.66	18	0.6	10	0.69	9	0.85	4	0.71	14
17	Increased client doubt and reluctance	0.63	21	0.7	7	0.66	10	0.8	5	0.7	15
18	Clients struggle to embrace the concept	0.67	17	0.8	4	0.77	6	0.8	5	0.75	10
19	Public misunderstandings of modular construction	0.73	11	0.7	6	0.83	4	0.8	5	0.77	8
20	Lack of awareness of the benefits of modular construction	0.71	13	0.7	7	0.83	4	0.8	5	0.76	9
21	Workforce lacks experience in both traditional and modular construction	0.73	11	0.7	7	0.83	4	0.8	5	0.77	8
22	Limited expertise in designing and managing	0.74	10	0.7	8	0.77	6	0.8	5	0.75	10
23	Inexperienced personnel in handling the unique demands of modular construction	0.67	17	0.8	4	0.74	7	0.8	5	0.75	10
24	High upfront cost burden	0.65	19	0.7	8	0.74	7	0.85	4	0.73	12
25	Uncertain return on initial investment	0.69	15	0.8	3	0.8	5	0.85	4	0.79	6
26	Viability of the initial investment in modular construction	0.69	15	0.8	3	0.83	4	0.85	4	0.79	6

27	Workforce lacks experience in modular construction	0.7	14	0.7	9	0.83	4	0.85	4	0.76	9
28	Skill gap in overall project execution	0.69	15	0.8	5	0.71	8	0.85	4	0.75	10
29	Shortage of integrated project delivery	0.68	16	0.8	4	0.69	9	0.85	4	0.75	10
30	Shortage of qualified modular construction builders	0.55	27	0.8	5	0.69	9	0.85	4	0.71	14
31	Limited skilled contractors	0.78	6	0.8	3	0.8	5	0.85	4	0.81	4
32	Complex designs that are difficult to modularize	0.72	12	0.7	7	0.91	1	0.95	2	0.82	3
33	Restricted design options	0.74	10	0.7	6	0.83	4	0.95	2	0.81	4
34	Challenges achieving desired architectural styles	0.72	12	0.7	7	0.8	5	0.95	2	0.8	5
35	Limited flexibility for customization	0.72	12	0.8	5	0.86	3	0.95	2	0.82	3
36	Uniform appearance often associated with modular construction	0.71	13	0.7	8	0.8	5	0.95	2	0.79	6
37	Limited adaptability of modular buildings	0.74	10	0.7	8	0.8	5	0.95	2	0.79	6
38	Challenges with on-site modifications	0.78	6	0.8	5	0.77	6	0.95	2	0.81	4
39	Design rigidity in modular construction	0.77	7	0.6	11	0.89	2	0.9	3	0.79	6
40	Sequencing challenges	0.72	12	0.7	8	0.83	4	0.85	4	0.77	8
41	Limited design flexibility	0.71	13	0.6	10	0.71	8	0.8	5	0.72	13
42	Upfront design commitment	0.73	11	0.6	12	0.74	7	0.9	3	0.74	11
43	Unregulated modular construction industry	0.79	5	0.7	8	0.89	2	0.95	2	0.83	2

44	Lack of standardized building codes	0.75	9	0.8	5	0.86	3	0.95	2	0.83	2
45	Unfavorable government policies	0.71	13	0.8	5	0.71	8	0.95	2	0.78	7
46	Inadequate standardization	0.72	12	0.8	4	0.77	8	0.95	2	0.8	5
47	Local building codes not adapted to modular construction	0.76	8	0.7	6	0.86	3	0.95	2	0.83	2
48	Challenging supply chain coordination	0.73	11	0.7	7	0.74	7	0.95	2	0.78	7
49	Demanding logistics due to bulky components	0.73	11	0.8	5	0.74	7	0.95	2	0.79	6
50	Need for specialized transportation and assembly	0.75	9	0.8	4	0.71	8	0.95	2	0.8	5
51	Limited government support for modular building	0.75	9	0.8	1	0.8	5	0.9	3	0.82	3
52	Absence of targeted for modular construction	0.75	9	0.8	4	0.89	2	0.95	2	0.84	1
53	Unequal financial playing f due to government policies	0.79	5	0.8	3	0.8	5	0.95	2	0.84	1
54	Need for specialized lifting equipment	0.75	9	0.8	3	0.86	3	0.85	4	0.81	4
55	Limited lifting capacity on construction sites	0.73	11	0.7	8	0.83	2	0.85	4	0.77	8
56	Limited on-site handling capabilities	0.71	13	0.7	7	0.8	5	0.85	4	0.77	8
57	Challenges with temporary storage solutions	0.66	18	0.7	8	0.89	2	0.85	4	0.77	8
58	Transportation and handling risks	0.71	13	0.7	8	0.86	2	0.85	4	0.78	7

59	Site preparation and foundation challenges	0.67	17	0.7	7	0.71	8	0.8	5	0.72	13
60	Transportation restrictions for large modules	0.69	15	0.7	6	0.8	5	0.85	4	0.77	8
61	Limited adaptability during construction	0.63	21	0.7	7	0.74	7	0.95	2	0.76	9
62	Challenges with on-site adjustments	0.6		0.7	8	0.71	8	0.95	2	0.74	11
63	Inflexibility for last-minute design changes	0.67	17	0.6	10	0.71	8	0.95	2	0.74	11
64	Tight fit requirements for component assembly	0.66	18	0.7	6	0.66	10	0.95	2	0.75	10
65	Minimal margin for error during construction	0.64	20	0.7	6	0.66	10	0.95	2	0.75	10
66	Challenge in identifying the best fit projects for modular construction	0.63	21	0.7	7	0.71	8	0.95	2	0.75	10
67	Limited space for major construction projects	0.61	23	0.6	10	0.8	5	0.9	3	0.74	11
68	Constraints on developing large sites	0.62	22	0.6	11	0.74	7	0.9	3	0.72	13
69	Challenges adapting the site for modular construction	0.66	18	0.7	9	0.71	8	0.85	4	0.72	13
70	Existing site conditions hindering modular construction implementations	0.66	18	0.7	8	0.69	9	0.9	3	0.73	12

7.14. Appendix Table XIV Overall Results from group respondents the Challenges in Adopting Modular Construction with conventional one in terms of quality, time, and cost performance

S/N	Factors	Contractor		Consultant		Client		Government Body		Over All	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Longer lead times in design & manufacturing	0.62	22	0.53	14	0.69	9	0.85	4	0.67	8
2	Delays associated with component fabrication and construction	0.58	25	0.56	13	0.6	12	0.85	4	0.65	10
3	Component lead times	0.56	26	0.6	12	0.54	14	0.85	4	0.64	11
4	Prefabrication duration	0.53	28	0.6	12	0.54	14	0.85	4	0.63	12
5	Limited capacity of modular construction providers	0.55	27	0.56	13	0.63	11	0.85	4	0.65	10
6	Difficulties securing timely deliveries	0.55	27	0.62	11	0.63	11	0.85	4	0.66	9
7	Extended design phase due to complexities of	0.61	23	0.64	10	0.6	12	0.85	4	0.68	7

	MC										
8	High upfront costs	0.62	22	0.76	5	0.57	13	0.8	5	0.69	6
9	Difficulty achieving economies of scale	0.72	12	0.73	6	0.71	8	0.85	4	0.75	3
10	High initial investment costs	0.71	13	0.73	6	0.71	8	0.85	4	0.75	3
11	Scarce financial resources	0.73	11	0.69	8	0.8	5	0.85	4	0.77	1
12	High transportation costs	0.66	18	0.6	12	0.8	5	0.85	4	0.73	5
13	Uncertainty about component quality	0.7	14	0.6	12	0.8	5	0.95	2	0.76	2
14	Potential for on-site assembly errors	0.64	20	0.6	12	0.63	11	0.9	3	0.69	6
15	Workforce skills gap during construction	0.62	22	0.71	7	0.63	11	0.8	5	0.69	6
16	Fragmented information flow	0.8	4	0.67	9	0.69	9	0.8	5	0.74	4
17	Logistics expertise gap	0.62	22	0.67	9	0.57	13	0.8	5	0.66	9

7.15 Appendix Table XV Overall Results from group respondents the Challenges for proposing modular construction techniques future for building projects

S/N	factors	Contractor		Consultant		Client		Government Body	Over All		
		RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Economic challenges	0.8	4	0.8	3	0.86	2	0.85	4	0.83	3
2	Technical challenges	0.84	3	0.73	6	0.74	7	0.85	4	0.79	4
3	Market acceptance challenges	0.88	2	0.82	2	0.8	5	1	1	0.88	1
4	Regulatory and policy challenges	0.89	1	0.82	2	0.83	4	0.85	4	0.85	2

7.16 Appendix Table XVI Results from Interviews

Group Challenges Factors	Frequency
challenges due to supply chain and information system	4
challenges due to manpower or workers	2
challenges due to negative client perception	5
challenges due to contractor	6
challenges due to construction design	7
challenges due to behind government body	8
barriers due to equipment availability	6
barriers due to construction site and standard of offsite	2
versus. cost, time and quality	
cost,	17
time	8
quality	15
proposing modular construction techniques	
economic challenges	7
technical challenges	7
market acceptance challenges	14
regulatory and policy challenges	12

QUESTIONNAIRES

PART ONE: DETAIL INTRODUCTION OF THE RESEARCHER AND INSTRUCTION FOR RESPONDENT.

Dear Respondent:

This questionnaire organized to acquire evidence from key informants with structured questions for a master's research. The aim of this questioner is used to identify and rank the challenges of adopting modular construction industry. The information was necessary for the academic research authorized for the challenges adopting of modular construction industry in east wallaga zone. Your response in this regard is highly prized and influential to the outcome of the research.

All feedback will be kept strictly confidential and will be applied only for this academic research purpose. This questionnaire was required to been filled with exact and relevant facts as much as possible. I would kindly request your participation and cooperation of your construction project participants in providing the required information in the questionnaire, as well as to thank you for your valuable time and efforts.

PART TWO: PERSONAL INFORMATION AND EXPERIENCE OF THE WORKERS IN THE COMPANY

I) Personal Information

- 1) Educational level: 1] none degree ☐ 2] Degree ☐ 3] Masters ☐ 4] PH.D. ☐
- 2) Field of study: 1] contractor ☐ 2] consultant ☐ 3] client ☐ 4) government body ☐
- 3) How many years do you work in the sector?
- 1] 0-5 years ☐ 2] 5-10 years ☐ 3] 10-15 years ☐ 4] above fifty years ☐

PART THREE: Specific Objectives of the Study

- To access the challenges and barriers to the implementation of modular construction
- To conduct comparative analysis of modular construction with conventional one in terms of quality, fastening, cost performance
- To propose modular construction techniques for building projects.

PART FOUR: QUESTIONNAIRE

- Remark: please don't write your name
- fill the questionnaire honestly and freely
- Please put “□” in the box provided!

The Number indicates shown the degree of challenges of adopting modular construction industry based on the five form of the Liker scale (5='very high impact(VHI),4=high impact (HI), 3= medium impact (MI), 2= low impact (LI), and 1='very low impact(VLI)).

Table 1.1. Factors the challenges of adopting modular construction methods

factors the challenges of adopting modular construction methods	likert scale				
	1	2	3	4	5
1.1Challenges due to Supply Chain and Information Systems					
Fragmented communication & information flow					
Unclear industry standards					
Limited supplier options					
Disrupted supply chain					
Limited component options					
Logistics expertise gap					
Intricate on-site coordination					
Inexperienced logistics personnel					
Limited information transparency					
Disorganized supply chain management:					
Unreliable component availability					
1,2 challenges due to manpower or workers					
Fear of workforce reduction					
Lack of qualified workers					
Up skilling the workforce can be costly					
Acquiring new skills can be a financial burden.					

Limited availability of skilled personnel					
1.3,Negative challenges of client Perception					
Increased client doubt and reluctance					
Clients struggle to embrace the concept					
Public misunderstandings of modular construction					
Lack of awareness of the benefits of modular construction					
Workforce lacks experience in both traditional and modular construction					
Limited expertise in designing and managing					
Inexperienced personnel in handling the unique demands of modular construction					
1,4 Challenge due to contractor					
High upfront cost burden					
Uncertain return on initial investment					
Viability of the initial investment in modular construction					
Workforce lacks experience in modular construction					
Skill gap in overall project execution					
Shortage of integrated project delivery					
Shortage of qualified modular construction builders					
Limited skilled contractors					
1.5 challenges due to construction design					
Complex designs that are difficult to modularize					
Restricted design options					
Challenges achieving desired architectural styles					
Limited flexibility for customization					
Uniform appearance often associated with modular construction					
Limited adaptability of modular buildings					
Challenges with on-site modifications					
Design rigidity in modular construction					
Sequencing challenges					

Limited design flexibility					
Upfront design commitment					
1.6 Challenges Due To Behind Government Body					
Unregulated modular construction industry					
Lack of standardized building codes					
Unfavorable government policies					
Inadequate standardization					
Local building codes not adapted to modular construction					
Challenging supply chain coordination					
Demanding logistics due to bulky components					
Need for specialized transportation and assembly					
Limited government support for modular building					
Absence of targeted for modular construction					
Unequal financial playing f due to government policies					
1.7 barriers due to equipment availability					
Need for specialized lifting equipment					
Limited lifting capacity on construction sites					
Limited on-site handling capabilities					
Challenges with temporary storage solutions					
Transportation and handling risks					
Site preparation and foundation challenges					
Transportation restrictions for large modules					
1,8 Barriers Due To Construction Site And Standard Of Offsite					
Limited adaptability during construction					
Challenges with on-site adjustments					
Inflexibility for last-minute design changes					
Tight fit requirements for component assembly					
Minimal margin for error during construction					
Challenge in identifying the best fit projects for modular					

construction					
Limited space for major construction projects					
Constraints on developing large sites					
Challenges adapting the site for modular construction					
Existing site conditions hindering modular construction implementations					

Table2.1. factors the challenges of adopting modular construction methods vs. cost, time and quality

Factors To The Evaluate Challenges Of Adopting Modular Construction Methods Verses To Time, Cost, And Quality	likert scale				
	1	2	3	4	5
2. Challenges Due To Time, Cost, And Quality					
2.1 Time					
Longer lead times in design & manufacturing					
Delays associated with component fabrication and construction					
Component lead times					
Prefabrication duration					
Limited capacity of modular construction providers					
Difficulties securing timely deliveries					
Extended design phase due to complexities of MC					
2..2 Cost					
High upfront costs					
Difficulty achieving economies of scale					
High initial investment costs					
Scarce financial resources					
High transportation costs					
2.3 Quality					
Uncertainty about component quality					
Potential for on-site assembly errors					
Workforce skills gap during construction					
Fragmented information flow					
Logistics expertise gap					

Table 3.1. Factors that challenges for proposing the modular construction technique for future buildings.

Factors the challenges for proposing the modular construction technique for future buildings.	1	2	3	4	5
Economic challenges					
Technical challenges					
Market acceptance challenges					
Regulatory and policy challenges					

Part five: Interview Questionnaire for contractor, consultant, client, and Governmental body

1. What are the challenges that hinder the implementation of modular construction?

2. What are the benefits of adopting modular construction vs. to time, cost, and quality?

3. Which challenges are highly affected to implement modern method of construction?

4. Please put your most excellent idea to propose modular construction for future buildings project.

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Thank You for Your Time