2023

الجامعة الافتراضية السورية

SYRIAN VIRTUAL UNIVERSITY

BIMM Master

Building Information Modeling & Management

الجمهورية العربية السورية

وزارة التعليم العالي

الجامعة الافتراضية السورية

الإدارة الرشيقة للهدر ومستقبل صناعة البناء والتشييد في سوريا

Lean Waste Management and the future of architecture, engineering, and construction industry in Syria

إعداد:

علا عماد ضاحي

Ola_162348

إشراف:

د. عبد السلام شيباني

بحث مقدم استكمالاً لمتطلبات الحصول على درجة ماجستير التأهيل والتخصص في نمذجة وإدارة معلومات البناء

BIMM – S22

2023م

الإهداء

إلى مثال التفاني والإخلاص.. **أبي الحبيب**.

إلى من قدَّمت سعادتي وراحتي على سعادتها... **أمي الفاضلة**.

إلى مشجعي الأول.. شريك العمر والحياة.

زوجي العزيز.. الداعم الدائم والجندي المجهول في نجاحاتي.

إلى باقي **أفراد أسرتي**.. يا من وجودهم يمدني بالقوة

إلى كل أقاربي الذين لم تخلوا أيامهم من عبارات الدعاء لتوفيقي.

إلى **أصدقائي**.. زملاء الاختصاص الهندسي وزملاء العمل..

اللذين لم يترددوا في دعمي بكل ما احتجت إليه.

إلى الأيادي المعطاءة.. إلى من لم يدخروا جهداً في وصولي إلى ما وصلت إليه.

أساتذتي في الجامعة الافتراضية السورية كل باسمه ولقبه الذي يحبه.

إلى ربان سفينتنا الأكاديمية.. إلى من جعل كل هذا ممكناً

مديرة البرنامج د. سونيا أحمد، **ومشرفي المعطاء** د. عبد السلام شيباني

إلى كل من ساعدني ودعمني معنوياً أو علمياً..

أهدي إليكم ثمرة تعبي ورسالتي المتواضعة

المعدة لنيل درجة الماجستير في نمذجة معلومات البناء.

علا عماد ضاحي

Abstract

Despite the importance of the issue of waste in construction projects, especially in Syria, we find a lack of relevant research. For this and to explore the most important factors causing waste in construction projects in Syria, this study was carried out, as it followed the descriptive analytical method to explore the most important factors through a literature review and semi-structured interviews, then data was collected through a questionnaire. this data was analyzed to come up with results that can be addressed in a logical order according to importance and frequency. These findings can be used by construction professionals to help achieve lean buildings. The importance of this research stems from its novelty as it took place in the year 2022 when Syria is on the verge of an integrated reconstruction phase, and the fact that it deals with an existing and urgent problem in the Syrian construction industry. This research will be a valuable tool in the hands of those in charge of construction projects to increase awareness and responsibility and avoid wasting resources. Some solutions derived from building information modeling (BIM) applications were also proposed, in addition to the latest technologies, as guidance to those wishing to avoid waste-causing factors, and also as an indicator for future research in the development of the construction industry in Syria. It is suggested that quantitative and qualitative studies be carried out to assess the impact of factors and proposed solutions on waste in projects.

Keywords: lean, lean waste management, waste, waste minimizing, Syria AEC, BIM, waste factors.

خلاصة

على الرغم من أهمية موضوع الهدر في المشاريع الإنشائية وخاصة في سوريا، نجد نقصاً في الابحاث المختصة به. لهذا ولاستكشاف أهم العوامل المسببة للهدر في المشاريع الإنشائية في سوريا تم القيام بهذه الدراسة حيث اتبع الأسلوب التحليلي الوصفي لحصر أهم العوامل عن طريق المراجعات الأدبية والمقابلات النصف مهيكلة، وتم جمع البيانات عنها عن طريق الاستبيان، وتم تحليل هذه البيانات للخروج بنتائج يمكن معالجتها بترتيب منطقي وفق الأهمية والتكرار. يمكن استخدام هذه النتائج من قبل العاملين في قطاع البناء للمساعدة في الوصول لأبنية رشيقة خالية من الهدر. وتأتي أهمية هذا البحث من كونه يتعامل مع مشكلة قائمة وملحة في صناعة البناء السورية، ومن حداثته حيث تم في عام٢٠٢٢ حيث سوريا مقبلة على مرحلة إعادة إعمار متكاملة، سيكون هذا البحث أداة قيمة في أيدي القائمين والعاملين على المشاريع الإنشائية لزيادة الوعي والمسؤولية ولتجنب الهدر في الموارد. كما تم اقتراح بعض الحلول المستقاة من تطبيقات نمذجة معلومات البناء بالإضافة لأحدث التكنولوجيات لتكون موجهاً للراغبين في تفادي العوامل المسببة للهدر وأيضاً كمؤشر للأبحاث المستقبلية في تطوير صناعة البناء في سوريا. من المقترح أن يتم القيام بدراسات كمية ونوعية لتقييم أثر العوامل والحلول المقترحة على الهدر في المشاريع.

الكلمات المفتاحية: البناء الرشيق، الإدارة الرشيقة للهدر، الهدر، تخفيض الهدر، صناعة البناء في سوريا، نمذجة معلومات البناء، عوامل الهدر.

Index

Table of Figures

Table of Tables

1. Introduction

Before 2011, the Syrian economy relied mainly on agriculture, natural resources, and industry, then trade, services, and tourism. Now, after 11 years of war in Syria, there is no major sector of the economy whose different facilities were not affected, so it is not possible to expect the movement of the economy wheel to return to its previous position directly.

In order for the economic sectors to rise, they need facilities and services that allow them to carry out their various activities. Therefore, the construction sector is likely to be one of the most important sectors participating in the Syrian national economy in the upcoming reconstruction phase. In developing countries, the construction industry has a major influence on the economic growth (Aziz & Abdel-Hakam, 2016; Niazi & Painting, 2017; Bajjou M, Chafi A, 2020).

Hence, the next stage must be a qualitative stage with high-quality specifications to suit the current reality and the expectations that must be achieved in order to reach buildings of high economic return and free of waste, and that we do not go back to repeating old practices during the next urban renaissance stage. Traditional practices must be corrected and awareness raised towards wasted resources in projects that are often overlooked or ignored. Controlling and reducing waste will lead to reducing the increase in project costs and benefiting from this saving in other projects, also, waste has a harmful effect on the environment (Jrad 2016). We have to emphasize that each project, whatever its type and size, is not a single project, but rather on the basis of being part of a large comprehensive reconstruction plan, thus raising the sense of responsibility to achieve correct and sound construction operations. Looking at resources as a whole of the comprehensive construction plan and not for a single project, so that waste (in all its forms, if it was a waste of materials, time, effort, skills, money, or others) in one project inevitably affects the progress of other projects. Lessons learned of the past buildings can revolutionize the way we design buildings and transform design from human-centered to humanity-centered (Petrova, 2019).

Lean construction provides an effective management approach to overcoming the common and prevalent issues related to waste generation. However, construction managers fail to consider new principles of lean construction such as the elimination of waste related to time given, they typically believe waste in the construction process is strictly related to waste of materials and other non-value-adding operations such as transport, waiting, work accidents, inspection, and others are not considered as waste (Emuze & Saurin, 2015, Bajjou M, Chafi A, 2020).

Many modern technologies appeared in light of the great technological progress witnessed by the world, which opened great horizons in various fields of life, but someone forgot to invite the construction industry to this party!! In contrast to other industries, the production efficiency of the construction industry is relatively low (Sun, Kim et al 2022). So far, we do not see much progress in modern technology implemented regarding construction industry projects, perhaps Because of its complexity and the large number of parties contributing to it, and perhaps because this industry does not rest, does not stop, and does not wait for development, it is continuous and can be added to, not restructured.

However, information technology has contributed greatly to the development of the AEC industry, facilitating its many operations, managing its products, and many other areas that have helped simplify the job of everyone who works in it, from site workers to the building owner. But this technology doesn't worth anything unless it is used by expert operators who can organize their time and arrange their thoughts on a daily basis without any change in that level of performance.

So, because the human psyche is by nature volatile and it is not possible to provide equal and balanced performance daily by anyone, and the process of sharing knowledge and experience is complex and often incomplete. We must continue the search for solutions and applications that will reduce the burden on all parties of the project, and we find this need urgent in large and complex projects. That is why we must move to BIM and artificial intelligence and explore its applications to gain extra help side-by-side with the worker, the engineer, the project manager, and even the owner and operator. keeping in mind the principles of lean construction, waste reduction, and resource utilization, we can take the construction industry to the next level and enter the construction 4.0 era in steady steps. There was a significant increase in the adoption of BIM (Safour, et al., 2021) for its positive effect in solving problems with construction projects and other positive aspects such as improving the performance and quality of the project (Elhendawi, 2018). Nevertheless, the implemented level of BIM is still lower than expected (Yusof, et al., 2018).

2. Literature review

2.1. Research problem

- **Construction industry** is a vital core of any country's economy, However, **In Syria**, it is more important at the present time given all the destruction this country suffered from due to the last 10 years. Better and more efficient ways of construction must be explored to face the upcoming period of reconstruction thus and due to the large amounts of money, material, time, and effort required, there should be more consideration of the construction methods in hand.

- **Waste**: there isn't a lot of studies that explored or analyzed factors causing construction waste in developing countries (Khanh & Kim, 2014a, 2014b, 2015; Bajjou M, Chafi A, 2020). The Syrian price analysis guide notes 20% of the price of each item for administrative expenses, profits, and waste, and the waste cost is on average (2-5%) of the item price according to the type of material (Price Analysis Guide, 2009; Jrad A 2016). Waste is related to any actions that would consume money, equipment, labor, and materials without adding true value to the production of the construction project (Khanh & Kim, 2015).
- **Lean construction** and **Lean Waste Minimizing** should be thoroughly explored and understood to deliver more efficient buildings with less cost, time, effort, etc.
- **BIM**: Building Information Modeling (BIM) methodologies offer great opportunities in terms of planning and documenting the entire project process and the steps it goes through in an electronic way that is correct and understandable by man and machine. Syrian AEC industry has witnessed the start of adopting BIM, However, more efforts should be made by the government, major firms, and experts to emphasize its use as possible and make sure to keep up with the latest technologies (Al Hammoud, 2021). In the past few years and since this technology began to spread globally, a huge amount of data, information, ready-made templates, and standards documented in an electronic form that is fully understood and pre-modeled, has been available to us. This wonderful technology is not easy or simple, and most importantly, it has not yet reached the max of its maturity, so work is still being done on developing and enriching it. In most cases, optimal solutions and BIM application have not been devised at the beginning of the project, rather, the application of this technique and the search for solutions stemmed from

a fundamental problem often during the implementation of the project or during its schedule. which is understandable for everyone who works in the construction industry, as we all face time pressures preventing us from taking steps that are new and unfamiliar such as those necessary to the implementation of BIM methodology. Al Hammoud and Ahmed (2022) propose a new plan to prepare a new generation of architects to be high-tech qualified and fully aware of BIM, which gives these architects advantages at the beginning of their career and help them fulfill AEC firms' new requirements, this would also promote the university's reputation and help in spreading BIM education among other local universities and competencies (Al Hammoud & Ahmed, 2022)

2.2. Previous Studies

- **تحليل هوالك التشـيـيد الســورية وصــياغة نموذج لتقليل هوالك حديد التســليح / [Analysis Waste in Syrian construction and Developing Model to Reduce Waste of Reinforced steel Bars].**

  Ali Jrad, F. (2016). Tishreen University Journal for Research and Scientific Studies-Engineering Sciences Series, 38(3), 153–174.

This research discusses the most important factors affecting the increased material waste in Syrian construction projects by identifying the most important causes that lead to an increase in material waste, associated with design, storage, or supervision. These factors are arranged to determine their effects on the project. At the end of the research, the authors formulated a mathematical model to optimize the cutting of reinforced steel bars and used the Lindo program to solve this model. It has been shown by the study that a large proportion of waste is resulting from random cutting bars.

- **Critical factors in effective construction waste minimization at the design stage: A Shenzhen case study, China**

  Jiayuan Wang, Zhengdao Li, Vivian W.Y. Tam, Resources, Conservation and Recycling 82 (2014) 1– 7

This paper presents a set of critical factors that inform and improve the practice of waste minimization design, particularly in the context of Shenzhen, China. Nineteen potential factors which can influence effective waste minimization are presented based on related official guidelines, reports, and literature. Top institutions in Shenzhen that have received a Grade A building design certification were surveyed through a questionnaire. From this survey, six critical factors are derived: (1) large-panel metal formworks, (2) prefabricated components, (3) fewer design modifications, (4) modular design, (5) waste reduction investmen,t and (6) economic incentive. The applicability and significance of the identified critical factors for effectively designing waste minimization are also explored.

- **Identifying and Managing Critical Waste Factors for Lean Construction Projects**

  Mohamed Saad Bajjou & Anas Chafi (2020) Engineering Management Journal

This study highlights the findings of an empirical study to investigate critical waste factors (CWFs) affecting the performance of construction projects. Twenty-four CWFs were identified through an extensive literature review and consolidated by semistructured interviews with construction experts. A structured questionnaire was designed and completed by 330 participants from public and private projects in Morocco. The statistical analysis indicated that the top five ranked factors are Activity Start Delays, Rework, Unused Employee Creativity, Long Approval Process, and Waiting Due to Work Not Completed by Others.

Factor analysis was conducted and indicates the underlying factors for the 24 CWFs are inefficient site management, improper planning, and poor communication, rework and poor quality, and human-related factors.

The findings of this study provide guidance to practicing engineering managers to develop appropriate strategies to effectively manage CWFs for lean construction projects through waste reduction.

- **AUTOMATED CHECKING SYSTEM FOR MODULAR BIM OBJECTS**
  Hongwei SUN, Inhan KIM, Department of Architecture, Kyung Hee University, Yongin, Republic of Korea, 2022

With the increasing popularity of modular buildings, many manufacturers have made BIM objects for use by designers. However, these BIM objects must satisfy specific regulations and requirements, and their quality needs to be verified. In this study, the authors propose an automated checking system for modular BIM object quality verification. The system includes three parts, which are modular BIM object guidelines, a pre-checking module, and an automated code-checking module. The modular BIM object quality verification system is proposed to be applied to government modular product certification site for checking the modular BIM objects. It is expected that the use of this automated checking system will make it possible to connect users and manufacturers to promote the circulation of modular building products, as well as provide designers with standardized modular BIM objects for design purposes.

- **دعم القرار في مجال الصيانة بمنهجية متكاملة بين إدارة المعرفة والواقع الافتراضي في بيئة نمذجة معلومات البناء / [Support Decision-Making in Maintenance Work Using an Integrated Methodology Between Knowledge Management and Virtual Reality in BIM Environment].**

Omran Jamal, Ali Jrad F, Alhassan Bassel (2019) Tishreen University Journal for Research and Scientific Studies-Engineering Sciences Series, 41(2), 351–367.

This research discusses the issue of many facilities being subjected to unjustified waste during the implementation of maintenance work. therefore, the authors seek to develop a technical and software framework that helps to obtain knowledge while performing maintenance and store this knowledge in a database in the BIM environment and transfer this knowledge using the Dynamo software, and then use virtual reality to create a model loaded with all these data to overcome communication problems and errors that occur between staff members and thus save in the cost and time during the implementation of maintenance.

❖ **Commentary on previous studies:**

Local studies: previous studies show a clear shortage of research concerning waste in construction projects in Syria, especially waste in time and effort, also it shows that the common definition of waste is still primitive to include only material waste and money. However, previous studies show a great interest in investigating the causes of waste in building materials and measuring its impact according to the wasted material and according to the stage causing the waste, which shows the great interest in waste in the Syrian projects and the importance of the subject and the efforts made to optimize buildings. Even though; it's outdated and observes waste of material only. Studies also show efforts exploring new technologies that would assist the Syrian AEC industry stakeholders to achieve a better building life cycle in total through BIM in the matter of maintenance waste.

Global and neighbor studies: these studies show a better understanding to waste in definition, also, they provide critical factors affecting various waste categories in their origin country, therefore, can't be reliable for the Syrian industry. Also, most of the studies are outdated and don't include any suggested solutions. On the other hand, we find a vast variety of research on technological approaches for automating BIM processes that are tempting to merge the two outcomes for a creative solution that could help minimize the waste in the AEC industry with minimal effort.

2.3. Research assumptions

After this research, we are supposed to be able to understand waste factors' origins in the Syrian construction industry and come up with a kind of creative approach that integrates lean waste minimization through the application of BIM and AI.

It's assumed to be possible to benefit from many applications of artificial intelligence mixed with applications of building information modeling in the development and progress of the lean construction industry, especially in Syria, regarding the next phase of reconstruction, which must be qualitative to suit the requirements of the upcoming phase.

Statistical assumptions:

1- Is there a statistical difference in responses according to years of experience? Between respondents with more than 10 years of experience and respondents with less than 10 years of experience.

2- Is there a statistical difference in responses according to the sector of work? Between respondents experienced in the governmental sector, respondents experienced in the private sector, and respondents experienced in both sectors.

2.4. Research Importance

The importance of this research comes from the following:

• Scientifically:

- The research deals with the issue of waste that the construction industry suffers from in general and in Syria in particular.
- The novelty of the research, as it was conducted in 2022.
- The novelty of the research topic, as it is always under constant research and needs to be updated regularly.

• Practically:

- Identifying and documenting waste factors in the Syrian construction industry, especially those resulting from poor project design or planning.
- Explore possible solutions to help reduce the effects of the highest-ranked factors after the analysis.

2.5. Research Goals

Research Aim:

To investigate the waste factors in construction projects in Syria.

Research Objectives:

1. Review literature on the topic of waste, lean, BIM, and AI globally and locally.
2. Gather data through semi-structured interviews with experts in the field of construction in Syria from both private and public sectors. Then conduct a questionnaire to finalize the list of ranked factors affecting waste in construction projects in Syria.
3. Develop perceptions of what can be achieved from solutions as a result of the integration between the building information modeling approach and artificial intelligence and the impact of these proposed solutions on the process, product, and organization.

3. Research Terminology

- **BIM:** Building information modeling (BIM) is a process supported by various tools, technologies, and contracts involving the generation and management of digital representations of physical and functional characteristics of places. Building information models (BIMs) are computer files (often but not always in proprietary formats and containing proprietary data) that can be extracted, exchanged, or networked to support decision-making regarding a built asset. BIM software is used by individuals, businesses, and government agencies who plan, design, construct, operate and maintain buildings and diverse physical infrastructures. The concept of BIM has been in development since the 1970s, but it only became an agreed term in the early 2000s. The development of standards and adoption of BIM has progressed at different speeds in different countries.
- **Lean:** Lean is the concept of efficient manufacturing/operations that grew out of the Toyota Production System in the middle of the 20th century. It is based on the philosophy of defining value from the customer's viewpoint, and continually improving how value is delivered, by eliminating every use of wasteful resources, or that does not contribute to the value goal. Lean is centered on preserving value with less work; with the ultimate goal of providing perfect value to the customer through a perfect value creation process that has zero waste. This is done by empowering every individual worker to achieve his or her full potential, and so to make the greatest possible contribution. The goal of Lean is waste reduction, increased customer value, and continuous improvement. Just as Edwards Deming said, "It is not enough to just do your best or work hard. You must know what to work on." (Mandujano et al, 2016). Lean has five principles that are considered a recipe for improving workplace efficiency and include: 1)

defining value, 2) mapping the value stream, 3) creating flow, 4) using a pull system, and 5) pursuing perfection.

- **Waste:** Waste is any action or step in a process that does not add value to the customer. In other words, waste is any process that the customer does not want to pay for. Taiichi Ohno, the chief engineer at Toyota, identified the following seven types of waste in production in 1988: defects/rework, overproduction, waiting, transportation, inventory, movement/motion, and over-processing. A few years later, Womack and Jones added the eighth type of waste, non-utilized workers' talent.
- **Artificial Intelligence (AI):** Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. The term may also be applied to any machine that exhibits traits associated with a human mind such as learning and problem-solving. The ideal characteristic of artificial intelligence is its ability to rationalize and take actions that have the best chance of achieving a specific goal. A subset of artificial intelligence is machine learning (ML), which refers to the concept that computer programs can automatically learn from and adapt to new data without being assisted by humans. Deep learning techniques enable this automatic learning through the absorption of huge amounts of unstructured data such as text, images, or video.
- **Process Automation:** uses technology to automate complex business processes. It typically has three functions: automating processes, centralizing information, and reducing the requirement for input from people. It is designed to remove bottlenecks, and reduce errors and loss of data, all while increasing transparency, communication across departments, and speed of processing.

4. Research Methodology

The study adopts the descriptive analytical approach which is implied as follows:

4.1. Research Tools

- literature review: checking primary and secondary sources, globally and locally to determine a preliminary list of factors causing waste in construction projects.
- Data gathering tools: observation from personal experience in addition to semi-structured interviews to help finalize the list of factors to be formulated into a questionnaire to measure the importance of factors and the level of occurrence based on the Likert scale, accompanied by the information regarding the participants.
- Data analysis tools: SPSS program (Statistical Package for the Social Sciences) was used to develop useful information and measurements from collected data.

4.2. Research Community

- **The research will include:**
    1. Internationally: regarding the collection of information and primary and secondary sources.
    2. Locally: regarding applied research tools, which include companies and individuals involved in the construction industry in Syria.
- **The research will benefit:**
    1. All construction companies, governmental or private, either present in Syria or considering entering the Syrian market, to better understand how to deliver better more efficient buildings as the research is derived from the Syrian reality in 2022.

2. Individuals working in the construction sector in Syria to help them achieve their goals and avoid making frequent mistakes regarding waste in projects.
3. Researchers who wish to continue exploring more solutions and conduct impact studies in the future.

4.3. Research Limits

- Objectivity: the research deals with a pressing matter globally and locally of waste reduction and hidden costs within construction projects that could be avoided if identified properly.

  The research deals with the applications of artificial intelligence and machine learning but does not deal with deep learning, as it is still a theoretical thought that has not been publicly applied yet.

- Geographical: research includes the global scientific community and is not limited to one region without another; however, its results might be specific to the Syrian AEC only.
- Temporal: The research covers the period from 2016 until the date of the research, which will take place in 2022.
- Human limits: every specialist concerned with the construction industry and the development of technology that serves this sector in Syria.

4.4. Data Collection and Interview Protocol

Identification of considered Waste Factors:

The identification of the preliminary waste factors consists of two key phases: (1) literature review and (2) semi-structured interviews. As in phase (1) a preliminary list of waste factors was extracted based on a thorough assessment of previous investigations. Then in phase (2), In order to gather more data regarding the Syrian AEC industry, semi-structured interviews were conducted to enrich the data gathering. The reason for using semi-structured interviews is that it's open, allowing new ideas to be brought up during the interview as a result of what the interviewee says.

interviews were conducted with 5 construction industry experts, to discuss the completeness and rationality of this initial set of preliminary waste factors, through a phone call and in writing, provided with the following question: "according to your experience, what are the most critical factors causing different waste types in construction projects in Syria?", then they were given time to think and consider the question and asked to provide answers in two days.

The interviewees were 5 experts consisting of one site manager (private sector), one head of studies department (governmental sector), one head of execution department (governmental sector), one academic\architect (private sector), and one project costs manager (private sector). As shown in Table 1.

Table2 nterviewees' information

count	interviewee current position	working sector
1	site manager	**private**
1	head of the studies department	**governmental**
1	head of the execution department	**governmental**
1	academic\architect	**private**
1	project costs manager	**private**

Interviewees were requested to provide their perceptions of the most important factors causing waste in construction projects in Syria then they were asked to examine whether the initial draft list included all waste factors in view of context and construction markets in Syria. Based on the outcome of these interviews, several improvements were introduced in the final version of the questionnaire aimed at identifying those most relevant to the Syrian construction industry. In particular, some factors were merged together, additional factors were added, and some factors were redefined or omitted. The final list of 45 waste factors constituted the core content of the questionnaire design, distributed over 4 main categories which are: design factors (DF) included 16 factors, organizational and administrative factors (OF) included 12 factors, construction factors (CF) included 13 factors, and external factors (EF) included 4 factors. This categorization was presented by the author for easier access to factors according to origin regarding different project stakeholders roles, as shown in Table 2.

Table 3 the considered 45 waste-causing factors

Design Factors DF		
code	**factor**	**source**
DF1	lack of use of Prefabricated components in design	Wang, J., Li, Z., & Tam, V. W. Y. (2014).
DF2	lack of Modular design	Wang, J., Li, Z., & Tam, V. W. Y. (2014).
DF3	Unused employee creativity	Bajjou, M. S., & Chafi, A. (2020).
DF4	Educational background shortage	Wang, J., Li, Z., & Tam, V. W. Y. (2014).
DF5	Poor coordination and communication between the design team	Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020).
DF6	Poor quality practices	Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020).
DF7	Misunderstanding of client/end-user requirements	Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020).
DF8	Design change at the client order or end-user	Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020).
DF9	Design change due to its contradiction with the utilities	Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020).
DF10	Design change because of the difficulty of implementation	Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020).
DF11	Incomplete design at the time tender	Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020).

DF12	Mistakes and discrepancies in design documents	Bajjou, M. S., & Chafi, A. (2020).
DF13	Calculation errors in quantities, increase or decrease	Interviews
DF14	Non-compliance with specifications and standards	Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020).
DF15	Lack of using modern technology and software	Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020).
DF16	Lack of clarity on the concept of waste and its size among the participating designers	Author
Organization Factors OF		
code	**factor**	**source**
OF1	Inadequacy between the staff qualification and the position held	Bajjou, M. S., & Chafi, A. (2020).
OF2	Not allocating enough time to study and plan the project.	Interviews
OF3	Lack of training for engineering teams, failure to enable new skills, and failure to optimally utilize the current skills of the team	Interviews
OF4	The lack of a communication plan between the project parties	Interviews
OF5	Unclear definition of the project parties' responsibilities	Interviews
OF6	The scope of the project is not clearly defined	Interviews
OF7	Long approval process	Bajjou, M. S., & Chafi, A. (2020).
OF8	Inadequate definition for authority or responsibility as well as supervision overlapping	Issa, U. H., & Alqurashi, M. (2020).
OF9	lack of investment in Waste reduction	Wang, J., Li, Z., & Tam, V. W. Y. (2014).
OF10	Lack of a waste management and control plan	Author

OF11	The lack of clarity on the concept of waste and its size in the organization	Author
OF12	Problems in project schedules that lead to waiting times or ineffective time constraints in completing the design, implementation, and other works.	Bajjou, M. S., & Chafi, A. (2020) \ Issa, U. H., & Alqurashi, M. (2020).
Construction Factors CF		
code	**factor**	**source**
CF1	Lack of consultants' experience in design, supervision, and quality control	Issa, U. H., & Alqurashi, M. (2020).
CF2	Conflicts, poor communication, and coordination among contractors and other parties	Issa, U. H., & Alqurashi, M. (2020).
CF3	Quality defects	Bajjou, M. S., & Chafi, A. (2020).
CF4	Materials damaged/deteriorated during construction time	Bajjou, M. S., & Chafi, A. (2020).
CF5	Using unsuitable tools to perform the work during implementation, causes losses in the material used as a result of spilling or splashing	Interviews
CF6	Unavailability of the required materials and replacing them with close alternatives	Interviews
CF7	Equipment breakdown	Bajjou, M. S., & Chafi, A. (2020).
CF8	Materials and equipment were stolen/lost from the site during construction time.	Bajjou, M. S., & Chafi, A. (2020).
CF9	Material wastes either due to poor design or poor execution	Issa, U. H., & Alqurashi, M. (2020).
CF10	Unskilled workers and poor labor productivity	Issa, U. H., & Alqurashi, M. (2020).
CF11	Rework and correctional work	Bajjou, M. S., & Chafi, A. (2020).
CF12	Changes during the implementation phase	Interviews

CF13	Starting execution although project documents are not completed	Issa, U. H., & Alqurashi, M. (2020).
External Factors EF		
code	**factor**	**source**
EF1	lack of Construction waste regulation	Wang, J., Li, Z., & Tam, V. W. Y. (2014).
EF2	The long approval and contracting periods lead to a waste of time, reduce the economic return of the project, and increase the prices of materials	Interviews
EF3	Country's economic situation (currency exchange, inflation)	Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020).
EF4	Impact of social and cultural factors	Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020).

Questionnaire Design

As mentioned above, the resulting questionnaire was used in investigating factors causing waste in Syrian construction projects. The questionnaire was formed using "google forms" and consisted of two sections: (1) respondent information and (2) waste importance and occurrence frequency. Section 1 aimed at gathering respondent information according to two groups; clustering of individuals (education level, expertise sector, number of years of working experience, working sector, and current position) and clustering of organization information (organization size, organization average project size, organization average project budget). Section 2 aimed at assessing the level of importance and occurrence for each given waste factor based on respondents' experiences. A 5-point Likert scale was employed to evaluate the importance level of each waste factor (with 1 for "not important", 2 for "a little important", 3 for "important", 4 for "highly important", and 5 for "most important") and evaluate the occurrence level of each waste factor (with 1 for “unlikely", 2 for “few times", 3 for “sometimes", 4 for “very often", and 5 for “always”). In the end, there was extra space for respondents to add more factors if they thought something was not included in the questionnaire. The final questionnaire is included in Appendix 1. The questionnaire was presented to the supervising professor to express his opinion and make any necessary modifications before publishing and collecting responses. Then it was published between the time from 11-29-2022 to 12-15-2022 and received 49 responses.

5. Data Analyze

5.1. Characteristics of the study sample

First- By gender:

Table 4 Characteristics of the research sample by gender

		Frequency	Percentage
Valid	Male	26	53.1 %
	Female	23	46.9 %
	Total	49	100.0 %

From the previous table, we find that the percentage of males from the research sample amounted to 53.1%, while the percentage of the research sample from females amounted to 46.9%.

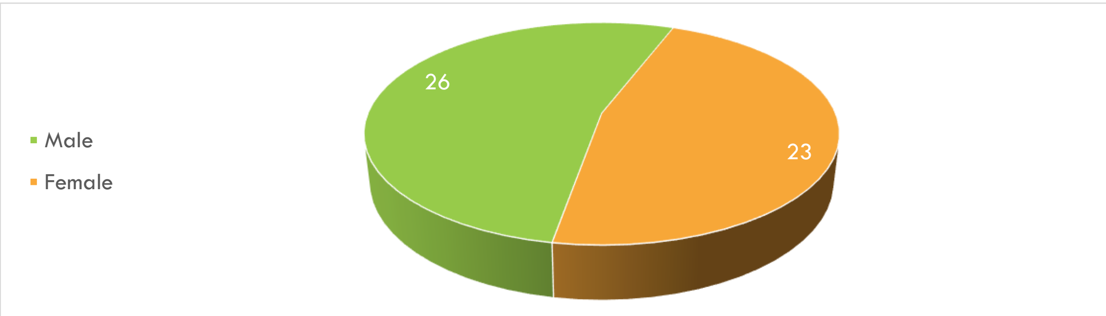

Figure 1 Percentage of the research sample by gender

Second - according to the level of education:

Table 5 Characteristics of the research sample according to the level of education

		Frequency	Percent
Valid	Graduated from an engineering college	33	67.3
	Holds a master's degree in engineering	8	16.3
	Obtained a high school diploma	5	10.2
	Student of an engineering institute or engineering college	1	2.0
	Holds a Ph.D. in engineering	2	4.1
	Total	49	100.0

From the previous table, we find that the largest percentage of the research sample, according to the educational level, was a sample that graduated from an engineering college, which amounted to 67.3%, while a group with a master's degree in engineering specialization came in second place, amounting to 16.3%, and in the third place was a group with a general secondary certificate, with a rate of 10.2%. And in fourth place is a group with a doctorate with an engineering specialization with a rate of 4.1%, and finally a group of engineering institute or engineering college students with a percentage of 2%.

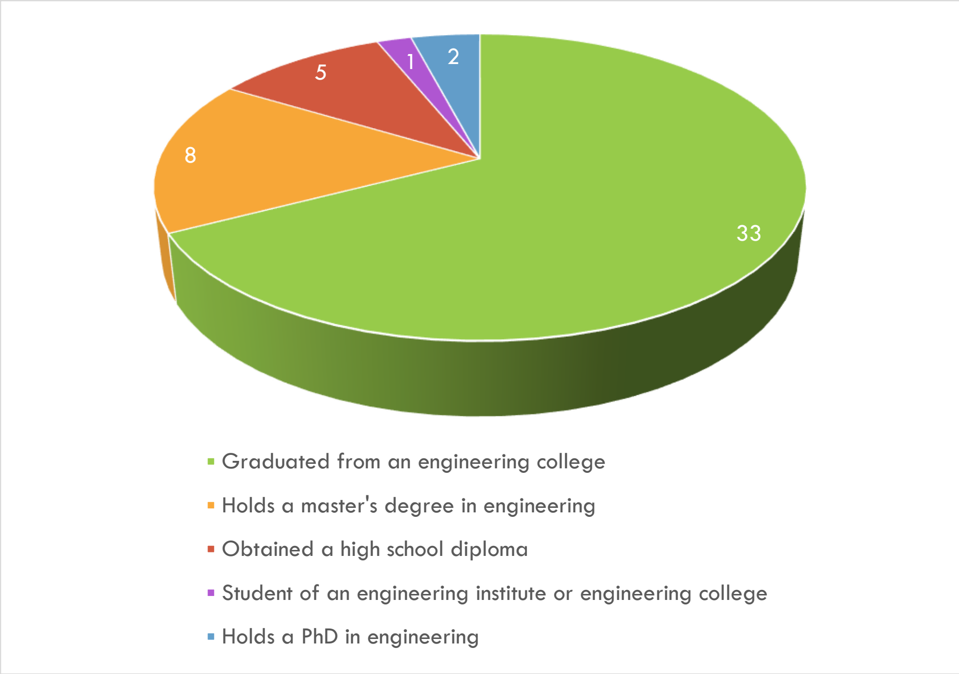

Figure 2 the research sample by level of education

Third - According to the field of expertise of the respondent:

Table 6 the research sample according to the field of expertise of the respondent

		Frequency	Percent
Valid	Site worker	1	2.0
	Contractor	2	4.1
	Civil Engineer	21	42.9
	Architect	9	18.4
	Electrical Engineer	2	4.1
	Mechanical Engineer	1	2.0
	Owner	6	12.2
	Others	7	14.3
	Total	49	100.0

From the previous table, we find that the largest percentage of the research sample, according to the specialization of experience of the respondent, was a civil engineering sample, which amounted to 42.9%, while the architectural engineering group came in second place, with a rate of 18.4%, and in the third place a group others with a rate of 14.3%, and in the fourth place a group Owner with a percentage of 12.2%, and in the fifth place a contracting and electrical engineering group equaled 4.1%, and finally a group of mechanical engineering and field workers with a percentage of 2%.

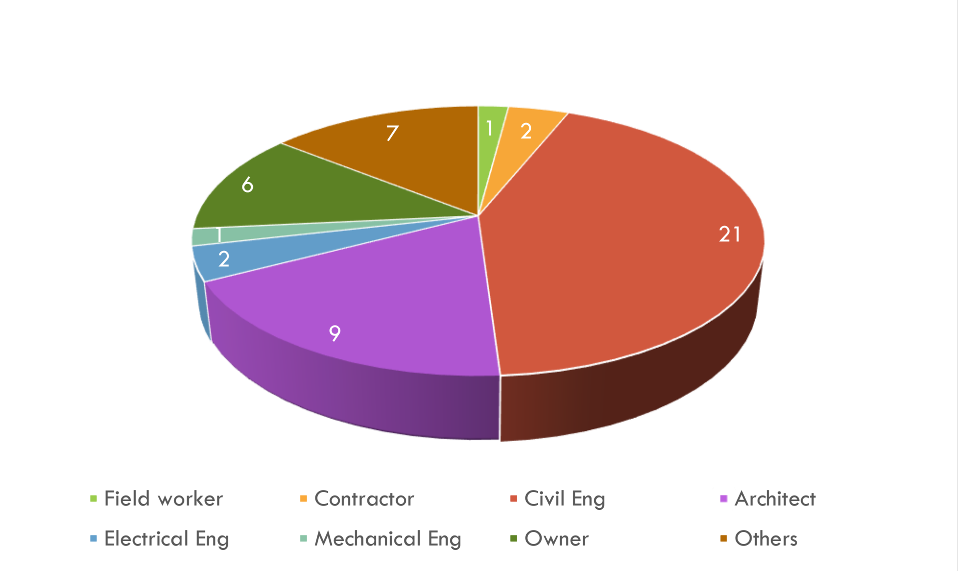

Figure 3 the research sample according to the field of expertise of the respondent

Fourth - According to the number of years of experience in the field of specialization:

Table 7 the research sample according to the number of years of experience in the field of specialization

		Frequency	Percent
Valid	From 0 to 2 years	9	18.4
	From 2 years to 5 years	11	22.4
	From 5 to 10 years	14	28.6
	From 10 to 20 years	10	20.4
	More than 20 years	5	10.2
	Total	49	100.0

From the previous table, we find that the largest percentage of the research sample according to the number of years of experience in the field of specialization was the experience group (from 5 to 10 years), which amounted to 28.6%, while the second place came from the group from 2 years to 5 years, with a rate of 22.4%, and in the third place A group from 10 to 20 years with a rate of 20.4%, and in fourth place, a group from 0 to 2 years with a rate of 18.4%, and in the fifth place came a group of more than 20 years with a percentage of 10.2%.

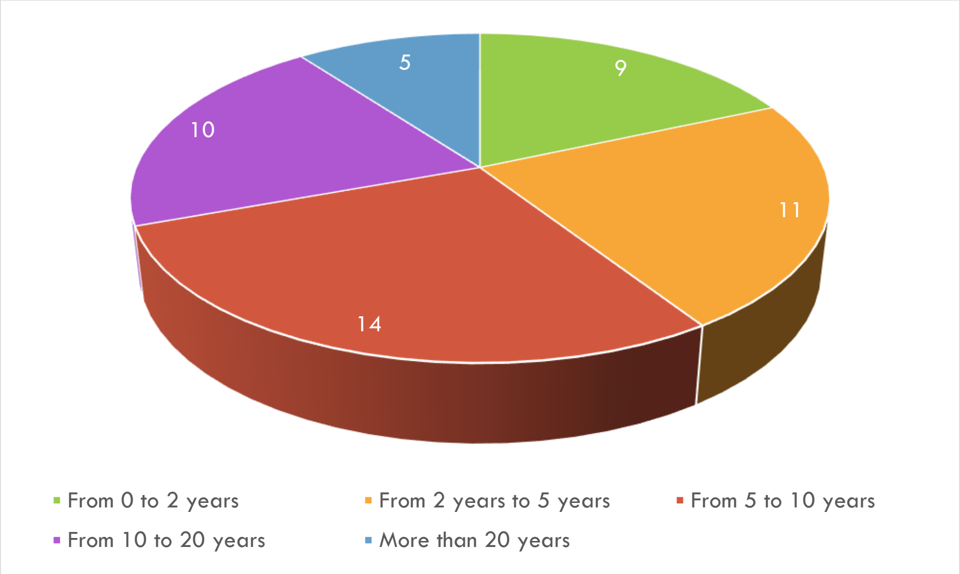

Figure 4 the research sample according to the number of years of experience in the field of specialization

Fifth - According to the sector of expertise:

Table 8 the research sample by sector of expertise

		Frequency	Percent
Valid	Public sector	11	22.4
	Private sector	26	53.1
	Public and private sectors	12	24.5
	Total	49	100.0

From the previous table, we find that the largest percentage of the research sample according to the sector of experience (multiple choice) was a private sector group, which amounted to 53.1%, while the public and private sector group came in second place, with a rate of 24.5%, and in the third place was a public sector group, with a rate of 22.4%.

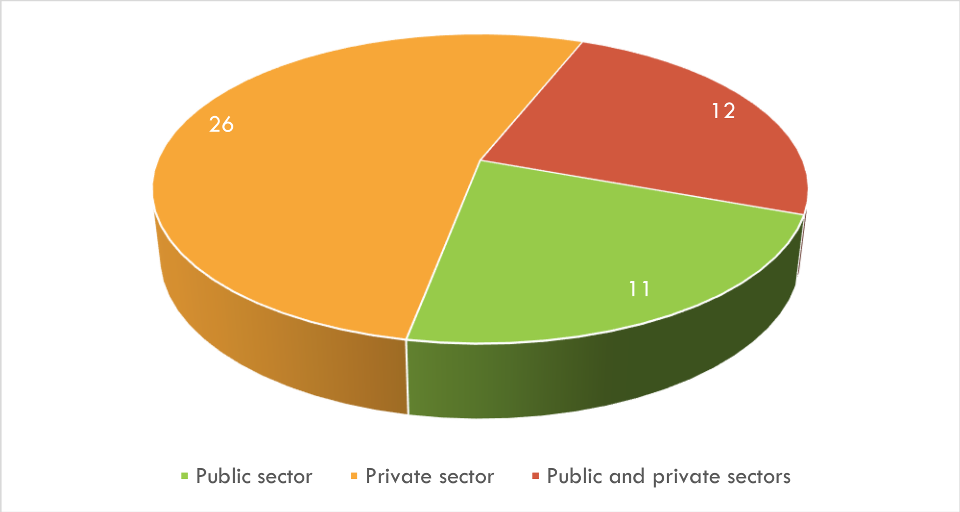

Figure 5 the research sample by sector of expertise

Sixth - according to the current position occupied by the respondent:

Table 9 the research sample according to the current position occupied by the respondent

		Frequency	Percent
Valid	Supervisor	8	16.3
	Site engineer	11	22.4
	Studies engineer	9	18.4
	Owner or Financier	7	14.3
	Site worker	1	2.0
	Private contractor	2	4.1
	Others	11	22.4
	Total	49	100.0

From the previous table, we find that the largest percentage of the research sample, according to position, was equal to two groups of Site engineer and others, which amounted to 22.4%, while the group of studies engineer came in second place, with a rate of 18.4%, and in the third place a group of supervisor with a rate of 16.3%, and in fourth place was the owner group Or financier by 14.3%, and in fifth place came the private contractor group with a percentage of 4.1%, and finally the site worker group with a percentage of 2%

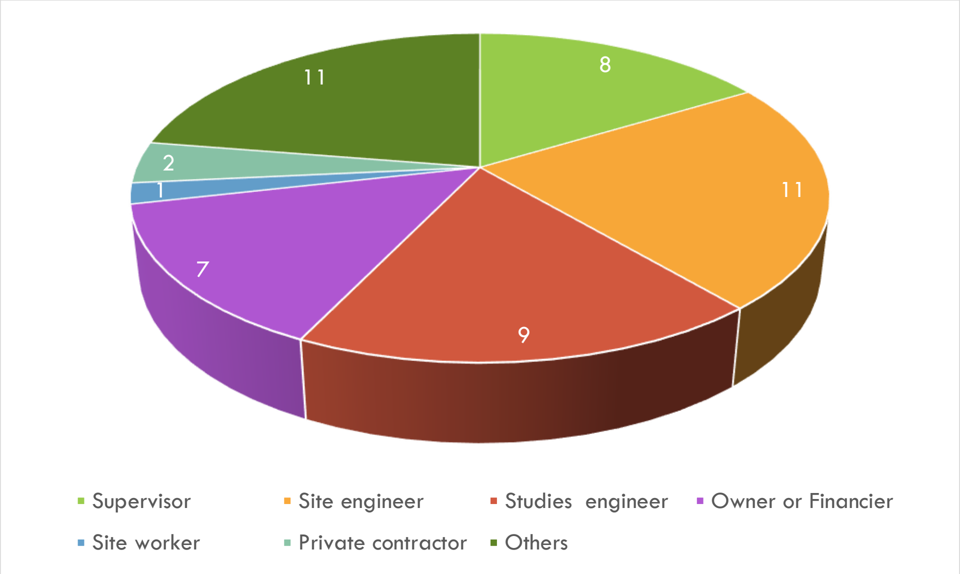

Figure 6 the research sample according to the current position occupied by the respondent

Company information the respondent currently works for

First - the number of employees in the construction department

Table 10 Characteristics of the establishment in which the respondent works according to the number of construction department employees

		Frequency	Percent
Valid	I don't have the information	7	14.3
	Small	14	28.6
	Medium	11	22.4
	Big	17	34.7
	Total	49	100.0

From the previous table, we find that the largest percentage is the type of establishments according to the number of employees of the construction department, large establishments came, which amounted to 34.7%, while the second rank came the group of small enterprises, with a rate of 28.6%, and in the third rank was a medium group with a rate of 22.4%, and finally a group that I do not have information with a percentage of 14.3%.

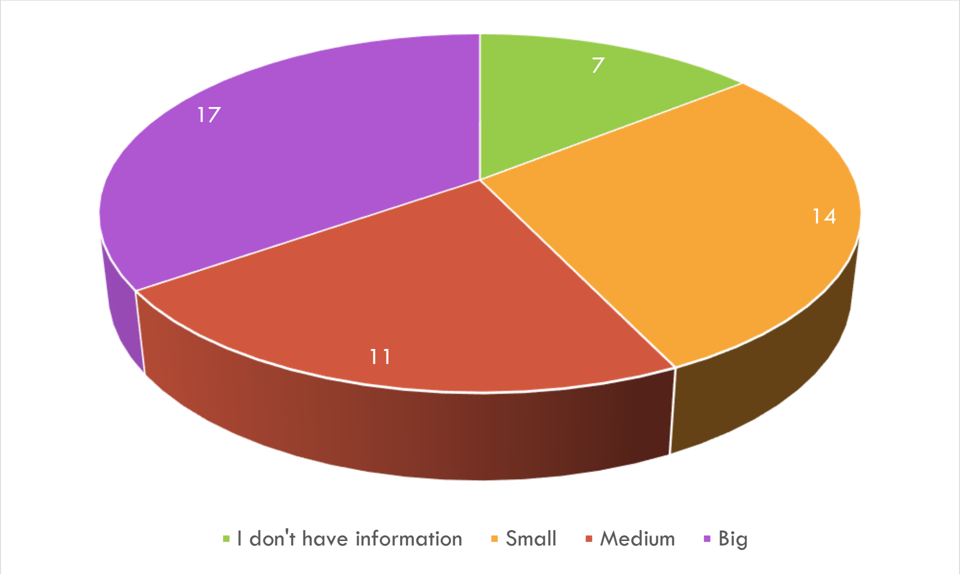

Figure 7 Respondents according to the number of construction department employees in the establishment

Second: Average total area of projects:

Table 11 Characteristics of the establishment in which the respondent works, according to the average total area of projects

		Frequency	Percent
Valid	I don't have the information	5	10.2
	Small	21	42.9
	Medium	10	20.4
	Big	13	26.5
	Total	49	100.0

From the previous table, we find that the largest percentage of the type of institutions, according to the average total area of projects, came small enterprises, which amounted to 42.9%, while the second came the group of large enterprises, with a rate of 26.5%, and in the third place a medium group with a rate of 20.4%, and finally a group that I have no information with a percentage of 10.2%.

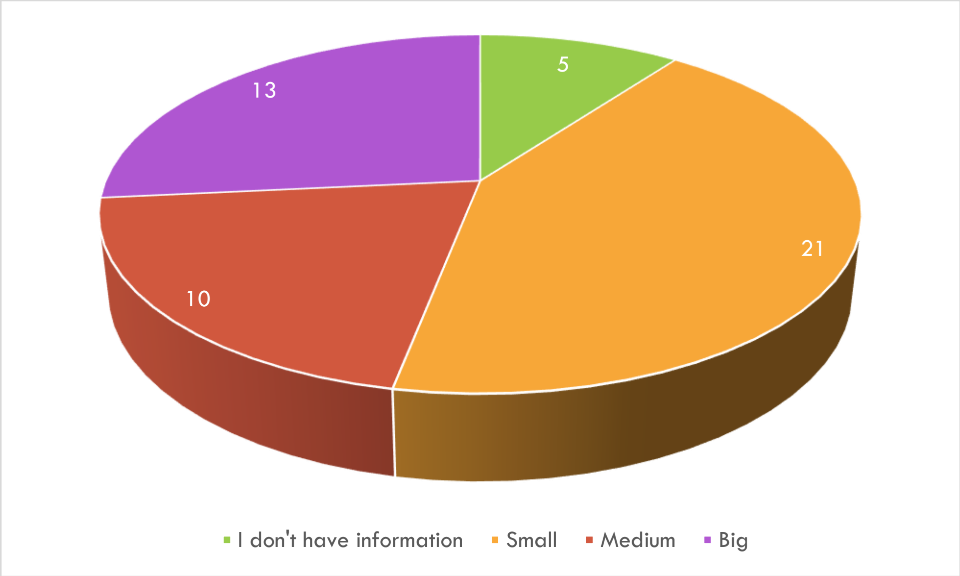

Figure 8 the average total area of projects in the organization

Third - The amount of funding allocated to projects:

Table 12 Characteristics of the institution in which the respondent works, according to the amount of funding allocated to projects

		Frequency	Percent
Valid	I don't have the information	8	16.3
	Small	16	32.7
	Medium	14	28.6
	Big	11	22.4
	Total	49	100.0

From the previous table, we find that the largest percentage of institutions, according to the volume of financing allocated to projects, came to small enterprises, which amounted to 32.7%, while the medium enterprises group came in second place, with a rate of 28.6%, and in the third place came the large group with a rate of 22.4%, and finally a group that I do not have information with a percentage of 16.3%.

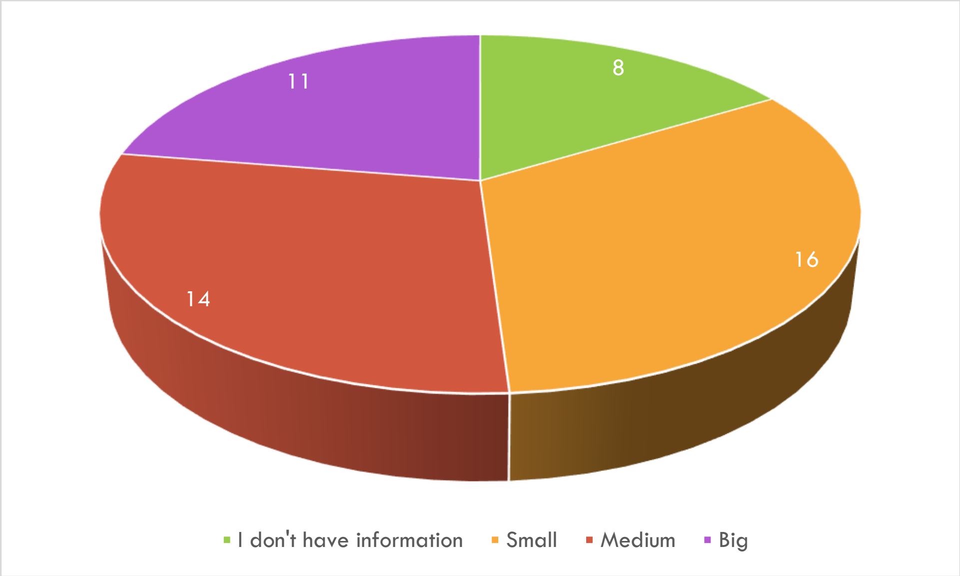

Figure 9 the size of funding allocated to projects in the institution

5.2. Factor analysis

What are the most important factors that lead to waste of all kinds in projects؟

To answer the question, the arithmetic mean and standard deviation were calculated for the scores of the research sample for each item, and the degree of importance was determined after assigning the arithmetic mean for the Likert scale answers as shown in Table 12.

Then the frequency of occurrence was calculated and given the right rank and percentage. That ranking method was used for each factors' category, except for the fourth group that once it affected the project, the level of recurrence can't be determined since it's complicated and might be fatal for the project.

Table 13 Estimating the degree of importance according to the arithmetic mean

Arithmetic mean	Estimate
1.8 – 1	Very weak
2.60 – 1.81	weak
3.40 – 2.61	Average
4.20 – 3.41	High
5 – 4.21	very high

First - Factors related to designers and the design phase of the project:

classification of factors related to designers and the design phase of the project according to their importance

Table 14 Rank of the factors related to the design phase of the project according to their importance

Rank	Items	Arithmetic mean	standard deviation	Estimate
1.	Poor coordination and communication between the design team	4.2653	0.81075	very high
2.	Poor quality practices	4.1224	1.01309	High
3.	Weak scientific and cultural background of the designers	4	0.95743	High
4.	Misunderstanding of customer/end-user requirements	3.9388	0.89926	High
5.	Not using the team's creative talents	3.898	0.98414	High
6.	Design change based on customer or end user request	3.898	1.02561	High
7.	Not using modern technology and software	3.898	0.91844	High
8.	Lack of clarity on the concept of waste and its size among the participating designers	3.8776	0.90445	High
9.	Errors and inconsistencies in the design files	3.8571	1.04083	High

10.	Non-compliance with specifications and standards	3.8163	0.97197	High
11.	Design change due to its inconsistency with facilities	3.7551	1.12788	High
12.	Errors in calculating quantities, increase or decrease	3.7143	1.04083	High
13.	Incomplete design at the time of bid	3.5918	1.11651	High
14.	Design change due to difficulty in implementation	3.4898	1.15691	High
15.	Not adopting modular design (repeated units)	3.0204	1.05059	Average
16.	Not designing based on the use of prefabricated elements	3	1.13652	Average

classification of factors related to designers and the design phase of the project according to their frequency of occurrence

The sum of the scores obtained for each item was calculated and then the percentage was calculated

Table 15 Total scores and percentages of the factors related to the designers and the design stage of the project, according to their frequency of occurrence

Rank	Items	Total scores	Percentage
1.	Poor quality practices	183	%73.2
2.	Lack of clarity of the concept of waste and its size among the participating designers	176	%70.4

3.	Poor coordination and communication between the design team	175	%70
4.	Not using the team's creative talents	173	%69.2
5.	Not using modern technology and software	172	%68.8
6.	Design change based on customer or end user request	169	%67.6
7.	Weak scientific and cultural background of the designers	164	%65.6
8.	Errors and inconsistencies in the design files	163	%65.2
9.	Non-compliance with specifications and standards	163	%65.2
10.	Misunderstanding of customer/end user requirements	161	%64.4
11.	Errors in calculating quantities, increase or decrease	156	%62.4
12.	Not adopting modular design (repeated units)	152	%60.8
13.	Not designing based on the use of prefabricated elements	151	%60.4
14.	Incomplete design at the time of bid	151	%60.4
15.	Design change due to its inconsistency with facilities	150	%60
16.	Design change due to difficulty in implementation	142	%56.8

Second - Organizational and administrative factors in the organization:

Classification of organizational and administrative factors in the organization according to their importance

Table 16 Rank of the factors related to the organizational and administrative factors according to their importance

Rank	Items	Arithmetic mean	standard deviation	Estimate
1.	Lack of a waste management and control plan	3.8367	0.9863	High
2.	Not investing in reducing waste	3.7755	1.06586	High
3.	Problems in project scheduling that lead to waiting times or ineffective time constraints in completing design, implementation and other works	3.6735	0.98716	High
4.	The lack of clarity of the concept of waste and its size in the organization	3.6327	1.13089	High
5.	Inadequate qualifications of employees and the position they occupy	3.6122	0.90867	High
6.	Not allocating enough time to study and plan the project	3.6122	0.93131	High
7.	Not clearly defining the responsibilities of the project parties	3.5714	1.20761	High
8.	The long approval process	3.551	1.1004	High

9.	Lack of training for engineering teams, failure to enable new skills, and failure to optimally utilize the current skills of the team	3.5306	1.08209	High
10.	The lack of a communication plan between the project parties	3.4898	1.13876	High
11.	The scope of the project is not clearly defined	3.4898	1.06306	High
12.	Inappropriate definition of authority or responsibility as well as overlapping supervision	3.449	1.00127	High

Classification of organizational and administrative factors in the organization according to their recurrence:

Table 17 Total scores and percentages of the factors related to the organizational and administrative factors in the organization, according to their recurrence

Rank	Items	Total scores	Percentage
1.	Lack of training for engineering teams, failure to enable new skills, and failure to optimally utilize the current skills of the team	188	75.2
2.	The lack of a communication plan between the project parties	185	74
3.	Inadequate qualifications of employees and the position they occupy	180	72%

4.	Not allocating enough time to study and plan the project	178	71.2
5.	The lack of clarity of the concept of waste and its size in the organization	177	70.8
6.	Problems in project scheduling that lead to waiting times or ineffective time constraints in completing design, implementation and other works	177	70.8
7.	Inappropriate definition of authority or responsibility as well as overlapping supervision	175	70
8.	The scope of the project is not clearly defined	174	69.6
9.	Lack of a waste management and control plan	173	69.2
10.	The approval process is long	171	68.4
11.	Not investing in reducing waste	171	68.4
12.	Not clearly defining the responsibilities of the project parties	169	67.6

Third - factors imposed by the reality of work in the implementation phase

Classification of factors imposed by the reality of work in the implementation phase according to their importance:

Table 18 The arithmetic mean and standard deviation of the factors imposed from the implementation phase, according to their importance

Rank	Items	Arithmetic mean	standard deviation	Estimate
1.	Changes during the implementation phase	4.1429	0.91287	High
2.	Implementation commenced despite incomplete project documents	4.0204	0.87773	High
3.	Unskilled workers and poor labor productivity	4	0.97895	High
4.	Rework and corrective action	4	0.76376	High
5.	Materials damaged/deteriorated during construction time	3.9796	0.96803	High
6.	Using unsuitable tools to perform the work during implementation, leads to losses in the material used as a result of spilling or runny	3.9796	0.90115	High
7.	Lack of experience of consultants in design, supervision, and quality control	3.898	1.06546	High
8.	Conflicts and poor communication and coordination between the contractor and other parties	3.8571	0.8165	High
9.	Quality problems	3.8367	0.6876	High
10.	Unavailability of the required materials and replacing them with close alternatives	3.7755	0.9413	High

11.	Loss or theft of materials and equipment from the construction site	3.7347	0.9304	High
12.	Equipment malfunction	3.6122	0.88545	High
13.	Material waste either due to poor design or poor implementation	3.5714	0.88976	High

Classification of factors imposed from the reality of work in the implementation phase according to their frequency:

Table 19 Total scores and percentages of factors imposed from the implementation phase, according to their frequency

Rank	Items	Total scores	Percentage
1.	Quality problems	183	73.20%
2.	Changes during the implementation phase	177	70.80%
3.	Conflicts and poor communication and coordination between the contractor and other parties	171	68.40%
4.	Unavailability of the required materials and replacing them with close alternatives	171	68.40%
5.	Unskilled workers and poor labor productivity	171	68.40%
6.	Using unsuitable tools to perform the work during implementation, which leads to losses in the material used as a result of spilling or runny	167	66.80%

7.	Implementation commenced despite incomplete project documents	167	%/66.8
8.	Rework and corrective action	164	65.60%
9.	Lack of experience of consultants in design, supervision and quality control	163	65.20%
10.	Material waste either due to poor design or poor implementation	162	64.80%
11.	Materials damaged/deteriorated during construction time	161	64.40%
12.	Equipment malfunction	160	64%
13.	Loss or theft of materials and equipment from the construction site	152	60.80%

Fourth - External factors (legislative - economic - social):

Classification of external factors (legislative - economic - social) according to their importance:

Table 20 The arithmetic mean and standard deviation of the external factors (legislative - economic - social) according to their importance

Rank	Items	Arithmetic mean	standard deviation	Estimate
1.	The economic situation of the country (currency exchange, inflation)	4.2857	.93541	very high
2.	The impact of social and cultural factors on the awareness of	3.8571	.84163	High

	aspects of waste and its importance			
3.	Lack of laws to eliminate waste	3.8163	.78192	High
4.	The periods required for approvals and contracts lead to a waste of time, reduce the economic return of the project, and increase the prices of materials	3.8163	1.01393	High

Going back to the first question

What are the most important studied items affecting waste according to their importance? From all four groups.

Table 21 Arrangement of the studied factors affecting waste from the four groups, according to their importance

Rank	Items	Arithmetic mean	standard deviation	Estimate
1.	The economic situation of the country (currency exchange, inflation)	4.2857	.93541	very high
2.	Poor coordination and communication between the design team	4.2653	0.81075	very high
3.	Changes during the implementation phase	4.1429	0.91287	High
4.	Poor quality practices	4.1224	1.01309	High

5.	Implementation commenced despite incomplete project documents	4.0204	0.87773	High

The full list of 45 factors is available in Appendix 2.

What are the most important studied items affecting wastage according to its frequency? From all three groups.

Table 22 Arrangement of the studied items affecting waste from the three groups, according to their frequency

Rank	Items	Total scores	Percentage
1.	Lack of training for engineering teams, failure to enable new skills, and failure to optimally utilize the current skills of the team	188	%75.2
2.	The lack of a communication plan between the project parties	185	%74
3.	Quality problems	183	%73.2
4.	Poor quality practices	183	%73.2
5.	Inadequate qualifications of employees and the position they occupy	180	72%

The full list of 41 factors is available in Appendix 3.

What is the order of importance of the four factors' group studied affecting waste?

Table 23 Ranking the importance of the four factors' group studied affecting waste

Rank	Items	Arithmetic mean	standard deviation	Estimate
1.	External factors (legislative - economic - social)	3.9439	.70943	High
2.	Organizational and administrative factors in the organization	3.9337	.58457	High
3.	Factors imposed from the reality of work in the implementation phase	3.8776	.60872	High
4.	Factors related to designers and the design phase of a project	3.7589	.60192	High

What is the order of recurrence of the three factors' group studied affecting waste?

Table 24 Ranking the recurrence of the three factors' group studied affecting waste

Rank	Items	Total scores	Percentage
1.	Organizational and administrative factors in the organization	176.5	70.6
2.	Factors imposed from the reality of work in the implementation phase	166.85	66.738
3.	Factors related to designers and the design phase of a project	162.56	65.025

5.3. Testing of the hypothesis

- **The first hypothesis:**

There is a statistically significant difference in responses to the most important factors affecting wastage according to experience

Table 25 T-test for the significance of differences according to experience

Factors' group	hypothesis	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Factors related to designers and the design phase of the project	Less than 10 years	34	3.7335	.56874	-.442-	47	.660
	more than 10 years	15	3.8167	.68891			
Organizational and administrative factors in the organization	Less than 10 years	34	3.9706	.57145	.662	47	.511
	more than 10 years	15	3.8500	.62536			
Factors imposed from the reality of work in the implementation phase	Less than 10 years	34	3.8733	.62086	-.073-	47	.942
	more than 10 years	15	3.8872	.60140			
External factors (legislative - economic - social)	Less than 10 years	34	4.0441	.66135	1.509	47	.138
	more than 10 years	15	3.7167	.78414			

From the table (24), using the T-test to study the variance according to experience, we find that all factors had a level of statistical significance greater than the default significance level of 0.05, and thus this confirms that there is no variance according to experience.

Result: There is no statistically significant difference in responses to the factors affecting wastage according to experience.

- **The second hypothesis:**

There is a statistically significant variation in responses to the most important factors affecting waste, according to the type of sector.

Table 26 Anova test for the significance of differences by sector type

		Sum of Squares	df	Mean Square	F	Sig.
Factors related to designers and the design phase of the project	Between Groups	1.030	2	.515	1.448	.246
	Within Groups	16.361	46	.356		
	Total	17.391	48			
Organizational and administrative factors in the organization	Between Groups	.948	2	.474	1.410	.254
	Within Groups	15.455	46	.336		
	Total	16.402	48			
Factors imposed from the reality of work in the implementation phase	Between Groups	.206	2	.103	.270	.765
	Within Groups	17.580	46	.382		
	Total	17.786	48			
External factors (legislative - economic - social)	Between Groups	.670	2	.335	.656	.524
	Within Groups	23.488	46	.511		
	Total	24.158	48			

From the table (25), and using the Anova test to study the variance according to the type of sector, we find that all factors had a level of statistical significance greater than the default level of significance of

0.05, and thus this confirms that there is no variation according to the type of sector.

- **The third hypothesis:**

There is a statistically significant difference in responses to the frequency of factors affecting wasting according to experience.

Table 27 T-test for the significance of differences according to experience

		N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Factors related to designers and the design phase of the project	Less than 10 years	34	3.2757	.72056	-.631-	47	.531
	more than 10 years	15	3.4125	.64771			
Organizational and administrative factors in the organization	Less than 10 years	34	3.6127	.83482	.138	47	.891
	more than 10 years	15	3.5778	.76666			
Factors imposed from the reality of work in the implementation phase	Less than 10 years	34	3.4525	.74285	.701	47	.487
	more than 10 years	15	3.2974	.63822			

From the table (26), using the T-test to study the variance according to experience, we find that all factors had a level of statistical significance greater than the default significance level of 0.05, and thus this confirms that there is no variance according to experience.

Result: There is no statistically significant difference in responses to the frequency of factors affecting wasting according to experience.

- **The fourth hypothesis:**

There is a statistically significant difference in the responses to the frequency of factors affecting waste according to the type of sector

Table 28 Anova test for the significance of differences by sector type

		Sum of Squares	df	Mean Square	F	Sig.
Factors related to designers and the design phase of the project	Between Groups	1.855	2	.927	1.998	.147
	Within Groups	21.347	46	.464		
	Total	23.202	48			
Organizational and administrative factors in the organization	Between Groups	4.454	2	2.227	3.824	.029
	Within Groups	26.786	46	.582		
	Total	31.240	48			
Factors imposed from the reality of work in the implementation phase	Between Groups	3.510	2	1.755	3.909	.027
	Within Groups	20.653	46	.449		
	Total	24.163	48			

From the table (27), and using the Anova test to study the variance according to the type of sector, we find the following:

As for the factors related to designers and the design stage of the project, the level of statistical significance was greater than the default level of significance of 0.05, and thus this confirms that there is no variation according to the type of sector in this factor.

As for the factors (organizational and administrative factors in the organization and the factors imposed by the implementation phase), the level of statistical significance was smaller than the default significance level of 0.05, and thus this confirms the existence of variation according to the type of sector in these two factors.

To find out the differences between the groups, we use the Scheffe test:

Table 29 Scheffe test for the significance of differences by sector type

Dependent Variable	(I) Sector	(J) Sector	Mean Difference (I-J)	Sig.
Organizational and administrative factors in the organization	Public	Private	-.50058-	.201
		Public and private	**-.87879-***	**.030**
	Private	Public	.50058	.201
		Public and private	-.37821-	.373
	Public and private	Public	.87879*	.030
		Private	.37821	.373
Factors imposed from the reality of work in the implementation phase	Public	Private	-.48575-	.143
		Public and private	**-.77273-***	**.029**
	Private	Public	.48575	.143
		Public and private	-.28698-	.477
	Public and private	Public	.77273*	.029
		Private	.28698	.477

We find from Table (28) that there is a difference between the public sector group and the public and private sector group.

- Result (1): There is no statistically significant difference in the responses to the repetition of the factors related to the designers and the design stage of the project affecting waste according to the type of sector.

- Result (2): There is a statistically significant difference in the responses to the frequency of the organizational and administrative factors in the organization and the factors imposed by the reality of work in the implementation phase affecting waste according to the type of sector between the public sector group and the public and private sector group.

6. Discussion

6.1. Highest ranked factors

In the following, we will discuss each group of factors independently, and we will start with the **design-related factors'** group, which contains 16 factors. We will discuss the first five factors with the highest evaluation in terms of importance and frequency, which are:

(1) Poor coordination and communication between the design team: (ranked 1st in importance, and 3rd in recurrence). Teams working in the construction industry globally and locally in particular suffer from the problem of controlling and improving communication methods and avoiding misunderstandings. Coordination of communication within the design team is considered one of the most important factors that raise the work to a high level because of its importance being in the early stages of the project, in which it is important to pay attention to all details by everyone involved in the design process. The absence of this coordination causes confusion at the beginning of the project and leads to a lot of wasted effort and time. Also, the absence of a clear communication plan and the lack of leading software that helps in linking the different designs carried out by several people at the same time. Information exchange (IE)

needs to be planned from the beginning of the project, agreed upon between different parties, tested, and verified. (Mashali & El tantawi, 2022). In addition to weakness in the management and leadership of the design team and the lack of confirmation of the project's goals and determinants are among the most important factors that cause poor coordination and conflicts within the design team for any project.

(2) Poor quality practices: (ranked 2nd in importance, and 1st in recurrence). In the design stage, the necessary quality standards are often overlooked, especially in the stage of finalizing designs and contracting; moreover, after the initial designs and the first drafts of the building are accepted, pressure is placed on the design team to finish all detailed plans in a short time, which is often insufficient, due to lack of awareness of the importance of the consistency of these plans and their completion with the highest quality possible. Also, quality problems at this stage are often hidden and not apparent, thus, controlling and monitoring them requires time and effort that most companies are not willing to spend. As a result, these problems often appear during the procurements or implementation phases, which doubles their impact on time, effort, materials, and cost. Although its effect can often be remedied, treatment at its point of origin is the best preventive measure for proper engineering practice.

(3) The weakness of the scientific and cultural background of the designers: (ranked 3rd in importance, and 7th in recurrence). It is a fact that a person can't take into account something unknown to them, so raising awareness about the issue of waste, its size, and the need to address it before its impact grows is one of the most important ways to cultivate responsibility within the design team- especially to those freshly graduated- to be at a high level of

performance and not fall into repeated mistakes. On the other hand, such an aspect is not covered during the educational stage, even if it was mentioned, it would be in theory.

There should be more time allocated by Syrian educational institutes to upgrade engineers' qualifications with the latest technologies, however, institutes themselves are taking long time in implementing the digital transformation, which is due to the lack of engineering and technological knowledge and experience, which also affects Syrian AEC as most engineers are not used to modern technologies and new methodologies in construction (Salami & Alothman, 2022). The leader of the design team or the leader of any organization must point out the importance of waste in all its forms and take preventive measures that would protect the organization from falling into waste and help individuals to do their work properly.

(4) Misunderstanding of customer/end-user requirements: (ranked 4th in importance, and 10th in recurrence). It is one of the most critical problems facing engineering projects as it may lead to a complete re-work. Its causes are varied, and it is mostly due to the lack of clear communication between the client and the design team, in addition, to not asking all the questions related to the main subject of the required project resulting from the lack of experience in the person in charge; furthermore, the lack of correct and clear documentation of the client's requirements certainly leads to confusion.

(5) Not using the team's creative talents: (ranked 5th in importance, and 4th in recurrence). One of the most important reasons for the lack of creativity in the design team is work pressure and lack of time, which leave no room to encourage creative thinking in the team to reach innovative solutions, resulting in automatic tendencies towards familiar traditional solutions that were applied before so the

team automatically repeat traditional processes and provide the same solutions that were applied before as there is no time to experiment. Thus, it becomes acceptable to repeat the previous work that had the same mistakes, another reason is the ignorance of the team leader about the capabilities of his team members, and the lack of a positive environment that encourages creativity and putting forward new ideas.

(6) Lack of clarity of the concept of waste and its importance among the participating designers: (ranked 8th in importance, and 2nd in recurrence). This factor has a great impact, as most of the time the participation of the design team ends with the beginning of implementation or even contracting. There is no feedback available on the impact of the study they carried out during the implementation. In most cases, the project ends without the team knowing whether the design caused a problem, waste, or loss of time, effort, or materials.

(7) Not using modern technology and software: (ranked 7th in importance, and 5th in recurrence). It is not possible to ignore the great impact provided by modern technology in facilitating the operations of the construction industry in terms of the consistency of the files, their conformity with reality, the accuracy of the details, in addition to the ease of clarifying ideas to the unspecialized clients, as the difficulty of imagining among clients who are not engineers or site workers or even between engineers, contributes to the exacerbation of this problem. Thus, we find the engineering team making great efforts in an attempt to reflect images close to reality according to the proposed plans, which in many cases does not contribute much to closing this gap, and often the customer returns after a few days with some requested modifications if not request a complete re-work, sometimes the implemented works differ from

what was described in the drawings due to different vision between the design engineer; the implementation engineer, the supervision engineer and the worker himself.

For the second group, **organizational and administrative factors**, the 5 top-ranked factors from both importance and recurrence analysis, out of 12 factors, are:

(1) Lack of a waste management and control plan. (Ranked 1st in importance, and 9th in recurrence). It is necessary to have a plan to manage and control waste in the organization, including all instructions and procedures for controlling waste, and explaining the principles of lean management adopted and future steps to develop them. The plan is the reference for all working engineers, old and new. The absence of the plan does not mean the absence of waste control procedures in the organization, but it shows the organization's lack of interest in the issue of lean construction and lean waste management.

(2) Not investing in reducing waste. (Ranked 2nd in importance, and 11th in recurrence). The organization can invest in reducing waste, increase its environmental participation, reduce its carbon footprint, and join the local and global movements concerned with this matter, which raises its status and classification locally and globally. The organization can also encourage and consolidate the concept of controlling waste internally through incentives or other methods of motivating workers, as this reflects the strong organizational culture that the organization is working to consolidate.

(3) Problems in project scheduling that lead to waiting times or ineffective time constraints in completing design, implementation, and other works. (Ranked 3rd in importance, and 6th in recurrence). Project scheduling problems are among the most difficult types to control, because they involve many, varied variables with wide-

ranging impacts. Therefore, this task must be given great attention, and the organization must use the lessons learned from its years of work, in addition to market analyzes, to control it and avoid unplanned events that may lead to a lot of waste of time, effort, money, and sometimes materials. Delaying an activity due to a problem with supplies, for example, may damage the results of the previous activity, and thus waste of all kinds.

(4) The lack of clarity of the concept of waste and its size in the organization. (Ranked 4th in importance, and 5th in recurrence). In the previous paragraph, we discussed the impact of the design team's lack of knowledge of the importance of waste and its size in projects, in the same way, the matter applies to the organization. Therefore, care must be taken to continue research and work to improve operations in the construction industry, including modern local and international trends in addition to training workshops and modern technology.

(5) Inadequate qualifications of employees and the position they occupy. (Ranked 5th in importance, and 3rd in recurrence). this issue must be addressed wherever it occurs because of the high effect it has on the performance of any team, and the negative effect on the organizational culture, thus, limiting the creativity and development of the team.

(6) Lack of training for engineering teams, failure to enable new skills, and failure to optimally utilize the current skills of the team. (Ranked 9th in importance and 1st in recurrence). training is very essential to the success of any procedure or plan, thus, if there wasn't proper training for the team, it wouldn't matter what the organization's other factors status.

(7) The lack of a communication plan between the project parties. (Ranked 10th in importance, and 2nd in recurrence). Syrian AEC

suffers from different communication inefficiencies. we discussed the importance of communication among the design team. In fact, communication is very important wherever it presents.

(8) Not allocating enough time to study and plan the project. (Ranked 6th in importance, and 4th in recurrence). As presented before, suffering from time pressure would cause very bad results, on the other hand, time should be controlled so it's not wasted as well on ineffective actions. close attention should be paid to time allocation so it balances between the two points.

As for the third group, **Factors related to the implementation phase**, it had 13 factors, and the 5 top-ranked factors from both importance and recurrence analysis were:

(1) Changes during the implementation phase. (Ranked 1st in importance, and 2nd in recurrence). There is no doubt about the extremely high risk of this factor, it is considered the worst nightmare of any project, at the same time, almost no project goes without suffering from it, so, very close attention should be paid to avoid changes at any phase, especially, at the implementation phase.

(2) Implementation commenced despite incomplete project documents. (Ranked 2nd in importance, and 7th in recurrence). This factor may be one of the most dangerous incorrect practices in the progress of projects. The problems that may result from such a dangerous practice are not considered and their effects cannot be expected. Therefore, it must be avoided by all means. And in the event that it is necessary, the level of management must be raised and the work monitored vigorously.

(3) Unskilled workers and poor labor productivity. (Ranked 3rd in importance, and 5th in recurrence). The absence of skilled labor causes many quality problems and thus waste in many areas. Such a

problem can be avoided by contracting with skilled, experienced workshops that undergo continuous training.

(4) Rework and corrective work. (Ranked 4^{th} in importance, and 8^{th} in recurrence). They are the result of errors in implementation or deviations from the plan, and they are considered a waste of time, effort, materials, and money, but they are necessary to achieve the desired benefit from the work and return to the progress of the basic plan. Therefore, to avoid errors and deviations, errors and deviations must be avoided in the first place, because once they occur, they cannot be left without correction.

(5) Materials damaged/deteriorated during construction time. (Ranked 5^{th} in importance, and 11^{th} in recurrence). One of the most important factors affecting the damage of materials at the construction site are the factors of storage, transportation and movement of workshops within the work fronts at the site. These points must be taken into account, especially for high-priced and fragile materials.

(6) Quality problems. (Ranked 9^{th} in importance, and 1^{st} in recurrence). Quality problems are all the problems facing the construction site. The objective of developing this factor is to measure the frequency of problems that are attributed to the absence of a quality management plan during the implementation phase, and this effect is evident in the rank obtained by the factor as the most frequent at this stage.

(7) Conflicts and poor communication and coordination between the contractor and other parties. (Ranked 8^{th} in importance, and 3^{rd} in recurrence). We note the emergence of communication problems for the third time within the first five ranks of the factors that cause waste in engineering projects, and they are no less important according to the parties involved in them, as they are of great

importance wherever they occur, and this confirms the need to control and clarify them.

(8) Unavailability of the required materials and replacing them with close alternatives. (Ranked 10^{th} in importance, and 4^{th} in recurrence). In fact, the reader can imagine that this factor belongs to the group of external factors, but the author preferred to include it in this list because although the availability of materials in the markets is a factor outside the boundaries of the project, the decision to replace the materials with other similar materials is often made by the implementing team and with the approval of the supervising team, without making an extensive determination of the impact resulting from this replacement and without reviewing the decision with the designing team, so there would be other purposes than the job to use one material over another, so the work would be a waste.

Finally, the fourth group, **External Factors**, had 4 factors, all considered important, and they are:

(1) Country's economic situation (currency exchange, inflation): (Ranked 1st in importance). One of the most important factors affecting all sectors in any country, and the construction sector is no exception to the rule. This factor is complex and carries many details. It is an economic factor, not an engineering one.

(2) The impact of social and cultural factors on the awareness of aspects of waste and its importance (Ranked 2nd in importance). Once again, the author emphasizes the importance of awareness of the problem of waste. Without social awareness of the existence of a problem, we cannot see steps to solve it. That is why we must always work to raise awareness of this issue on a societal level, not just engineering so that avoiding it becomes a general concept.

(3) lack of Construction waste regulation (Ranked 3^{rd} in importance). The existence of laws that punish unjustified waste and provide

economic advantages and opportunities will encourage companies to invest in reducing waste. Thus, reducing waste becomes one of the competitive advantages that companies compete to prove.

(4) The periods required for approvals and contracts lead to a waste of time, reduce the economic return of the project, and increase the prices of materials. (Ranked 4th in importance).

6.2. Approach to solutions

So, what are the possible solutions to overcome these factors?

Lean Construction which refers to maximizing productivity and minimizing waste generation in construction projects has taken the concern of many researchers, engineering organizations, and companies in the field of construction management. There are multiple ways to address this issue. Perhaps one of the clearest solutions that must be promoted to address a large part of the waste issue is the introduction of **modern techniques** and technology in the construction process from its inception to its end. Moreover, adopting the **Building Information Modeling (BIM)** approach, in addition to its software and the recommendations for its application, has the greatest impact in mitigating the impact of the previous factors with the least effort, if not completely removing them. There are many global examples and experiences of the success of this method, and it cannot be ignored. BIM extends to many topics. Its application improves agreements and stakeholders' behavior, it also facilitates their relationships eliminating conflict and dispute. It lay out the basis of fluent flow of information allowing healthy interactions between project stakeholders in ways that improves problem-solving methods (Evans, et al., 2020).

The current trend is also concerned with **merging building information modeling and artificial intelligence** to automate its operations, which transfers many engineers from their current positions, in following up plans and trying to adjust and fix them, to a position of thinking about improvement, development, and true contributing to the construction industry. It’s very important to discover all potentials of merging technological applications so we can reach novel knowledge obtained from previous projects. That knowledge should be documented in a shareable, reusable, modular, and extensible way. The use of shared information through the BIM environment and its application alongside AI applications, would positively influence decision-making, therefore, advance the performance of other project’s operations (Petrova, 2019).

Prefabrication is another vital and important concept of controlling errors in construction, especially in qualitative projects, therefore, reducing waste. It also provides a great saving in time and material. However, from previously demonstrated factor ranking, it was clear that there isn’t much awareness of the importance of prefabricated elements in controlling the waste, since it was one of the lowest rated factors alongside design using modular units in the design-related factors group. Nonetheless, it would help greatly with the rapid reconstruction that is necessary for the upcoming phase in Syria (Ahmed.S, 2016).

All of that should be done in the light of the organization's **Strategic management** which is the ongoing planning, monitoring, analysis, and assessment of all necessities an organization needs to meet its goals and objectives. As changes in business environments will require organizations to constantly assess their strategies for success.

6.3. Point of view

The application of **virtual reality (VR)** in construction, practically, from an engineering point of view in Syria. An interview was conducted to learn about the actual experience of applying VR in construction projects in Syria, where it was explained how it did indeed help with keeping the owner and the design on the same path and avoiding confusion. "We searched for a tool that helps the engineer to overcome the obstacle of delivering his vision to the customer, and this tool was the virtual reality glasses" (S. Kiorkji, personal communication, Jan. 1, 2022). In addition, using VR with site workers helped in clarifying many aspects of the design and reducing misunderstandings and mistakes. Not to mention the competitive advantage it provided.

To sum it up, the following table shows suggested practices to approach solutions for the most important factors discussed before.

Table 30 practices to approach solutions for the most important factors

#	factor	solution	method
Design phase factors			
1	Poor coordination and communication between the design team	BIM	Proper project management Communication plan
2	Poor quality practices	BIM	Quality control plan Better engineering practice
3	Weak scientific and cultural background of the designers	LEAN + SM	Raising awareness to the principles of LEAN
4	Misunderstanding of customer/end-user requirements	BIM + VR	Documenting and validating customer requirement Realistic representation of the design.
5	Not using the team's creative talents	SM	Team leading and development
6	Lack of clarity of the concept of waste and its size among the participating designers	LEAN + SM	Raising awareness to the principles of LEAN
7	Not using modern technology and software	BIM+AI	Provides the use of modern software and technologies.
Organizational and administrative factors			
1	Lack of a waste management and control plan	BIM	Proper project planning
2	Not investing in reducing waste	SM	Measure waste effect on the organization and act accordingly

3	Problems in project scheduling that lead to waiting times or ineffective time constraints in completing design, implementation and other works	BIM	Accurate scheduling for all project activities
4	The lack of clarity of the concept of waste and its size in the organization	SM	Measure waste effect on the organization and act accordingly
5	Inadequate qualifications of employees and the position they occupy	SM	Team leading and development
6	Lack of training for engineering teams, failure to enable new skills, and failure to optimally utilize the current skills of the team	SM	Team leading and development
7	The lack of a communication plan between the project parties	BIM	Proper project management Communication plan
8	Not allocating enough time to study and plan the project	BIM	Proper project management
Implementation factors			
1	Changes during the implementation phase	BIM + VR	Documenting and validating customer requirements Realistic representation of the design Managing change orders
2	Implementation commenced despite incomplete project documents	BIM	Proper project management and planning
3	Unskilled workers and poor labor productivity	BIM	Discovering weaknesses in the work and developing its methods through modern technology
4	Rework and corrective action	BIM	Proper project management and planning
5	Materials damaged/deteriorated during construction time	BIM	LEAN princibles: Better inventory management
6	Quality problems	BIM	Quality control plan Better engineering practice

7	Conflicts and poor communication and coordination between the contractor and other parties	BIM	Proper project management Communication plan
8	Unavailability of the required materials and replacing them with close alternatives	BIM	Better procurement management
External factors			
1	The economic situation of the country (currency exchange, inflation)	Governmental	Governmental plan
2	The impact of social and cultural factors on the awareness of aspects of waste and its importance	Governmental SM	Governmental plan Raising awareness about LEAN
3	Lack of laws to eliminate waste	Governmental SM	Governmental plan
4	The periods required for approvals and contracts lead to a waste of time, reduce the economic return of the project, and increase the prices of materials	Governmental SM	Governmental plan

6.4. Consistency with other local studies

- This study agrees with the study carried out by D. Jrad in 2016 on waste factors regarding the effect of material storage, material movement, most of the design phase factors, and most of the implementation phase factors.

  However, it differs in terms of factors count and ranking because of 2 reasons: 1- the two studies were carried out in different years which means different circumstances in the construction industry - 2- in this study the author cared for more than just material waste, thus there were more factors to consider.
- It also agrees with the study carried out by Omran Jamal, Ali Jrad F, and Alhassan Bassel (2019) on the positive application of modern

technological solutions and the integration of building information modeling with virtual reality applications in reducing waste in projects. As it helps reduce costs, risk, and detect errors, in addition to more effective communication between the various parties to the project. It also creates an exciting environment for the user, which makes it ideal to carry out maintenance work (Jamal et al. 2019). The current study suggests that the application of these techniques and methods from the beginning of the project has the greatest impact on reducing waste and limiting its causes.

7. Conclusion

In this research, a number of factors causing waste in the Syrian construction industry (45 factors) were identified through a literature review and semi-structured interviews, and they were classified into four main groups for ease of handling and review, which are design factors (16 factors), implementation factors (13 factors), Internal factors in the organization (12 factors) and external factors (4 factors), then the 45 factors were ranked according to importance and frequency via the questionnaire, where there were 49 valid responses, which were analyzed by calculating the arithmetic mean and deviation of the importance ratings, and calculating the frequencies and their percentage for the recurrence rating, then presented the results are in the form of tables for each group separately, the full factors' ranking in the appendix (45 importance factors and 41 recurrence factors). The result of the classification of the top 5 waste-causing factors according to importance was: the economic situation in Syria, poor coordination and communication between the design team, changes during the implementation phase, poor quality practices, and the start of implementation despite the incompleteness of project documents. Regarding the classification of redundant factors, external factors were excluded as their impact was considered to extend throughout the project period and the estimated redundancy cannot be calculated, so the top 5 factors in terms of redundancy are lack of training for engineering teams, failure to enable new skills, and failure to optimize the existing skills of the team, lack of a communication plan between the project parties, quality problems, poor quality practices, inadequate personnel qualifications and the position they occupy.

The negative impact of the previous factors can be reduced or even avoided by adopting the Building Information Modeling methodology, and the results of its application are enhanced by its attachment to modern technological applications, especially artificial intelligence. Adopting these methodologies in the early stages of the project exacerbates its positive results and helps reach the highest building standards. Its inclusion in the educational curricula of all engineering specializations has the same positive impact and helps in preparing qualified and pioneering classes for engineers.

8. Recommendations

- It is recommended to pay special attention to the results of this study by stakeholders in the construction industry no matter what position they hold
- concentrate efforts on reducing the negative effects of these factors and raising the quality of the projects.

8.1. suggested future research:

- More research should be done to measure in a quantitative way the effect of the most important factors causing waste in construction projects in Syria.
- More research is necessary to describe the best suitable solution for each high-ranked factor qualitatively.

- The factor lists and ranking should be updated regularly to contribute to the right advancement of the construction industry.

9. Research limitation

- This study was affected by the lack of previous studies on the topic locally, in addition to the difficulty in obtaining them, especially those presented from academic sources.
- There was limited access to data regarding questionnaire respondents, most of the participants faced difficulties dealing with the electronic questionnaire due to not being able to reach it by the corresponding link, and some of them had to answer it using their smartphones. furthermore, some couldn't open the questionnaire at all.
- The study might be limited in terms of solution explanation due to time constraints.

10. Acknowledgments

The author gratefully acknowledges Dr. Abdussalam Shibani, Coventry University, United Kingdom, and Dr. Sonia Ahmed, SVU, Syria, for their great efforts and time given to the benefit of this research.

The author also gratefully acknowledges the surveyed participants and the interviewees for their generous contributions and collaborations to this study.

11. References

Ahmed, S. (2016). MODELING SYSTEM FOR THE RAPID CONSTRUCTION IN SYRIA. *Business & IT*, *VI*(1), 7–13. https://doi.org/10.14311/bit.2016.01.02

Ahmed, S., Hossain, M. M., & Haq, I. (2021). Implementation of lean construction in the construction industry in Bangladesh: awareness, benefits and challenges. *International Journal of Building Pathology and Adaptation*, *39*(2), 368–406. https://doi.org/10.1108/IJBPA-04-2019-0037

Akhmetzhanova, B., Nadeem, A., Hossain, A., & Kim, J. R. (2022). *Clash Detection Using Building Information Modeling (BIM) Technology in the Republic of Kazakhstan*. https://doi.org/10.3390/buildings

Al Hammoud, E., 2021. Comparing BIM Adoption Around The World, Syria's Current Status and Furture. *International Journal of BIM and Engineering Science, 4(2), pp. 64-78.*

Al Hammoud, E. & Ahmed, S., 2022. Submitting BIM to the Educational Plan for the Faculty of Architecture According to NARS and ARS Standards. *International Journal of BIM and Engineering Science, 5(1), pp. 20-40.*

Al-Janabi, A. M., Abdel-Monem, M. S., & El-Dash, K. M. (2020). Factors causing rework and their impact on projects' performance in Egypt. *Journal of Civil Engineering and Management*, *26*(7), 666–689. https://doi.org/10.3846/jcem.2020.12916

Arunagiri, P., & Gnanavelbabu, A. (2014). Identification of major lean production waste in automobile industries using weighted average method. *Procedia Engineering*, *97*, 2167–2175. https://doi.org/10.1016/j.proeng.2014.12.460

Babalola, O., Ibem, E. O., Ezema, I. C., & Olanipekun, A. O. (2019). Assessment of the role of Lean Construction Practices in Environmental Sustainability. *Journal of Physics: Conference Series*, *1299*(1). https://doi.org/10.1088/1742-6596/1299/1/012002

Bajjou, M. S., & Chafi, A. (2020). Identifying and Managing Critical Waste Factors for Lean Construction Projects. *EMJ - Engineering Management Journal*, *32*(1), 2–13. https://doi.org/10.1080/10429247.2019.1656479

Bajjou, M. S., Chafi, A., & En-Nadi, A. (2017). A comparative study between lean construction and the traditional production system. *International Journal of Engineering Research in Africa*, *29*, 118–132. https://doi.org/10.4028/www.scientific.net/JERA.29.118

Banihashemi, S., Ding, G. K. C., & Wang, J. J. (2015a). *DEVELOPING A FRAMEWORK OF ARTIFICIAL INTELLIGENCE APPLICATION FOR DELIVERING ENERGY EFFICIENT BUILDINGS THROUGH ACTIVE BIM BIM Implementation in Iran: A Five-year Plan to Mandate BIM in Iranian Construction and Infrastructure Projects View project Sustainable Development of the Construction Engineering and Project Management View project*. www.rics.org/cobra

Banihashemi, S., Ding, G. K. C., & Wang, J. J. (2015b). *DEVELOPING A FRAMEWORK OF ARTIFICIAL INTELLIGENCE APPLICATION FOR DELIVERING ENERGY EFFICIENT BUILDINGS THROUGH ACTIVE BIM BIM Implementation in Iran: A Five-year Plan to Mandate BIM in Iranian Construction and Infrastructure Projects View project Sustainable Development of the Construction Engineering and Project Management View project*. www.rics.org/cobra

Bekr, G. A. (2014). Study of the Causes and Magnitude of Wastage of Materials on Construction Sites in Jordan. *Journal of Construction Engineering*, *2014*, 1–6. https://doi.org/10.1155/2014/283298

Belvedere, V., Cuttaia, F., Rossi, M., & Stringhetti, L. (2019). Mapping wastes in complex projects for Lean Product Development. *International Journal of Project Management*, *37*(3), 410–424. https://doi.org/10.1016/j.ijproman.2019.01.008

Bilal, M., Oyedele, L. O., Qadir, J., Munir, K., Akinade, O. O., Ajayi, S. O., Alaka, H. A., & Owolabi, H. A. (2015). Analysis of critical features and evaluation of BIM software: towards a plug-in for construction waste minimization using big data. *International Journal of Sustainable Building Technology and Urban Development*, *6*(4), 211–228. https://doi.org/10.1080/2093761X.2015.1116415

Chahrour, R., Hafeez, M. A., Ahmad, A. M., Sulieman, H. I., Dawood, H., Rodriguez-Trejo, S., Kassem, M., Naji, K. K., & Dawood, N. (2021). Cost-benefit analysis of BIM-enabled design clash detection and resolution.

Construction Management and Economics, *39*(1), 55–72. https://doi.org/10.1080/01446193.2020.1802768

Durdyev, S., & Ismail, S. (2019). Offsite Manufacturing in the Construction Industry for Productivity Improvement. *EMJ - Engineering Management Journal*, *31*(1), 35–46. https://doi.org/10.1080/10429247.2018.1522566

Elhendawi, A., 2018. Methodology for BIM Implementation in KSA in AEC Industry. *Master of Science MSc in Construction Project Management ed. Edinburgh, UK: Edinburgh Napier University, UK.*

Evans, M., Farrell, P., Elbeltagi, E., Mashali, A. and Elhendawi, A., 2020. Influence of partnering agreements associated with BIM adoption on stakeholder's behavior in construction mega-projects. *International Journal of BIM and Engineering Science, 3(1), pp.1-20.*

Gao, S., & Low, S. P. (2014). The Toyota Way model: An alternative framework for lean construction. *Total Quality Management and Business Excellence*, *25*(5–6), 664–682. https://doi.org/10.1080/14783363.2013.820022

Herrera, R. F., Mourgues, C., Alarcón, L. F., & Pellicer, E. (2020). An assessment of lean design management practices in construction projects. *Sustainability (Switzerland)*, *12*(1). https://doi.org/10.3390/su12010019

Hosseini, S. A. A., Nikakhtar, A., Wong, K. Y., & Zavichi, A. (2012). Implementing lean construction theory into construction processes' waste management. *ICSDC 2011: Integrating Sustainability Practices in the Construction Industry - Proceedings of the International Conference on Sustainable Design and Construction 2011*, 414–420. https://doi.org/10.1061/41204(426)52

Issa, U. H., & Alqurashi, M. (2020). A model for evaluating causes of wastes and lean implementation in construction projects. *Journal of Civil Engineering and Management*, *26*(4), 331–342. https://doi.org/10.3846/jcem.2020.12323

Joshi, A., Kale, S., Chandel, S., & Pal, D. (2015). Likert Scale: Explored and Explained. *British Journal of Applied Science & Technology*, *7*(4), 396–403. https://doi.org/10.9734/bjast/2015/14975

Jrad, F. (2016). تحليل هوالك التشييد السورية وصياغة نموذج لتقليل هوالك حديد التسليح / [Analysis Waste in Syrian construction and Developing Model to Reduce Waste of

Reinforced steel Bars.] *Tishreen University Journal for Research and Scientific Studies-Engineering Sciences Series*, *38*(3), 153–174.

Khanh, H. D., & Kim, S. Y. (2015). Development of waste occurrence level indicator in Vietnam construction industry. *Engineering, Construction and Architectural Management*, *22*(6), 715–731. https://doi.org/10.1108/ECAM-01-2014-0005

Liu, J., Liu, P., Feng, L., Wu, W., Li, D., & Chen, F. (2020). Towards automated clash resolution of reinforcing steel design in reinforced concrete frames via Q-learning and building information modeling. *Automation in Construction*, *112*. https://doi.org/10.1016/j.autcon.2019.103062

Luangcharoenrat, C., Intrachooto, S., Peansupap, V., & Sutthinarakorn, W. (2019). Factors influencing construction waste generation in building construction: Thailand's perspective. *Sustainability (Switzerland)*, *11*(13). https://doi.org/10.3390/su11133638

Mashali, A. & El tantawi, A., 2022. BIM-based stakeholder information exchange (IE) during the planning phase in smart construction megaprojects (SCMPs). *International Journal of BIM and Engineering Science, 5(1), pp. 08-19.*

Mandujano, M. G., Alarcón, L. F., Kunz, J., & Mourgues, C. (2015). Vicuña Mackenna 4880. In *Casilla* (Vol. 360, Issue 2).

Manzoor, B., Othman, I., & Pomares, J. C. (2021). Digital technologies in the architecture, engineering and construction (Aec) industry—a bibliometric—qualitative literature review of research activities. *International Journal of Environmental Research and Public Health*, *18*(11). https://doi.org/10.3390/ijerph18116135

Mirarchi, C., Lucky, M. N., Ciuffreda, S., Signorini, M., Lupica Spagnolo, S., Bolognesi, C., Daniotti, B., & Pavan, A. (2020). An approach for standardization of semantic models for building renovation processes. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives*, *43*(B4), 69–76. https://doi.org/10.5194/isprs-archives-XLIII-B4-2020-69-2020

Muthumanickam, N. K., Duarte, J. P., Nazarian, S., Memari, A., & Bilén, S. G. (2021). Combining AI and BIM in the design and construction of a Mars habitat.

In *The Routledge Companion to Artificial Intelligence in Architecture* (pp. 251–279). Routledge. https://doi.org/10.4324/9780367824259-17

Peansupap, V., & Ly, R. (2015). Evaluating the Impact Level of Design Errors in Structural and Other Building Components in Building Construction Projects in Cambodia. *Procedia Engineering*, *123*, 370–378. https://doi.org/10.1016/j.proeng.2015.10.049

Porwal, A., Parsamehr, M., Szostopal, D., Ruparathna, R., & Hewage, K. (2020). The integration of building information modeling (BIM) and system dynamic modeling to minimize construction waste generation from change orders. *International Journal of Construction Management*. https://doi.org/10.1080/15623599.2020.1854930

Omran Jamal, Ali Jrad F, Alhassan Bassel (2019) دعم القرار في مجال الصيانة بمنهجية متكاملة بين إدارة المعرفة والواقع الافتراضي في بيئة نمذجة معلومات البناء / [Support Decision-Making in Maintenance Work Using an Integrated Methodology Between Knowledge Management and Virtual Reality in BIM Environment.] Tishreen University Journal for Research and Scientific Studies-Engineering Sciences Series, 41(2), 351–367.

Ramani, P. V., & KSD, L. K. L. (2021). Application of lean in construction using value stream mapping. *Engineering, Construction and Architectural Management*, *28*(1), 216–228. https://doi.org/10.1108/ECAM-12-2018-0572

Sacks, R., Girolami, M., & Brilakis, I. (2020). Building Information Modelling, Artificial Intelligence and Construction Tech. *Developments in the Built Environment*, *4*. https://doi.org/10.1016/j.dibe.2020.100011

Safour, R., Ahmed, S. & Zaarour, B., 2021. BIM Adoption around the World. *International Journal of BIM and Engineering Science, 4(2), pp. 49-63.*

Salami, H. & Alothman, K., 2022. Engineering Training and its Importance for Building Information Modelling. *International Journal of BIM and Engineering Science, 5(1), pp. 41-60.*

Salman, K., & Abdulghafour, A. (2021). Stakeholders' Insight on the Delay of Constructions Projects in the Makkah Region- KSA. *The Open Construction & Building Technology Journal*, *15*(1), 164–175. https://doi.org/10.2174/1874836802115010164

Shamreeva, A., & Doroschkin, A. (2021). Analysis of the influencing factors for the practical application of BIM in combination with AI in Germany. In *ECPPM 2021 – eWork and eBusiness in Architecture, Engineering and Construction* (pp. 536–543). CRC Press. https://doi.org/10.1201/9781003191476-72

Shibani, A., Ghostin, M., Hassan, D., Saïdani, M., Ghostin, M., Saidani, M., & Agha, A. (2021). *Exploring the Impact of Implementing Building Information Modelling to Support Sustainable Development in the Lebanese Construction Industry: A Qualitative Approach Stability of Structures View project Novel cementitious material View project Exploring the Impact of Implementing Building Information Modelling to Support Sustainable Development in the Lebanese Construction Industry: A Qualitative Approach*. https://www.researchgate.net/publication/349057972

Sun, H., & Kim, I. (2022a). APPLYING AI TECHNOLOGY TO RECOGNIZE BIM OBJECTS AND VISIBLE PROPERTIES FOR ACHIEVING AUTOMATED CODE COMPLIANCE CHECKING. *Journal of Civil Engineering and Management*, *28*(6), 497–508. https://doi.org/10.3846/jcem.2022.16994

Sun, H., & Kim, I. (2022b). AUTOMATED CHECKING SYSTEM FOR MODULAR BIM OBJECTS. *Journal of Civil Engineering and Management*, *28*(7), 554–563. https://doi.org/10.3846/jcem.2022.17230

Wang, J., Li, Z., & Tam, V. W. Y. (2014). Critical factors in effective construction waste minimization at the design stage: A Shenzhen case study, China. *Resources, Conservation and Recycling*, *82*, 1–7. https://doi.org/10.1016/j.resconrec.2013.11.003

Yücenur, G. N., & Şenol, K. (2021). Sequential SWARA and fuzzy VIKOR methods in elimination of waste and creation of lean construction processes. *Journal of Building Engineering*, 44. https://doi.org/10.1016/j.jobe.2021.103196

Yusof, N., Ishak, S. & Doheim, R., 2018. An Exploratory Study of Building Information Modelling Maturity in the Construction Industry. *International Journal of BIM and Engineering Science, 1(1), pp. 6-19.*

عوامل الهدر في المشاريع الإنشائية في سوريا

يهدف الاستبيان لجمع المعلومات الخاصة بالعوامل التي تؤدي إلى كافة أنواع الهدر في مشاريع التشييد في سوريا (مواد - مال - وقت - جهد وغيرها) وذلك من وجهة نظر جميع المعنيين بصناعة البناء من دارسين ومقاولين ومالكين وعمال وغيرهم من المهتمين

سيتم تحليل البيانات الواردة من هذا الاستبيان ضمن بحث معد لنيل درجة الماجستير في نمذجة وإدارة معلومات البناء في الجامعة الافتراضية السورية

القسم الأول: معلومات المستجيب

ساعدنا للتعرف إليك

1- الاسم الثلاثي للمستجيب (اختياري)

____

2-الجنس ● ذكر ●أنثى

3-التعليم الحاصل عليه

- غير حاصل على الشهادة الثانوية العامة
- حاصل على الشهادة الثانوية العامة
- طالب معهد هندسي أو كلية هندسية
- متخرج من معهد هندسي
- متخرج من كلية هندسية
- حاصل على الماجستير باختصاص هندسي

- حاصل على الدكتوراه باختصاص هندسي

4- اختصاص الخبرة لدى المستجيب

- أعمال ورش
- أعمال مقاولة
- هندسة مدنية
- هندسة معمارية
- هندسة كهربائية
- هندسة ميكانيكية
- هندسة زراعية
- مالك
- ممول
- غير ذلك

5- عدد سنوات الخبرة بمجال الاختصاص

- من 0 إلى 2 سنة
- من 2 سنة إلى 5 سنوات
- من خمس سنوات إلى 10 سنوات
- من 10 سنوات إلى 20 سنة
- أكثر من 20 سنة

6-قطاع الخبرة (متعدد الخيارات)

- قطاع عام
- قطاع خاص

7- المنصب الحالي الذي يشغله المستجيب

- عامل ورشة
- مقاول خاص
- مقاول شركة
- مسؤول دراسات (إن كان مهندس أو طالب أو خبير يعمل في القسم المسؤول عن الدراسات)

- مسؤول تنفيذ (إن كان مهندس أو طالب أو خبير يعمل في القسم المسؤول عن التنفيذ)
- مسؤول إشراف (إن كان مهندس أو طالب أو خبير يعمل في القسم المسؤول عن الإشراف)
- مالك أو ممول
- غير ذلك

8- معلومات المؤسسة العامل بها حالياً

	صغيرة	متوسطة	كبيرة	لا يتوفر معلومات
حجم المؤسسة (عدد موظفين قسم التشييد): أقل من عشرة موظفين (صغيرة) بين 10 إلى 35 (متوسطة) أكثر من 35 (كبيرة)				
حجم المشاريع/ متوسط مساحة اجمالية للمشاريع: أقل من 10,000 م2 (صغيرة) بين 10,000 و25,000 م2 (متوسطة) أكبر من 25,000 م2 (كبيرة)				
حجم الاعتماد الخاص بمشاريع التشييد/حجم التمويل المخصص للمشاريع: أقل من 500 مليون ل.س(صغيرة) بين 500 مليون و5 مليار ل.س (متوسطة) أكثر من 5 مليار ل.س (كبيرة)				

القسم الثاني: أهم العوامل التي تؤدي للهدر بأنواعه في المشاريع

الهدر بكل أنواعه أي يمكن أن يكون بالمال أو المواد او الجهود أو الوقت أو ضياع الفرص.. إلخ

العوامل المتعلقة بالمصممين ومرحلة التصميم في المشروع (من حيث الأهمية والتكرار)

9- يرجى تصنيف العوامل التالية وفق أهميتها برأيك (حيث 1 غير مهم - 5 مهم جدا) وذلك بما يخص العوامل المتعلقة بالمصممين ومرحلة التصميم في المشروع

	غير مهم 1	قليل الأهمية 2	متوسط الأهمية 3	مهم 4	مهم جداً 5
عدم التصميم على أساس استخدام العناصر مسبقة الصنع					
عدم اعتماد التصميم الموديولي (وحدات متكررة)					
عدم استخدام مواهب الفريق الإبداعية					
ضعف الخلفية العلمية والثقافية للمصممين					
ضعف التنسيق والتواصل بين فريق التصميم					
ممارسات الجودة الرديئة					
سوء فهم متطلبات العميل / المستخدم النهائي					
تغيير التصميم بناءً على طلب العميل أو المستخدم النهائي					
تغيير التصميم بسبب تناقضه مع المرافق					
تغيير التصميم بسبب صعوبة التنفيذ					
تصميم غير مكتمل في وقت العطاء					
أخطاء وعدم اتساق في الملفات التصميمية					
أخطاء بحساب الكميات زيادة او نقصان					
عدم الالتزام بالمواصفات والمعايير					
عدم استخدام التكنولوجيا الحديثة والبرمجيات					
عدم وضوح مفهوم الهدر وحجمه لدى المصممين المشاركين					

10- يرجى تصنيف نفس العوامل السابقة وفق تكرار حدوثها برأيك (حيث 1 غير مرجح التكرار - 5 كثير التكرار) وذلك بما يخص العوامل المتعلقة بالمصممين ومرحلة التصميم في المشروع

	غير مرجح التكرار 1	قليل التكرار 2	متوسط التكرار 3	متكرر 4	كثير التكرار5
عدم التصميم على أساس استخدام العناصر مسبقة الصنع					
عدم اعتماد التصميم الموديولي (وحدات متكررة)					
عدم استخدام مواهب الفريق الإبداعية					
ضعف الخلفية العلمية والثقافية للمصممين					
ضعف التنسيق والتواصل بين فريق التصميم					
ممارسات الجودة الرديئة					
سوء فهم متطلبات العميل / المستخدم النهائي					
تغيير التصميم بناءً على طلب العميل أو المستخدم النهائي					
تغيير التصميم بسبب تناقضه مع المرافق					
تغيير التصميم بسبب صعوبة التنفيذ					
تصميم غير مكتمل في وقت العطاء					
أخطاء وعدم اتساق في الملفات التصميمية					
أخطاء بحساب الكميات زيادة او نقصان					
عدم الالتزام بالمواصفات والمعايير					
عدم استخدام التكنولوجيا الحديثة والبرمجيات					
عدم وضوح مفهوم الهدر وحجمه لدى المصممين المشاركين					

العوامل التنظيمية والداخلية في المؤسسة (من حيث الأهمية والتكرار)

11- يرجى تصنيف العوامل التالية وفق أهميتها برأيك (حيث 1 غير مهم - 5 مهم جدا) وذلك بما يخص العوامل التنظيمية والداخلية في المؤسسة

	غير مهم 1	قليل الأهمية 2	متوسط الأهمية 3	مهم 4	مهم جداً 5
عدم كفاية مؤهلات الموظفين والوظيفة التي يشغلونها					
عدم تخصيص الوقت الكافي للدراسة والتخطيط للمشروع.					
قلة التدريب للفرق الهندسية وعدم تمكين مهارات جديدة وعدم استغلال المهارات الحالية للفريق بالشكل الأمثل					
عدم وجود خطة تواصل بين أطراف المشروع					
عدم تحديد مسؤوليات أطراف المشروع بشكل واضح					
عدم تحديد نطاق المشروع بشكل واضح					
عملية الموافقة طويلة					
تعريف غير ملائم للسلطة أو المسؤولية وكذلك تداخل الإشراف					
عدم الاستثمار في تقليل الهدر					
عدم وجود خطة لإدارة الهدر والسيطرة عليه					
عدم وضوح مفهوم الهدر وحجمه لدى المؤسسة					
مشكلات في جدولة المشروع التي تؤدي لأوقات انتظار أو ضيق وقت غير فعالة في إنجاز الأعمال التصميمية والتنفيذية وغيرها					

12- يرجى تصنيف نفس العوامل السابقة وفق تكرار حدوثها برأيك (حيث 1 غير مرجح التكرار - 5 كثير التكرار) وذلك بما يخص العوامل التنظيمية والداخلية في المؤسسة

	غير مرجح التكرار 1	قليل التكرار 2	متوسط التكرار 3	متكرر 4	كثير التكرار5
عدم كفاية مؤهلات الموظفين والوظيفة التي يشغلونها					
عدم تخصيص الوقت الكافي للدراسة والتخطيط للمشروع.					
قلة التدريب للفرق الهندسية وعدم تمكين مهارات جديدة وعدم استغلال المهارات الحالية للفريق بالشكل الأمثل					
عدم وجود خطة تواصل بين أطراف المشروع					
عدم تحديد مسؤوليات أطراف المشروع بشكل واضح					
عدم تحديد نطاق المشروع بشكل واضح					
عملية الموافقة طويلة					
تعريف غير ملائم للسلطة أو المسؤولية وكذلك تداخل الإشراف					
عدم الاستثمار في تقليل الهدر					
عدم وجود خطة لإدارة الهدر والسيطرة عليه					
عدم وضوح مفهوم الهدر وحجمه لدى المؤسسة					
مشكلات في جدولة المشروع التي تؤدي لأوقات انتظار أو ضيق وقت غير فعالة في إنجاز الأعمال التصميمية والتنفيذية وغيرها					

العوامل المفروضة من واقع العمل في مرحلة التنفيذ (من حيث الأهمية والتكرار)

13- يرجى تصنيف العوامل التالية وفق أهميتها برأيك (حيث 1 غير مهم - 5 مهم جداً) وذلك بما يخص العوامل المفروضة من واقع العمل في مرحلة التنفيذ

	غير مهم 1	قليل الأهمية 2	متوسط الأهمية 3	مهم 4	مهم جداً 5
قلة خبرة الاستشاريين في التصميم والإشراف ومراقبة الجودة					
النزاعات وضعف الاتصال والتنسيق بين المتعاقد والأطراف الأخرى					
مشكلات في الجودة					
تلف وتضرر المواد أثناء تنفيذ المشروع					
استخدام ادوات غير مناسبة لأداء العمل اثناء التنفيذ مما يؤدي لضياعات في المادة المستخدمة نتيجة السكب او السيلان					
عدم توفر المواد المطلوبة والاستعاضة عنها ببدائل قريبة					
عطل في المعدات					
ضياع او سرقة المواد والمعدات من موقع البناء					
النفايات المادية إما بسبب سوء التصميم أو سوء التنفيذ					
العمال غير المهرة وضعف إنتاجية العمالة					
إعادة العمل والأعمال التصحيحية					
التغييرات اثناء مرحلة التنفيذ					
بدء التنفيذ بالرغم من عدم اكتمال مستندات المشروع					

14- يرجى تصنيف نفس العوامل السابقة وفق تكرار حدوثها برأيك (حيث 1 غير مرجح التكرار - 5 كثير التكرار) وذلك بما يخص العوامل المفروضة من واقع العمل في مرحلة التنفيذ

	غير مرجح التكرار 1	قليل التكرار 2	متوسط التكرار 3	متكرر 4	كثير التكرار5
قلة خبرة الاستشاريين في التصميم والإشراف ومراقبة الجودة					

النزاعات وضعف الاتصال والتنسيق بين المتعاقد والأطراف الأخرى					
مشكلات في الجودة					
تلف وتضرر المواد أثناء تنفيذ المشروع					
استخدام ادوات غير مناسبة لأداء العمل اثناء التنفيذ مما يؤدي لضياعات في المادة المستخدمة نتيجة السكب او السيلان					
عدم توفر المواد المطلوبة والاستعاضة عنها ببدائل قريبة					
عطل في المعدات					
ضياع او سرقة المواد والمعدات من موقع البناء					
النفايات المادية إما بسبب سوء التصميم أو سوء التنفيذ					
العمال غير المهرة وضعف إنتاجية العمالة					
إعادة العمل والأعمال التصحيحية					
التغييرات اثناء مرحلة التنفيذ					
بدء التنفيذ بالرغم من عدم اكتمال مستندات المشروع					

العوامل الخارجية (التشريعية - الاقتصادية – الاجتماعية) (من حيث الأهمية فقط)

15- يرجى تصنيف العوامل التالية وفق أهميتها برأيك (حيث 1 غير مهم - 5 مهم جدا) وذلك بما يخص العوامل الخارجية (التشريعية – الاقتصادية – الاجتماعية)

	غير مهم 1	قليل الأهمية 2	متوسط الأهمية 3	مهم 4	مهم جداً 5
عدم وجود قوانين تخص الهدر					
الفترات اللازمة للموافقات والتعاقدات تؤدي لهدر في الوقت وتقليل العائد الاقتصادي للمشروع وزيادة في أسعار المواد					
الوضع الاقتصادي للبلد (صرف العملات، التضخم)					
تأثير العوامل الاجتماعية والثقافية من وعي لنواحي الهدر وأهميتها					

16- أضف أي عوامل مهمة برأيك لم يتم ذكرها سابقاً بالإضافة للمجموعة التي تظن أنها تنتمي إليها

Appendix 2: Rank of waste-causing factors according to importance

Table 31 Arrangement of the studied items affecting waste, according to their importance

Rank	Items	Arithmetic mean	standard deviation	Evaluation
1	The economic situation of the country (currency exchange, inflation)	4.2857	0.93541	very high
2	Poor coordination and communication between the design team	4.2653	0.81075	very high
3	Changes during the implementation phase	4.1429	0.91287	High
4	Poor quality practices	4.1224	1.01309	High
5	Implementation commenced despite incomplete project documents	4.0204	0.87773	High
6	Weak scientific and cultural background of the designers	4	0.95743	High
7	Unskilled workers and poor labor productivity	4	0.97895	High
8	Rework and corrective action	4	0.76376	High
9	Damage and damage to materials during the implementation of the project	3.9796	0.96803	High
10	Using unsuitable tools to perform the work during implementation, which leads to losses in the material used as a result of spilling or runny	3.9796	0.90115	High
11	Misunderstanding of customer/end user requirements	3.9388	0.89926	High
12	Not using the team's creative talents	3.898	0.98414	High
13	Design change based on customer or end user request	3.898	1.02561	High
14	Not using modern technology and software	3.898	0.91844	High
15	Lack of experience of consultants in design, supervision and quality control	3.898	1.06546	High
16	Lack of clarity of the concept of waste and its size among the participating designers	3.8776	0.90445	High
17	Errors and inconsistencies in the design files	3.8571	1.04083	High
18	Conflicts and poor communication and coordination between the contractor and other parties	3.8571	0.8165	High
19	The impact of social and cultural factors on the awareness of aspects of waste and its importance	3.8571	0.84163	High

20	Lack of a waste management and control plan	3.8367	0.9863	High
21	Quality problems	3.8367	0.6876	High
22	Non-compliance with specifications and standards	3.8163	0.97197	High
23	No waste laws	3.8163	0.78192	High
24	The periods required for approvals and contracts lead to a waste of time, reduce the economic return of the project, and increase the prices of materials	3.8163	1.01393	High
25	Not investing in reducing waste	3.7755	1.06586	High
26	Unavailability of the required materials and replacing them with close alternatives	3.7755	0.9413	High
27	Design change due to its inconsistency with facilities	3.7551	1.12788	High
28	Loss or theft of materials and equipment from the construction site	3.7347	0.9304	High
29	Errors in calculating quantities, increase or decrease	3.7143	1.04083	High
30	Problems in project scheduling that lead to waiting times or ineffective time constraints in completing design, implementation and other works	3.6735	0.98716	High
31	The lack of clarity of the concept of waste and its size in the institution	3.6327	1.13089	High
32	Inadequate qualifications of employees and the position they occupy	3.6122	0.90867	High
33	Not allocating enough time to study and plan the project	3.6122	0.93131	High
34	Equipment malfunction	3.6122	0.88545	High
35	Incomplete design at the time of bid	3.5918	1.11651	High
36	Not clearly defining the responsibilities of the project parties	3.5714	1.20761	High
37	Material waste either due to poor design or poor implementation	3.5714	0.88976	High
38	The approval process is long	3.551	1.1004	High
39	Lack of training for engineering teams, failure to enable new skills, and failure to optimally utilize the current skills of the team	3.5306	1.08209	High
40	Design change due to difficulty in implementation	3.4898	1.15691	High

41	The lack of a communication plan between the project parties	3.4898	1.13876	High
42	The scope of the project is not clearly defined	3.4898	1.06306	High
43	Inappropriate definition of authority or responsibility as well as overlapping supervision	3.449	1.00127	High
44	Not adopting modular design (repeated units)	3.0204	1.05059	Average
45	Not designing based on the use of prefabricated elements	3	1.13652	Average

Appendix 3: Rank of waste-causing factors according to recurrence

Table 32 Arrangement of the studied items affecting waste according to their frequency

Rank	Items	Total Score	Percentage
1	Lack of training for engineering teams, failure to enable new skills, and failure to optimally utilize the current skills of the team	188	75.2
2	The lack of a communication plan between the project parties	185	74
3	Poor quality practices	183	73.20%
4	Quality problems	183	73.20%
5	Inadequate qualifications of employees and the position they occupy	180	72%
6	Not allocating enough time to study and plan the project	178	71.2
7	The lack of clarity of the concept of waste and its size in the institution	177	70.8
8	Problems in project scheduling that lead to waiting times or ineffective time constraints in completing design, implementation and other works	177	70.8
9	Changes during the implementation phase	177	70.80%
10	Lack of clarity of the concept of waste and its size among the participating designers	176	70.40%
11	Poor coordination and communication between the design team	175	70%
12	Inappropriate definition of authority or responsibility as well as overlapping supervision	175	70
13	The scope of the project is not clearly defined	174	69.6
14	Not using the team's creative talents	173	69.20%

15	Lack of a waste management and control plan	173	69.2
16	Not using modern technology and software	172	68.80%
17	The approval process is long	171	68.4
18	Not investing in reducing waste	171	68.4
19	Conflicts and poor communication and coordination between the contractor and other parties	171	68.40%
20	Unavailability of the required materials and replacing them with close alternatives	171	68.40%
21	Unskilled workers and poor labor productivity	171	68.40%
22	Design change based on customer or end user request	169	67.60%
23	Not clearly defining the responsibilities of the project parties	169	67.6
24	Using unsuitable tools to perform the work during implementation, which leads to losses in the material used as a result of spilling or runny	167	66.80%
25	Implementation commenced despite incomplete project documents	167	%/66.8
26	Weak scientific and cultural background of the designers	164	65.60%
27	Rework and corrective action	164	65.60%
28	Errors and inconsistencies in the design files	163	65.20%
29	Non-compliance with specifications and standards	163	65.20%
30	Lack of experience of consultants in design, supervision and quality control	163	65.20%
31	Material waste either due to poor design or poor implementation	162	64.80%
32	Misunderstanding of customer/end user requirements	161	64.40%

33	Damage and damage to materials during the implementation of the project	161	64.40%
34	Equipment malfunction	160	64%
35	Errors in calculating quantities, increase or decrease	156	62.40%
36	Not adopting modular design (repeated units)	152	60.80%
37	Loss or theft of materials and equipment from the construction site	152	60.80%
38	Not designing based on the use of prefabricated elements	151	60.40%
39	Incomplete design at the time of bid	151	60.40%
40	Design change due to its inconsistency with facilities	150	60%
41	Design change due to difficulty in implementation	142	56.80%