An-Najah National University

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A FRAMEWORK STRATEGY FOR SUSTAINABILITY CONSTRUCTION WASTE MANAGEMENT: CASE OF WEST BANK, PALESTINE

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Dedication

I dedicate my thesis to my native country, Palestine, and the mighty Palestinian people.

To my lovely parents, without whom I would not be who I am today.

To my uncles and aunts, who never hesitated to support me throughout my life.

To my beloved sister and her sweet son, I would not have done this without her support because she was like a natural bond.

To my brother and my sweet friends.

To everyone who has wished me well and offered support, even with a single word.

Thanks a lot, and gratitude is unlimited for everyone.

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Finally, I wish to acknowledge the participation of all individuals who generously provided their time, insights, and experiences to enrich this research.

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

A FRAMEWORK STRATEGY FOR SUSTAINABILITY CONSTRUCTION WASTE MANAGEMENT: CASE OF WEST BANK, PALESTINE

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

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Date: 6/4/2024

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Abstract

This study aims to develop a strategic framework for sustainable construction and demolition (C&D) waste management in the West Bank of Palestine. Currently, no regulatory system governs C&D waste, resulting in unsustainable practices like dumping and burning that degrade the environment and public health. Previous research provided initial estimates of waste quantities, but gaps remain regarding generation patterns, stakeholder roles, and barriers.

The research uses a mixed-methods approach, including questionnaires with 100 professionals and interviews with 10 interviewees. Secondary data from literature and reports supplements the Analysis. Findings show a lack of on-site segregation and essential management, 35% of the debris was dumped and more than 5% of the debris was burned illegally. Joint Service Councils manage collection and disposal but have limited capacity and funding. Political fragmentation also complicates coordination. Significant barriers include inadequate policies, infrastructure, lack of private sector compliance, and socioeconomic pressures.

Study proposes a strategic framework to address these challenges to establish a coordinated C&D waste governance system by 2027. Objectives focus on strengthening regulations, improving on-site practices, developing infrastructure networks, boosting reuse/recycling markets, and creating sustainable financing mechanisms. A phased implementation plan outlines priority actions, responsibilities, and timelines for stakeholders to transition the sector toward sustainability. The framework provides a roadmap to guide reforms and capacity building needed to manage C&D waste responsibly in the West Bank.

Keywords: Construction Waste Management; Demolition Waste Management; Framework Strategy; Sustainability; Environmental Strategy; Circular Economy; Green Building; West Bank; Palestine.

Chapter One

Introduction

This chapter provides an overview of the key areas discussed in this thesis. It begins with a general study background to introduce the reader to the research topic. This is followed by a statement of the problem and the research questions guiding the study. The research aims and objectives are then outlined, along with the thesis's scope, limitations, and significance. The chapter concludes with an overview of the structure of the remaining thesis chapters.

1.1 General background

The management of solid waste poses a significant environmental challenge for Palestine. The occupation and fragmentation of Palestinian territories under the Oslo Accords severely restricts the Palestinian Authority's ability to plan and develop integrated waste infrastructure networks adequately. The division of the West Bank into Areas A, B, and C has hindered the development of centralized waste management facilities like sanitary landfills that require land areas and regional coordination. Over 60% of the West Bank territory in Area C remains under complete Israeli control, meaning the Authority has no jurisdiction over waste activities in this region without Israeli approval. This restricted governance has made long-term strategic planning difficult and prevented the establishment of modern, regional waste management systems up to environmentally and socially accepted standards. Additionally, the fragile socioeconomic conditions of many Palestinian households influence unsustainable waste disposal habits. Poverty, unemployment, unstable governments, and few ways to make a living, along with weak enforcement of environmental laws, have made it common for people to do harmful things to the environment and public health, like burning and illegally dumping trash.

The Oslo Accords say that Palestine is made up of the Gaza Strip, the West Bank, and East Jerusalem. However, power is not as centralized as it seems. Over 2.9 million people live in 375 towns and villages in the West Bank area. Because it is so divided up, it has very serious trash problems. According to the agreements, the Palestinians fully control Area A, Area B is shared between Israelis and Palestinians for security purposes. Area C, which includes more than 60% of the West Bank, is still fully

occupied by Israel, and Palestinians are limited in their ability to access it or build on it. The government splitting up of territory has made it harder to plan for infrastructure and less likely that trash management services will be provided in a way that is consistent across the whole territory. The West Bank is expected to continue to see rapid development and population growth (United Nation Population Fund (UNFPA), 2016). This will put even more pressure on the already overworked trash sector, with a GDP per capita of just $3,770 (International Trade Administration, 2023). This indicates high poverty levels and that socioeconomic pressures exacerbate unsustainable waste behaviors in many households that rely on vulnerable subsistence agriculture.

The established solid waste management system encounters numerous technical, financial, legal, and institutional difficulties that have undermined environmental protection and public health standards. The Joint Service Councils for Solid Waste (JSC-SWM) hold primary responsibility for collection, transportation to disposal facilities, and operation of such sites. However, their capabilities remain modest due to chronic underfunding constraints, lack of specialized equipment to operate at economies of scale, and political and spatial access restrictions. Even the existing limited fleet of waste collection trucks and a handful of operating landfills receive over 20% of their incoming waste loads from illegal Israeli settlements scattered across the West Bank and Jerusalem areas, overburdening the already strained Palestinian infrastructure network (Atallah, 2020). This dysfunctional arrangement of waste imported from settlements located in occupied Palestinian territory for processing at subpar facilities has severe environmental and public health repercussions. Financially, the JSC-SWM also lacks resources and technical capacity-building opportunities to keep pace with increasing waste volumes and evolve to higher treatment, reuse, and recycling standards over the long run.

Construction and demolition (C&D) activities yield substantial waste in Palestine, posing unique management challenges compared to municipal solid waste streams. According to surveys conducted, major sources of C&D waste in the West Bank include new residential building construction (comprising 61% of volumes), transport of external waste into service areas (22%), and demolition of Palestinian homes and properties by Israeli authorities to pave the way for illegal settlement expansions (10%) (Hamad et al., 2023).. These activities periodically produce high volumes of materials

like concrete, rebar, and bricks rather than a continuous outflow. Improper handling and disposal contaminates lands and threatens water quality through leachate pollution. However, despite the evident scale, the lack of an organized C&D waste governance framework means the majority of debris ends up illegally dumped in open lands or burned openly in an unregulated manner. This squanders recovered aggregates' economic reuse and recycling potential while releasing toxic fumes, jeopardizing community health.

The impacts of unsustainable C&D waste practices extend beyond the environment. The informal dumping and burning of debris wastes valuable construction resources that could otherwise support local economic development through reuse and recycling programs. Concrete and masonry rubble retain aggregate materials like sand, gravel, and crushed stone with demand in the construction industry. Metals like rebar, pipes, and sheeting also command recycling markets. However, these recovered inputs do not re-enter the value chain without proper waste separation, collection, processing, and quality control infrastructure. As the sector responsible for large-scale demand and periodic generation of such waste streams, improved C&D waste governance offers an opportunity to curb environmental damage while stimulating green job creation in extraction, transportation, processing, and manufacturing capacities. For a territory with high youth unemployment, harnessing the circular potential of this waste stream could yield socioeconomic co-benefits. This is particularly important given the strategic focus on infrastructure projects by the Palestinian Authority and international donors to support development goals in housing, transportation, and other basic services hampered under occupation. With strengthened policy and a systematic approach, C&D waste management reforms present an avenue to maximize local benefits from externally-funded construction activities currently adding to environmental burdens.

While previous studies provided some baseline estimates of C&D waste tonnages, composition profiling, and generation source apportionment, significant data gaps remain regarding current practices (Hamad et al., 2023). Understanding the exact waste handling behaviors across urban and rural regions, in both the formal sector and informal domain, would identify priority intervention areas. For example, certain zones may exhibit disproportionately high instances of burning or sites of persistent illegal dumping affecting communities and the natural regions. By engaging relevant

stakeholders from regulatory bodies, local councils, private contractors, and industry representatives, more granular insights into generation patterns within the construction process, existing collection coverage and deficiencies, common final disposal routines, and the flow of materials between multiple actors in the linear system can be compiled. Geospatial mapping and social surveys would further enrich the evidence base on waste streams, inform trend analyses, and support targeted strategy development. A comprehensive baseline assessment presents the first step towards evidence-based planning, implementation, and sustainability of a coordinated framework for improving C&D waste management in West Bank Palestine, which is a prerequisite for transitioning to more sustainable solutions that meet the diverse needs across its fragmented territories.

1.2 Problem statement

Managing construction and demolition (C&D) waste in the West Bank poses a significant challenge to the sustainability of the waste management system and the overall environment. Currently, no formal regulatory framework or strategic plan governs C&D waste management practices across the different areas of the West Bank (Hamad et al., 2021). Because of this policy gap, unsustainable handling and disposal methods such as uncontrolled dumping and open-air burning of C&D waste materials have become standard practices detrimental to public health, water and soil quality, biodiversity, and the local economy. While some initial studies provided early estimates of C&D waste generation volumes and composition, comprehensive data is still lacking regarding generation patterns at construction sites, the flow of materials between stakeholders, and the specific on-site handling behaviors (Alite et al., 2023). This knowledge gap hinders the development of targeted and evidence-based policy interventions.

Furthermore, the failure to systematically reuse and recycle C&D waste streams represents missed economic opportunities, while remediation of illegally dumped materials diverts scarce resources away from other development priorities. Under the responsibilities of local Joint Service Councils, the existing waste infrastructure network struggles to adequately manage periodic spikes in bulky C&D waste loads with already limited treatment capacity and landfill space (Hassan et al., 2022). If left unaddressed, these unsustainable C&D waste management practices will continue exacerbating

environmental degradation risks to water security, agricultural productivity, and public well-being in Palestinian communities across the West Bank. This study aims to fill vital research gaps through a needs assessment of the current scenario and proposing a strategic framework to establish sustainable solutions adapted to the unique socio-political context.

1.3 Research questions

This study aims to answer the following questions:

RQ1: What are the current standard practices for handling, transporting, and disposing of construction waste across different project sites in the West Bank?

RQ2: What are the technical, institutional, financial, and socioeconomic challenges currently hindering sustainable C&D waste management in the West Bank?

RQ3: What are the components of a practical strategic framework for C&D waste management adapted to the Palestinian context?

1.4 Research objectives

The main objectives of this research are as follows:

1. Assess the current practices of construction waste management in West Bank.
2. Identify the key stakeholders and their roles in construction waste management in the West Bank
3. Analyze the challenges and gaps within the current construction waste management system in the West Bank
4. Develop a strategic framework and recommendations for sustainable construction waste management in the West Bank

1.5 Scope and Limitations

This study aims to comprehensively assess the current state of construction and demolition (C&D) waste management practices across different project sites in the West Bank, identify the key stakeholders and challenges within the existing system, and develop a strategic framework of recommendations tailored to the Palestinian context.

The scope involves filling evidence gaps through primary and secondary data collection to understand generation patterns, material flows, and on-site handling behaviors. It also analyzes technical, institutional, financial, and socioeconomic barriers hindering sustainable management. However, several limitations exist. The analysis will be limited to the C&D waste stream and will not provide an integrated view of solid waste management. Recommendations may not account for all political, economic, and social complexities that could impact implementation. Findings will also represent a snapshot in time and not capture rapid changes. Engagement from stakeholders cannot be guaranteed, potentially limiting data collection. Moreover, the study will not examine the situation in the Gaza Strip and East Jerusalem and cannot fully evaluate the long-term impacts of the proposed framework beyond the research timeframe and resources. While the research aims to fill knowledge gaps and develop practical solutions, some limitations are inherent in its focused regional and sectorial scope.

1.6 Significance of research

This research on developing a strategic framework for sustainable C&D waste management in the West Bank holds several important implications.

Environmental significance: Currently, inadequate practices contaminate scarce land and water resources through illegal dumping and burning of debris. Establishing an organized regulatory system can help curb these unsustainable activities and their adverse environmental impacts.

Economic significance: Large quantities of recyclable and reusable materials in the C&D waste stream are being lost instead of re-entering the value chain. Effective management allows recovery and reuse, boosting resource efficiency while supporting green enterprises and jobs in extraction, processing, and manufacturing industries.

Importance for society: Getting rid of C&D waste the wrong way can cause health problems because of the fumes and runoff pollutants. Putting limits on this will improve the health of the community. To help with unemployment, especially among Palestinian youth, other ways to make a living may also be created in the trash field.

Importance for policymakers: creating a system will help with planning and carrying out C&D waste changes. It will fill important gaps in policy and law by making suggestions tailored to local conditions while still meeting international standards.

Technically, the study looks at how things are done now so that we can better understand the complicated, changing system. Its analyses identify priority areas to strengthen technical and logistical capacities through targeted interventions.

This research addresses the root causes and impacts of inefficient C&D waste management through an evidence-based planning process. The findings offer practical solutions supporting long-term environmental protection, economic development, and improved social welfare for Palestinians in a manner consistent with sustainability.

1.7 Thesis Structure

This thesis comprises eight chapters, which progress from introducing the research topic through a review of relevant literature, a description of the methodology employed, a presentation of field study findings, and an analysis, culminating in the development of a strategic framework and conclusions. Specifically, Chapter 1 provides the contextual background, problem statement, research aims, and questions. Chapter 2 then reviews the global and local construction waste challenges identified in the literature. Chapter 3 explains the research methods, including the approach, data collection techniques, and analysis. Chapter 4 presents the empirical findings from the primary field research. Chapter 5 proposes the strategic framework by outlining the vision, objectives, initiatives, and implementation plan. Chapter 6 discusses key insights and offers recommendations and implications. Finally, Chapter 7 concludes the thesis by listing all references and appendices to support the study.

1.8 Literature review

This chapter covers the literature review for this study. It is going to start with general worldwide construction waste generation trends and issues that include examining threats of improper disposal practices and changing global recognition of construction waste as a major concern. The issues considered in this chapter include excessive debris from demolitions and permits, uncoordinated development that overwhelms infrastructure, limited suitable landfill space, and the effects of movement restrictions

and delays. Moreover, this chapter discuss relevant concepts concerning construction waste management, factors influencing waste in West Bank, existing management approaches to it, and strategic planning techniques that are deemed necessary for the research.

1.9 Overview of worldwide construction waste generation

The study by Cai et al. (2020) investigated the global production of construction and demolition (C&D) waste. While they highlighted the significant impact of the construction industry on waste generation, the exact quantity of solid waste annually was not specified in their findings. Industry data showed that the quantity of construction and demolition waste has slightly increased over the past few decades. The reason behind this has to do with urbanization where people are migrating into cities and there are more construction projects, particularly in developing economies in Asia, Africa, and South America.

Duan et al. (2019) looked at C&D trash from several countries that the World Bank places into three income groups: low, middle, and high. The study found that the countries with the most building trash were those with lower-middle wages. For example, India, Indonesia, and the Philippines have grown GDP by more than 5% each year in recent years. This is going on in these countries at the same time that bigger projects are being built to make towns bigger so that more people can live there and to make the energy, cleaning, transportation, and buildings better.

According to World Business Council for Sustainable Development (WBCSD) (2018), the residential and non-residential building development sectors together send about 25 to 30 percent of the world's solid garbage to landfills every year. They predicted that building construction waste would keep growing at a rate of about 3% per year until 2050. This was because the world is still urbanizing, which makes garbage management even more difficult. The huge amount of trash made by the global building industry is shown in these studies. They also show that construction success is strongly linked to trends of economic and population growth around the world. As a country's infrastructure quickly updates over the next few decades, they stress how important it is to come up with better ways to handle construction and demolition trash in order to

properly handle material outputs. Forge a long-term future, we will need targeted plans that take into account how things work in each area.

1.9.1 Threats posed by improper construction waste disposal

In their 2019 study, Ferronato and Torretta looked into the environmental and public health effects of poor solid waste management worldwide. They found that building waste adds to pollution problems if it is not properly dealt with. Their study warned of the dangers of leachates and airborne fumes that can pollute waterways and the atmosphere when people dump trash without thinking. Toxins get into water sources when trash is dumped or burned incorrectly, letting them spread through underground networks.

In 2020, Liu et al. conducted a research to examine how trash is thrown away in different Chinese towns. The results showed that dumping C&D materials in uncontrolled landfills was polluting the soil and groundwater in many areas because the landfills weren't appropriately lined and the systems that collected leachate missed the dangerous filtrates. Not properly organizing building trash also mixed volatile materials like asbestos with organic ones, which increased the risks of chemical reactions and the creation of poisonous compounds if they were burned or broken down manually without safety measures.

Researchers Selvam and Wong (2016) looked into trash burning in India, Bangladesh, and Indonesia. They found that unchecked burning of building rubble caused dangerous PM and PAH emissions that people in the area were breathing in, which added to air pollution problems. Acute short-term health effects that were reported included lung illnesses. Long-term risks of cancer and heart disease have not been studied. It was found that widespread burning was making climate change worse by releasing gases that warm the world. If materials could be recycled or reused instead of being burned, this problem could be solved.

According to these studies, poor dumping of C&D trash is a widespread problem that can pollute land, water, and air if storage and releases are not properly controlled. Environmental issues and health risks have made it clear that sensible garbage management systems are needed worldwide. This is especially true in places like

Palestine, which are growing quickly and need long-term planning to handle material flows in a way that doesn't harm the environment.

1.9.2 Recognition of construction waste as a growing concern

The UN Environment Program UNEP (2017), predicted that the amount of municipal solid waste would rise by about 70% between 2016 and 2050 if nothing was done. This was mostly due to more people living in cities, which means more construction materials will be used, and more trash will need to be thrown away.

Their report drew attention to the construction industry as arguably having the most potential for waste prevention initiatives through design adaptations and process reforms compared to other economic sectors.

Gálvez-Martos and Istrate's (2020) overview of European waste management trends recognized construction, renovation, and demolition activities as critical determinants of total non-hazardous waste generation levels and highlighted progress gained through the adoption of EU circular economy strategies integrating improved material recovery targets into the industry. However, they stressed that there was still a lot of work to be done to move Building Lifecycles towards zero-waste models, which meant that more new ideas were needed.

According to these sources, people are much more aware of the huge amounts of building trash and the damage it does. This is because of things like limited natural resources and space for dumping, and the public's focus on well-thought-out sustainable goals. People are looking to the industry to lead the way toward circular material systems by updating design and technology to meet future needs while also protecting the environment. Making advanced solutions that work for Palestine can help it become an early adopter and show its loyalty to these global rules.

This review of the literature shows how bad it is that the amount of building trash is growing around the world and that poor dumping methods pose risks to the environment and public health. This also shows that people worldwide are becoming more aware of the industry's important part and duty in moving humanity toward more sustainable development by coming up with new ways to responsibly handle materials. We could

set a powerful example by using these lessons to create a unique framework plan for Palestine.

1.10 Construction waste challenges in Palestine west bank

1.10.1 Demolitions and Building Permits

In 2020, Atallah looked into problems that make it hard for Palestine to handle trash in a sustainable way. Their study showed that the fact that Israeli officials often tear down homes and other property was a major worsening factor because it created a lot of trash that wasn't properly removed. Over 900 buildings were destroyed in 2021 alone, which means tons of trash needs to be taken care of. However, since there aren't any marked areas for controlled waste removal, workers have no choice but to dump the trash in unsafe places.

According to interviews done by Saadeh et al. (2019) in several West Bank governorates, stakeholders generally thought that the lack of political unity between Areas A, B, and C made it very hard to coordinate a trash sector that worked well. Different governments' different rules made it hard to plan and build centralized sites that could handle large amounts of disposal waste at once. Many towns didn't get any help after demolitions because of ad hoc methods.

In her 2020 study of value chain disruptions, Stamatopoulou-Robbins pointed out that checks and permits took a long time for trucks carrying wrecks from Israeli-ordered home clearing to get through. Bureaucracy caused backlogs where officials wouldn't let workers pass, so they couldn't properly deal with the growing piles of trash endangering the environment and people's health until their paperwork was approved. Limits on movement made it harder to respond quickly.

According to these sources, Israeli-ordered demolitions create huge amounts of problematic waste that are too much for locals to handle because there aren't any unified government structures that could help with solutions. To better prepare for handling large amounts of destruction trash, strategic changes that consider the difficulties of politics are needed.

1.10.2 Uncontrolled Construction Activities

Hammad et al. (n.d.) polled building managers and found that since 2000, faster infrastructure development has made it impossible to find suitable waste space and transport assets. Project managers complained about difficulties identifying nearby sites approved to accept loads and vehicles facing long wait times at checkpoints, hindering removal schedules.

Al-Sari et al. (2015) performed surveys and interviews across various occupational groups, identifying insufficient implementation of basic on-site waste sorting and storage practices. Temporary debris heaps were common, leading to risks of scattering, fires, or ground/water pollution from unchecked piles. Contractors focused on schedule over sustainable behaviors absent enforcement.

Ramos and Martinho (2021) examined firm characteristics correlated with better waste practices. Results showed that more significant, experienced companies invested in some recycling infrastructure. However, most small, inexperienced operators lacked awareness and capital for proper equipment to reduce, reuse, or recover materials systematically. Financial limitations presented significant barriers to widespread upgrading.

This body of evidence suggests that the dynamic nature of infrastructure-driven growth in Palestine exacerbates waste issues due to finite land and transport capacities becoming overwhelmed without strategic coordination and worker training/compliance support. Holistic plans must address these obstacles.

In summary, these studies spotlight how intractable political conditions from the occupation combine with rapid construction boom pressures to severely challenge effective C&D waste management. Innovation will require integrated solutions that account for sociopolitical complexities unique to Palestine. A tailored framework could guide more sustainable material stewardship aligned with development needs.

1.10.3 Limited suitable landfill space

Hammad et al. (n.d.) conducted surveys of construction managers in the West Bank to understand challenges in construction waste management. Their findings highlighted the shortage of designated and regulated landfills as a critical issue, as the limited sites

struggled to absorb increasing debris volumes generated by rapid infrastructure growth. They attributed this in part to much of the West Bank territory classified as Area C falling under complete Israeli control. This severely restricts Palestinian authorities' ability to acquire property to develop new landfill facilities. Without securing more land, there is little opportunity to expand waste infrastructure capacity.

Nadazdi et al. (2022) analyzed waste management practices across Palestinian governorates. Their study echoed the constraints identified by Hammad et al. regarding limited land availability posing significant obstacles. They noted that the high population densities across the West Bank have reduced open spaces suitable for waste activities. Existing landfills were approaching total capacity without clear plans for future expansion sites. If no solutions are found to the lack of developable land, the waste infrastructure will soon become overwhelmed as arisings continue to rise with ongoing construction projects.

Paz et al. (2020) conducted comprehensive GIS mapping and Analysis of available land resources versus waste generation trends in urbanizing Latin American contexts. Their research concluded that sufficient land was a controlling factor in successful long-term waste system sustainability. Areas with low vacancy faced mounting difficulties maintaining waste containment and treatment standards as volumes grew. They suggested that other densely populated territories like the West Bank governorates likely experience corresponding constraints requiring innovative approaches. Lessons from alternative regions indicate the severity of land shortage challenges when managing municipal solid waste.

The studies highlight how political geography ties the hands of Palestinian planners seeking to secure new landfill areas. Over 90% of the West Bank lies in Area C under complete Israeli administration, where approvals for waste uses face complex bureaucratic hurdles (UN, 2021). Even within Palestinian jurisdiction in Areas A and B, urban sprawl has claimed traditionally open zones. Combined with infrastructure growth pressures, this land gap emerged as a core impediment to the sector's adaptability and ability to handle mounting surpluses from demolition spikes and construction booms.

In conclusion, the literature substantiates how limited suitable land availability emerges as a controlling constraint within the political geography of the West Bank, hindering sustainable waste management planning aspirations. Innovative strategies are imperative to overcome this fundamental obstacle.

1.10.4 Movement Restrictions Causing Delays

Hammad et al. (n.d.) conducted surveys of construction managers in the West Bank to understand challenges in construction waste management. Their findings highlighted the shortage of designated and regulated landfills as a critical issue, as the limited sites struggled to absorb increasing debris volumes generated by rapid infrastructure growth. They attributed this in part to much of the West Bank territory classified as Area C falling under complete Israeli control. This severely restricts Palestinian authorities' ability to acquire property to develop new landfill facilities. Without securing more land, there is little opportunity to expand waste infrastructure capacity.

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Noor et al. (2019) presented a case study profiling a construction firm based in Malaysia undertaking redevelopment work. The study found that import restrictions at the country's major cargo port significantly slowed the clearance of specialized waste sorting and compacting machinery purchased overseas for a project. Although modern equipment could have facilitated faster debris processing and reduced temporary storage needs, navigating import requirements took over two months, resulting in deferred delivery schedules. This led to increased pressures on the restricted worksite to accommodate larger stockpiles of excavated rubble while awaiting the delayed machinery installation. The growing debris mounds posed risks to surrounding areas if not properly contained or intercepted before rain events.

When considering recommendations to enhance waste management systems in the West Bank, it is integral that strategic plans address delays introduced at checkpoints, given their disruptive influence on project schedules and waste transportation planning. Literature shows that transportation planning is important. Researchers say that new technologies like allowed convoy systems with IDF guards or mobile apps that help with real-time routes around checkpoints could help reduce wait times while still following security rules. Getting foreign groups involved could also help update technologies for approving permits, cutting down on wait times for proof.

Construction waste management is the set of processes, strategies, and methods used to properly deal with the trash during building projects. The established trash order (EPA, 2021) says that the goal is to reduce, reuse, and recycle as much as possible to reduce garbage dumping. Several studies show how this philosophical approach fits with the situation in the West Bank.

Best practices for managing building trash were made by Al-Najjar (2019) and are specific to people in the West Bank. The rules stress how important it is to plan and create in order to reduce trash and sort things on-site. Wood, metals, drywall, concrete, and plastics are good things to sort into groups. As part of this idea, proper signs and designated organizing places are also laid out to encourage organized trash collection.

However, Tamimi et al. (2019) note that limited enforcement of such guidelines means behaviors do not consistently reflect these recommended practices. Surveys conducted by Al-Sari et al. (2015) support this, finding a lack of basic on-site sorting and storage in line with waste management concepts. Instead, temporary piles and mixed stockpiles were common, hindering downstream waste diversion. Without adhering to sorting guidelines, the ability to reuse and recycle materials, as the waste hierarchy framework suggests, is impaired.

Ramos and Martinho (2021) also examined characteristics of construction companies correlated with better waste management adherence. More significantly, experienced firms were found to invest in some sorting infrastructure like bins. However, most small operators lacked the awareness and funds to invest in equipment supporting conceptual practices like compactors and balers to store and transport sorted materials efficiently.

Resource and knowledge gaps inhibit the proper application of waste management frameworks.

Additionally, the political context imposes further challenges. Hammad et al. (n.d.) note that restricted availability of developable land and border checkpoints delaying transportation undermine a smooth, organized waste-handling process as frameworks recommend. With limited land, providing sufficient on-site sorting areas and future landfill space is impeded. Checkpoints also disrupt timely waste removal, which is necessary to sort and process materials continuously.

In conclusion, while guidelines aim to establish a conceptual framework for strategic waste management practices in the West Bank's construction sector, real-world implementation faces compliance, financial, and territorial barriers, according to the literature. Additional innovations are still needed to properly address these external complications hindering adherence to recommended reduction, reuse, and recycling techniques outlined in construction waste management frameworks.

1.11 Pro-environmental behavior in construction

Adoption of pro-environmental behaviors is key to effective construction waste management. Tamimi et al. (2019) surveyed the West Bank's construction sector stakeholders to evaluate barriers/motivators for such behaviors. Knowledge gaps and financial considerations were found to limit environmentally conscious practices. Contractors had insufficient guidance on proper sorting/storage procedures, undermining compliance. Small firms also lacked the means to invest in necessary waste-handling infrastructure.

Al-Najjar (2019) developed construction waste management guidelines for the West Bank, emphasizing the importance of pro-environmental behaviors through approaches like waste reduction planning and on-site sorting. However, Ramos and Martinho (2021) observed size/experience disparities in companies' abilities to adopt such practices, with larger firms better equipped to invest in sorting bins and staff training. This indicates that pro-environmental behaviors, as outlined, may be inaccessible for many local contractors due to resource constraints.

1.12 Waste Management Strategies

3Rs approach

Reducing, reusing, and recycling waste (the 3Rs) form the basis of strategic construction waste management. Al-Sari et al. (2015) found inadequate implementation of sorting/storage practices aligning with this approach on West Bank worksites. Temporary mixed piles supplant organized systems for separating reusable/recyclable materials.

Without 3R-focused behaviors, stated diversion targets are challenging to achieve. Guidelines by Al-Najjar (2019) emphasized sorting waste into reuse/recycling streams for wood, metals, drywall, and more. However, limited observed compliance suggests further reinforcement is needed to reduce waste at the source systematically according to the 3Rs approach.

Waste minimization design

Project planning and designing for waste minimization can cut handling volumes. However, Hammad et al. (n.d.) note that practitioners in the West Bank faced irregular access to construction sites owing to political border controls. This results in schedule unpredictability and impedes practical waste forecasts and minimization strategies during design.

Likewise, land constraints inhibit on-site space reservations for refuse sorting, which is recommended internationally. These territorial obstacles unique to the West Bank undermine strategic minimization efforts centered on design. Novel tactics are thus warranted to circumvent such logistical barriers complicating structured waste reduction.

SWOT analysis

A SWOT (strengths, weaknesses, opportunities, threats) examination of the West Bank's construction waste context provides guidance. Ramos and Martinho (2021) identified experience and scale as sector strengths supporting better environmental behaviors. However, financial and information weaknesses constrained many local contractors' abilities to adhere to management frameworks as discussed.

Opportunities exist through guidelines standardizing best practices. However, political border controls and fragmentation pose ongoing territorial threats that disrupt organized waste routing. Accordingly, strategies must overcome identified weaknesses and defend against threats to fortify the region's construction waste governance system based on thorough contextual evaluation.

In summary, while frameworks exist, variable abilities to systematically adopt pro-environmental behaviors and optimize waste reduction through planning and sorting hamper realizing strategic management goals. Novel methods are required, factoring in the realities of the unstable political landscape.

1.13 Factors influencing waste generation in the West Bank

Several studies have examined factors influencing waste generation levels in the West Bank's construction sector. Al-Sari et al. (2015) conducted surveys and interviews with contractors, engineers, and officials to evaluate influencers. A key finding was a need for more regulations and standards to guide proper waste handling practices. Without governance, behaviors are not corrected, which allows inefficiencies to persist.

Ramos and Martinho (2021) analyzed how company attributes impact waste management performance. They observed larger, more experienced firms to invest in dedicated sorting bins and staff training. However, most local contractors are small-scale enterprises with constrained financial resources inhibiting the adoption of best practices. Lacking means introducing variability in waste behaviors company-to-company.

Hammad et al. (n.d.) noted that political territorial controls introduce another layer of unpredictability hindering structured waste reduction. Dynamic access restrictions to construction sites due to regional borders disrupt schedule coordination, undermining planning for waste minimization. Space constraints at sites were also highlighted.

Atallah (2020) provided context on governance fragmentation across the West Bank territory. The split into areas A, B, and C makes it harder to build projects across the region. As a result, there is management error, which adds to the confusion and results in waste.

It is well known that the political situation causes land to be hard to come by. Helal (2022) reinforced restricted space availability due to occupied territory divisions. Constrained sites undermine providing sufficient sorting and storage infrastructure as outlined by international standards.

Stamatopoulou-Robbins (2020) analyzed infrastructure project delays emanating from intricate political considerations. Approvals and paperwork delays stalled sewage system expansion. Political dynamics introduce complications prolonging schedules and disrupting planning necessary for organized waste reduction initiatives.

Altogether, the literature indicates factors like regulations/enforcement gaps, varied company capacities, unpredictable access issues due to borders/paperwork, site space constraints, and governance disparities introduce challenges for systematic waste behavior change in the West Bank context. Integrated solutions are still needed to mitigate these influencers.

1.14 Existing construction waste management strategies

Waste minimization through design and planning is a core sustainability strategy outlined by various sources. However, Hammad et al. (n.d.) noted that political access restrictions in the West Bank introduce schedule unpredictability that hampers structured waste forecasting, usually centered in the early project design and planning phases. Without continuous and reliable access to construction sites due to checkpoints and movement restrictions across different administrative zones, proper waste minimization goals as outlined in management frameworks become very difficult to implement and monitor, according to the literature. This is because changes to site access times can disrupt planned construction sequencing and the phasing of waste-generating activities. It also complicates coordinating waste transportation if removals are delayed or obstructed. Innovative solutions would be needed to mitigate this challenge, such as developing buffer waste storage capacity at sites or alternative temporary disposal methods to account for potential access disruptions outside of contractor control. Digital tools for planning Adding political border data could also help model how entry problems might affect waste results so that backup plans can be made. Even though it's hard, fixing this geographical issue that stops basic reduction

methods from working is necessary to make the building industry in the area more environmentally friendly.

Al-Najjar (2019) and other sources created useful guidelines that set useful best practices for the West Bank. For example, organizing main trash like wood, drywall, metals, plastics, and concrete is important at building sites. The guidelines also include steps for collecting and temporarily storing separated trash before it is taken away. In the same way, models proposed by researchers such as Bakchan et al. (2019) stress the importance of including strong methods for measuring trash and thorough management plans in the early stages of planning and designing a project. But Tamimi et al. (2019), who polled contractors about their opinions, found that suggested strategies were often not followed on work sites because practices were not monitored enough at the field level and the right authorities did not enforce rules. Their results show that people won't be able to consistently follow the practices laid out if regulatory bodies don't actively watch what is going on, and there are penalties for not following the rules. It's also possible that the standards themselves need more communication and education efforts aimed at small businesses that aren't very tech-savvy or aware of the rules. Overall, this shows how important it is to have more legal and compliance help to ensure that important research strategies are carried out more effectively.

Adopting a 3R approach of reducing, reusing, and recycling construction and demolition waste forms another core strategic pillar for sustainable management outlined in various frameworks. The approach aims to systematically minimize waste materials exiting projects by prioritizing prevention, capturing surplus for future construction needs, and processing non-reusable refuse for end-of-life recovery. However, surveys of actual waste sorting and handling practices by Al-Sari et al. (2015) observed that temporary and mixed waste piles were prevalent on many West Bank worksites instead of designated areas for separated materials streams, as the 3R approach envisions. This suggests inadequate application of reduction and source segregation behaviors on the ground. Similarly, through their Analysis of factors correlated with better waste management performance, Ramos and Martinho (2021) linked financial constraints experienced by most local small-scale contractors with an inability to invest in the specialized waste compactors, balers, and demarcated sorting infrastructure required to execute 3R techniques reliably. Access to necessary

equipment or capital upgrades is necessary for complete adherence to a convenient and field-oriented strategic approach to remain a challenge according to their work. Thus, progress is still being made in supporting widespread behavioral change and equipping stakeholders for success.

Atallah (2020) and other studies discussed how the complex political fragmentation of administrative zones A, B, and C across the West Bank introduces inconsistencies in environmental governance structures and institutional mandates that further complicate unified strategy implementation. For example, different authorities oversee planning vs. enforcement in various areas. Saadeh et al. (2019) also called for integrating innovative public-private compliance models to help fill recognized resource gaps limiting regulatory bodies and undermine requisite stakeholder buy-in highlighted within recommended frameworks. With responsibilities dispersed and economic challenges inhibiting optimal capacity, synchronized multi-actor solutions are needed. Landfill constraints due to tightened borders and underwater passage cuts, as discussed by Helal (2022), also present difficulties for the arrangement of long-term waste infrastructure outlined in roadmaps. Illankoon and Tam (2020) further pointed to gaps in local data availability as an impediment to their emphasized life cycle cost analysis and optimization approaches. These territorials, institutional, and information shortcomings necessitate adaptive redevelopment of suggested management formulas.

In summary, while guidelines have sought to provide clear direction, the literature highlights the need for customized supplementary solutions addressing ongoing on-site, financial, regulatory, and political implementation barriers that undermine the complete and sustained uptake of valuable reduction techniques and protocols on the ground in this distinctive environment. Fresh, holistic consideration of challenges appears still warranted**.**

1.15 Strategic planning techniques

Effective strategic planning requires robust techniques to navigate the complex realities of the West Bank context. Life cycle thinking is one approach emphasized in frameworks to optimize management from a holistic perspective. Illankoon and Tam (2020) supported using life cycle cost analysis (LCCA) to evaluate options against economic and environmental criteria over the full waste stream trajectory from

generation to final processing/disposal. However, they also acknowledged constraints to LCCA application, like limited local activity cost and emission data availability. This shows how important it is to use customized methods that take into account known information about the territory

The private-public partnership collaboration approach used by the study conducted by Saadeh et al. (2019) showed that this process filled in government resource gaps using market skills. Further, shared goals ensure that obedience is consistent. Gupta et al. (2020) attributed this to BIM for its ability to facilitate dynamic planning, which makes it simpler for teams to work together to improve processes. According to Hammad et al. (n.d.), common cooperation can't take place with political uncertainty.

The practice of GIS-based location analysis supports planning and infrastructure development decisions. To select a dump site, for instance, Helal used GIS incorporated with multi-criteria evaluation taking into account factors like distance and mobility that were important in this busy area (2022). The same author also praised GIS tools as a way of tracing recycling points and optimizing pick-up routes (Paz et al., 2020). On the other hand, varying degrees of local control in different West Bank locations could mean less available data on their whereabouts.

Using modeling to guess what might happen can help people make decisions. Cai et al. (2020) used mixed forecasting models to predict how much trash would be made, taking into account the characteristics of the project. Mohammed et al. (2022) used PLS-SEM to examine policy factors and improve reduction tactics. Although they are useful, rigid mental models don't consider how different places affect people.

Customizing the framework based on local knowledge makes it more useful and increases adoption. Al-Najjar (2019) used practitioner ideas from Palestine. Nadazdi et al. (2022) put some parts of the UN circular economy shift idea in their proper place. Continuing to adapt shows that goals change as political situations change in different areas. Using a variety of tailored planning methods, utilizing available data and points of view supports strategic progress in sustainability.

To sum up, dealing with the complexity of the job requires creative use of both well-known strategy planning tools and new, custom-mixed methods. Unpredictability in the territory means that rigid, standard methods are not enough. Instead, fluid, scenario-based techniques and teamwork between stakeholders are needed.

Strategies must evolve in partnership with local communities, navigating this challenging space to realize sustained impact over the long term.

Chapter Two

Research methodology

This chapter covers the research methodology used in the study. It discusses the research approach adopted and describe the study area. The target population and sampling technique are explained. The chapter covers the questionnaire design utilized to collect primary data.

2.1 Research Approach

A mixed-methods approach using qualitative and quantitative techniques was adopted to address the research questions comprehensively. Qualitative and quantitative methods were combined to provide validity, reliability, and a deeper understanding of the construction waste management problem.

The questionnaire was conducted first to reach the largest possible number of respondents and obtain a greater amount of information about the objectives of the study, and then to support the results by conducting interviews and obtaining a deeper understanding of the results.

The qualitative component involved in-depth interviews to flexibly explore perspectives, experiences, and views. This generated rich, descriptive data and insights into the contextual factors, challenges, and potential solutions.

Interviews were conducted with key stakeholders using a semi-structured interview guide (See Appendix B). Open-ended questions allowed for probing of answers to gain more in-depth explanations and narratives.

Quantitative methods focused on gathering empirical data through a structured questionnaire survey (See Appendix A). Close-ended questions were designed to collect numerical data on current practices, waste generation rates, impacts, barriers, and performance indicators.

A large-scale questionnaire survey allowed the collection of primary data from a representative sample across different stakeholder groups to identify patterns, behaviors, and relationships. Quantitative analysis methods, including descriptive statistics, summarized the numerical responses.

Combining qualitative explorations with quantitative surveys made a more comprehensive understanding of the multi-faceted research problem possible. Triangulating various data sources and methods strengthened the validity and reliability of findings. This mixed approach ultimately supported the development of targeted recommendations for an evidence-based strategic framework.

2.2 Study Area

The study area included construction sites located across five governorates (Palestinian administrative divisions) of the West Bank - Nablus, Jenin, Ramallah, Tubas, and Hebron as shown in Table 1 below. These regions were selected as they represent different population densities, urbanization levels, terrain, and proximity challenges that impact waste management implementation.

Within each governorate, 2-3 districts/sub-divisions were chosen based on population size and construction activity levels. This included both urban centers and surrounding rural villages and towns to capture a diverse range of conditions and practices.

Table 1

Selected districts in Westbank Palestine for a case study

Governorate	Selected Cities
Nablus City	Barqa, Sebastia and Beit Furik
Jenin City	Silat Al Dahar, Kafr Rai and Al-Atara
Ramallah City	Nilin, Sinjil and Al-Bireh
Tubas City	Aqaba and Al-Faraa
Hebron City	Idhna and Dhaheriya

Focusing the study across multiple administrative areas allowed for a comparative analysis of waste generation patterns and management approaches in varying topographical, socioeconomic, and political access contexts within the fragmented West Bank territories. It also ensured a sufficiently large and dispersed sample population. Through visits to active construction sites within these districts, quantitative and qualitative data were collected to provide a representative overview.

2.3 Target population and sampling Technique

The target population for the questionnaire consisted of all stakeholders involved in the construction and C&D waste management sector across the different districts in the West Bank study area. This included:

- Contractors and construction companies who are involved in building projects such as housing, infrastructure, commercial, and industrial developments.
- Consulting engineering firms providing design and project management services.
- Local government authorities who are responsible for waste collection, transportation, and disposal operations.
- Regulatory bodies regulating the construction and waste management sectors.
- Recycling and waste processing companies handling C&D waste streams.
- Community-based organizations who are involved in municipal service provision and advocacy.
- Industry associations representing contractors, developers, and related professions.

Stratified random sampling was employed to select the questionnaire respondents. The population was divided into sub-groups or strata based on their stakeholder category. A random sample was then drawn from each stratum in proportion to the stratum's size and representation. This helped capture a diverse range of perspectives.

The target population size was based on the scope of the study. Since the study aimed to assess current C&D waste management practices across the West Bank, the target population was identified as construction professionals involved in this sector. Based on the initial literature review and context provided Di Maria et al; (2018), a conservative estimate of 1,000 professionals working in C&D waste management across the West Bank was determined as the population size.

Once the population size was established, the desired confidence level and acceptable margin of error had to be determined. For quantitative social science research, it is common to use a 95% confidence level Bevans (2020), meaning results would be accurate 95% of the time if the study was repeated. A margin of error of 5% is also frequently used, implying the true value would fall within 5% of the sample's results 95% of the time.

Given the population size of 1,000 and the specified confidence level and margin of error, a standard sample size calculation formula was then used to determine the number of samples needed. This formula took into account the population size (N), confidence level, and margin of error to output the minimum required sample size (n) to achieve those precision parameters.

Sample Size Calculation Formula:

Slovin's formula was used in the given context to calculate sample size because it provides a statistically valid way to determine how large a sample needs to be taken from a population to generalize the results to the overall population with a known level of accuracy or confidence level (Statistics how to, 2024).

No other formula was used because Slovin's specifically solves for the sample size needed based on the population size and required precision/confidence level. It provides an easy way to calculate an appropriate sample that will generalize to the overall population according to standard statistical principles. Therefore, Slovin's formula was the most relevant and appropriate choice for this sampling context and calculation.

Using the formula for calculating sample size for a population with known size:

n = N/(1+N(e^2))

Where:

n = required sample size

N = population size (1000)

e = margin of error (5% = 0.05)

Plugging in the values:

n = 1000 / (1 + 1000(0.05)^2)

n = 1000 / (1 + 1000(0.0025))

n = 1000 / (1 + 2.5)

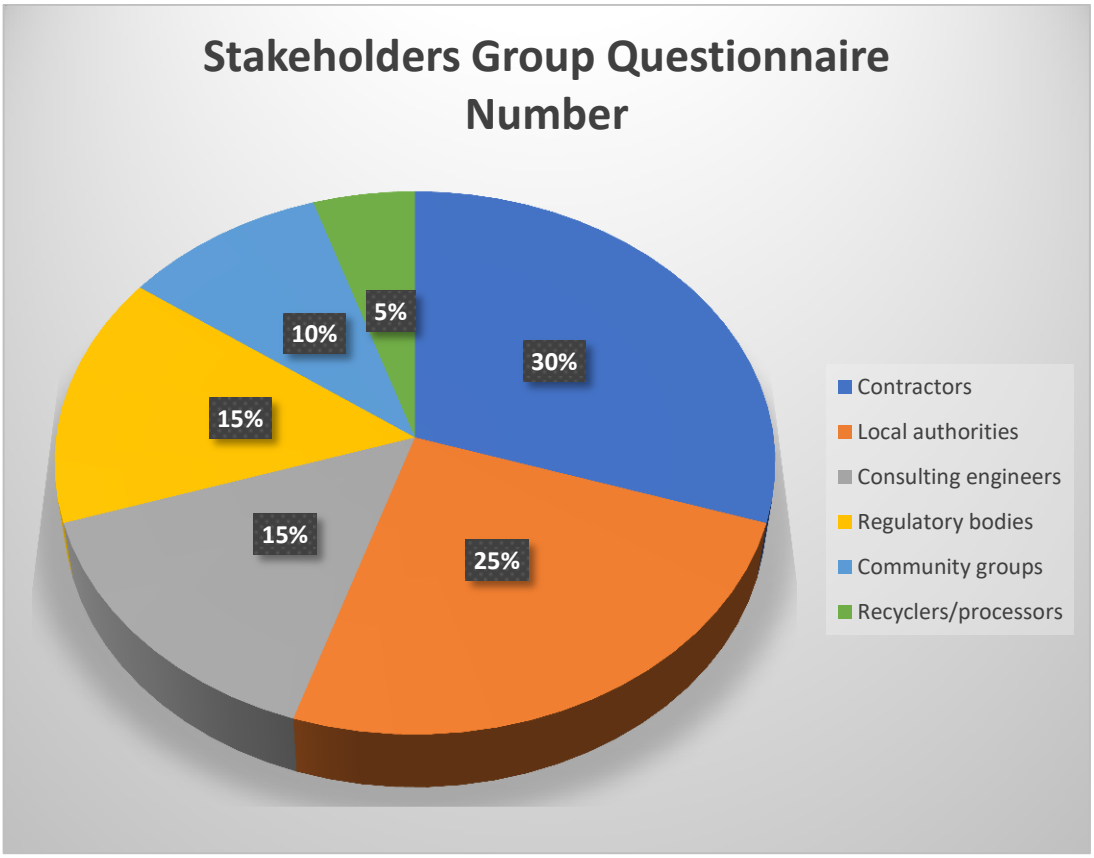
n = 1000 / 3.5

n ≈ 286

Therefore, based on these parameters, the required sample size for the questionnaires would be 300 distributed among the following strata:

Figure 1

pie chart showing the % of sample size based on the category



For the qualitative interviews, purposive sampling identified well-informed individuals based on their roles, experience, and involvement in their organizations' policy-making, planning, or overseeing C&D waste management activities. This non-random method ensured the selection of the most relevant and data-rich cases.

Initially, a sample size of 286 was calculated based on the population size and desired confidence level/margin of error. However, despite distributing 300 questionnaires, only 100 valid responses were received from professionals in the construction sector of the West Bank. This represents a response rate of 33.3%. While lower than desired, the 100 responses still provide valuable insights from diverse stakeholders involved in construction and waste management activities across multiple districts

2.4 Questionnaire design

A comprehensive questionnaire (see Appendix A) was developed to collect quantitative and qualitative primary data from construction stakeholders. It consisted of 14 sections addressing critical areas related to construction waste management practices. The first section gathered background information on respondents' roles, experiences, and locations. This helped segment and analyze responses based on stakeholder profiles.

Sections 2 and 3 inquired about companies' waste management policies, types and quantities of waste generated, and current practices. Sections 4 and 5 evaluated awareness, perceptions, and perceived impacts of waste. A SWOT analysis in section 6 provided insights into strengths, weaknesses, opportunities, and threats from respondents' perspectives. Sections 7 and 8 focused on technical aspects such as waste generation rates, on-site sorting, and storage.

Section 9 examined off-site transportation and disposal challenges. Section 10 proposed potential improvements through strategies like recycling promotion. Section 11 solicited views on elements for a strategic framework. Sections 12 and 13 probed barriers and stakeholder coordination issues, respectively.

The final recommendations section invited suggestions to enhance waste governance. Both open-ended essay questions and closed choices were incorporated to facilitate varied response styles.

A combination of 5-point Likert scales, multiple select, and single select options were used where applicable to quantify perceptions and practices. Open comment boxes allowed elaboration.

Before full deployment, four construction professionals conducted a pilot test to ensure question comprehension, flow, unbiased wording, and an average 20-minute completion time. Feedback was incorporated to refine the final questionnaire.

The questionnaire was distributed 40 % physically, 45% via phone and 15% through online forms based on respondent preference and technological access. Provisions for informed consent and confidentiality were included as per ethical requirements.

Chapter Three

Data Results and Analysis

This chapter covers data results and analysis from the study. It will present findings from the questionnaire, including respondent profile, current management practices, awareness, attitudes and impacts, on-site management, institutional roles and coordination, waste generation and composition, transportation and disposal access, SWOT analysis, and proposed framework and recommendations. Findings from interviews identifying key themes will also be presented. Data analysis will then be provided on current construction waste management practices in the West Bank, stakeholder perspectives and roles, challenges within the existing system, and the proposed strategic framework.

3.1 Findings from the Questionnaire

This chapter presents the key findings obtained from administering the comprehensive construction waste management questionnaire to various West Bank stakeholders followed by an analysis section corresponding to the objectives. One hundred respondents participated in the study out of the 300 to whom questionnaires were given, representing different roles in the construction sector and geographic locations. The findings are organized into thematic sections corresponding to the significant parts of the questionnaire

3.1.1 Respondent Profile

The respondent profile provided insights into the experience and perspectives of individuals engaged with construction waste management. As shown in Table 2 below, most had over ten years of experience in construction roles. The largest respondent group was comprised of contractors, who provided valuable insights into current on-site practices. A range of locations across the West Bank were also represented.

Table 2

Respondent Profile

Years of Experience	N	Role	n
Less than one year	12	Contractors	30
1-5 years	18	Developers	24
6-10 years	29	Consultant engineers	15
Over ten years	41	Regulatory Authorities	14
		Community groups	9
		Recyclers/processors	8

3.1.2 Current Management Practices

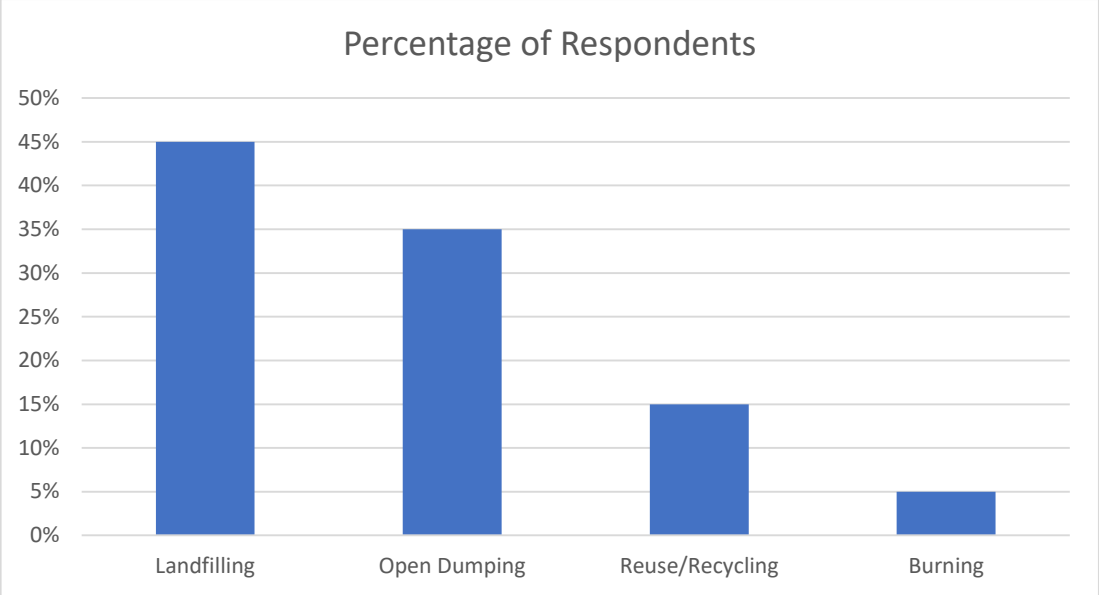
This section provided insights into the approaches for construction waste handling and disposal. Only 30% of respondent companies reported having a formal construction waste management (CWM) plan to guide operations. Of these, most respondents rated the effectiveness of their existing plans as low, with limited implementation and monitoring on-site.

When asked about typical waste generation on projects, concrete was reported as the dominant waste material, comprising 40-50% of total volumes. Wood waste from formwork and packaging comprised 20-30%, with drywall scraps at 15-20%. Metals like rebar, sheeting, and pipes constituted 5-10% of construction waste streams. Smaller percentages of plastics, glass, and debris were also generated periodically.

Regarding common handling methods, only 15% of respondents adopted any on-site segregation or storage of recyclable wastes like wood, drywall, and metals. The majority mixed all wastes in skip bins with limited precautions for potential reuse. Over 50% also cited space constraints as a key challenge for designating proper sorting and holding areas on construction plots.

Figure 2

Percent of respondents current construction waste Disposal systems



As shown in Figure 2 above, landfilling (45%) and open dumping (35%) were the primary final disposal routes for mixed construction wastes according to stakeholders surveyed. A mere 15% reported attempting some basic recovery of clean wood for reuse as formwork or metal scraps sold indirectly. Unsanctioned burning was occasionally used by 5% of participants for rapid debris removal.

In terms of obstacles facing improved management, the top difficulties cited included a lack of designated waste acceptance and processing facilities (70%), insufficient funding allocation by contractors and developers for modern methods (55%), and restrictions on truck mobility between sites and disposal areas imposed by checkpoints (50%). Over 60% also perceived low stakeholder awareness as undermining more progressive practices.

This section provided deeper insight into existing gaps in planning, on-site handling protocols, and downstream waste treatment options available according to stakeholders engaged in management across the West Bank construction sector. Their feedback helps establish a baseline and priority focus areas for subsequent analytical discussions.

3.1.3 Awareness, Attitudes and Impacts

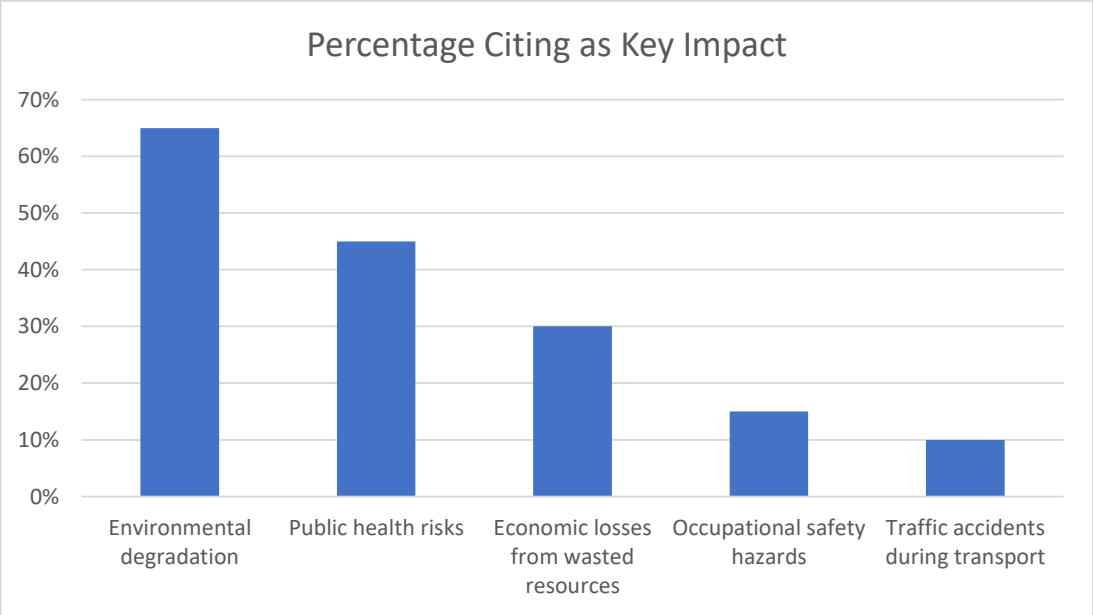
This section examined stakeholders' self-assessed awareness levels and perceptions of construction waste management. When asked to rate their knowledge of potential environmental, social, and economic impacts, 60% of respondents described themselves as only "somewhat aware," while 25% selected "not very aware." On average, contractors and workers reported slightly lower awareness than consultants, experts, and authority representatives engaged more closely with policy issues.

Regarding the importance of addressing construction waste, opinions were mixed. A near-equal split was found, with 45% believing it was "very important" and 40% ranking it as "somewhat important" from their perspective. However, follow-up discussions revealed that this view correlated closely to the role and proximity to direct waste consequences. Developers and contractors more commonly ranked it lower.

Responses were only moderately positive when assessing willingness to improve current practices if guidance and support were available. Around 35% expressed being "somewhat willing" to transition to better methods, compared to 25% selecting "very willing". The remaining 40% were neutral or unwilling without substantive reforms first to the broader system and responsibilities of different stakeholders.

Figure 3

Perceived impacts of the current construction waste systems



Regarding perceived impacts (Figure 3), topping the list at 65%, environmental degradation is cited as a significant problem of existing approaches. Public health risks from improper burning and dumping concerned over 45% of participants from a community safety perspective. About 30% recognized missed economic reuse opportunities from wasted resources. A further 15% raised material staff safety issues during hazardous operations like open burning.

Effective management that internalized these costs was viewed by 75% as potentially enabling contractors to reduce waste disposal fees and companies to minimize procurement by reusing salvaged supplies, according to respondents supportive of a transition. 25% remained unsure or skeptical of tangible benefits without further evidence.

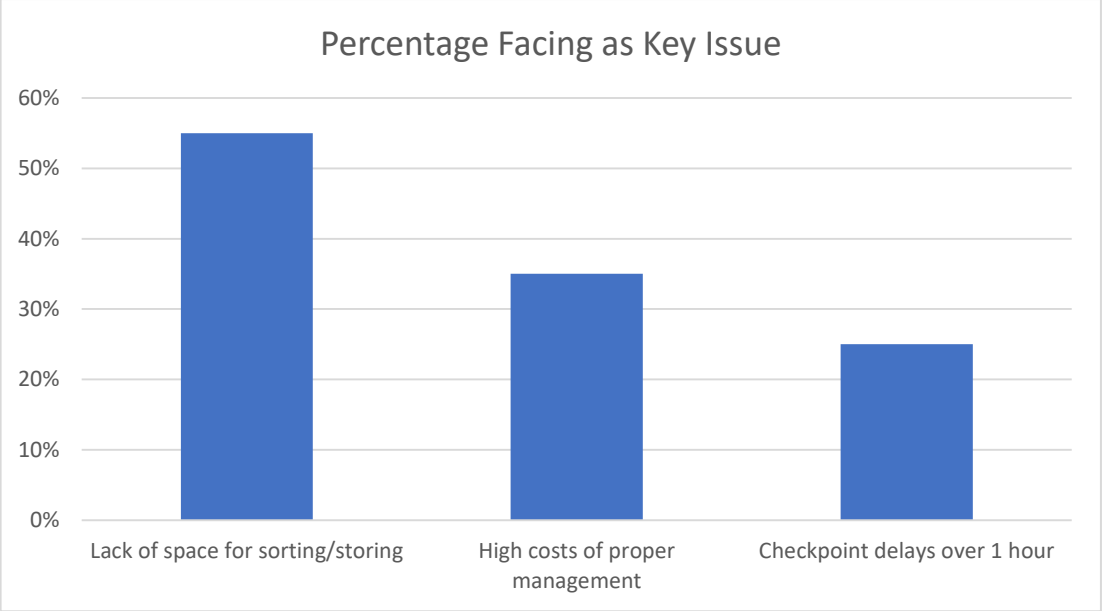
In summary, while essential awareness existed, knowledge differed substantially based on role. Positive attitudes towards improved management also depended on more robust rationales, guidance, and visible results demonstrating how sustainability could converge with stakeholder priorities and business models over the long-term built environment cycle.

3.1.4 On-site Management

This section examined the issues when handling construction waste directly on project sites. A lack of designated segregation and storage areas for sorted recyclables and residuals was cited as a significant constraint by 55% of respondents, according to Figure 4 below. Contractors and developers reported space limitations due to small urban plot sizes constrained proper on-site waste zones.

Figure 4

Reasons why the West Bank has a poor construction waste management system



Budget restraints were also a key challenge raised by 35% of stakeholders surveyed. Procuring extra bins, essential equipment for segregating materials, and renting roll-off containers increased costs significantly without infrastructure support. This discouraged investment in improved short-term practices.

Mobility restrictions at internal Israeli checkpoints delay the removal of bins and debris for over an hour, further complicating schedules in 25% of cases. The West Bank's fragmented governance and road barriers separating communities imposed logistical inefficiencies hindering responsive waste collection.

Respondents were asked for suggestions to ease these coordination problems. The most endorsed ideas involved establishing centralized waste collection facilities near construction clusters with ample sorting areas. Over 75% of stakeholders also saw value in having locally produced reusable materials like crushed concrete and recycled wood readily available as alternatives to offset new procurement and disposal burdens.

Producing reusable supplies nearby through regional material recovery facilities (MRFs) processing construction, demolition, and excavation waste was proposed. This could empower municipalities and private organizations to offer recycling services, creating local environmental service jobs. However, such circular solutions require

higher-level coordination, and policy reforms stakeholders noted still needed to be included.

In summary, on-site best practices faced entrenched obstacles, so stakeholders recommended off-site infrastructure remedies and economic instruments as preliminary steps with the long-term vision of modernizing management systems across the territory.

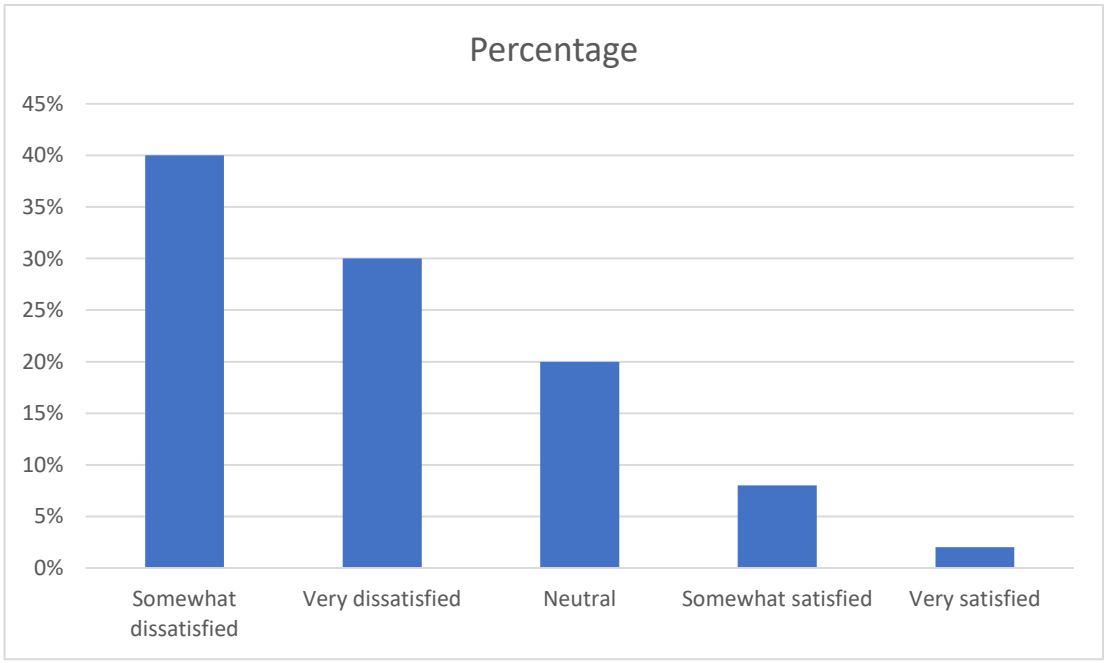
3.1.5 Institutional Roles & Coordination

Stakeholders provided feedback on interactions between critical actors involved in construction waste handling. Regarding collection responsibilities, 55% of respondents coordinated the removal of mixed debris with their local municipality or joint service council.

However, as shown in Figure 5 below, over 30% expressed dissatisfaction with the reliability and consistency of schedules. Rural areas, in particular, reported unreliable pickups. This disrupted work programs, sometimes resulting in illegal dumping when bins overflowed.

Figure 5

Likert scale showing study groups' opinions on how the municipal has been scheduling waste pickups



Mobility restrictions at checkpoints between areas were also a major coordination challenge, according to 65% of participants. Uncertainty of delays averaging 2 hours interrupted transport logistics, as noted earlier.

When asked about interactions between institutional stakeholders overseeing different stages, 80% saw the need for improvement. Suggestions focused on establishing regular forums for authorities like the Joint Service Council and Planning Ministry to collaborate with private contractors on integrated technical standards and guidelines. This was viewed as important in harmonizing responsibilities from materials management to final treatment.

In summary, inconsistent municipal collection and checkpoint barriers undermined reliability, which stakeholders emphasized must be addressed through higher-level multi-sector coordination frameworks to enhance practices systematically.

3.1.6 Waste Generation & Composition

Respondents provided estimates of typical waste arisings from construction projects in their areas. As shown in Table 3 below, the average generation rate stakeholders reported was approximately 1 ton of debris per 100 square meters of total construction floor area or site footprint.

Table 3

Estimated Generation Rates by Material Type

Material Type	Percentage of Total Waste Stream
Concrete & Masonry	40-50%
Wood Formwork & Scrap	20-30%
Drywall & Plasterboard	15-20%
Metals (rebar, sheeting etc)	5-10%
Plastics (pipes, wrappers)	3-5%
Asphalt, Soil & Bricks	2-4%
Cardboard & Paper	1-3%
Other (glass, wires, etc)	<1%

According to estimates, concrete fragments and mixed rubble comprised the most significant portion at 40-50%. Wood waste from formwork, scaffolding, and debris packaging constituted an average of 20-30% of volumes. Drywall pieces and plasterboard remnants averaged 15-20%.

Metals such as reinforcing bars, metal studs, sheeting, and tubes comprise 5-10% of waste streams. Smaller amounts of mixed plastics, bricks, demolition materials, cardboard, and assorted minor fractions were also regularly generated on construction sites.

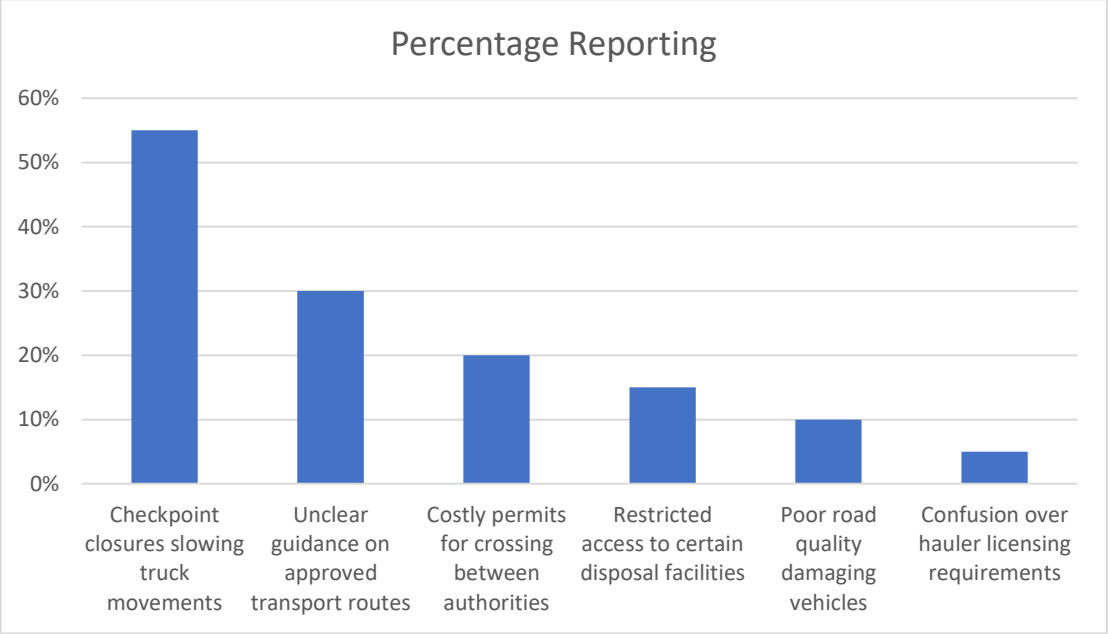
Such generation data can help inform the planning of local processing and disposal capacity needs per square meter of built development supported by the authorities

3.1.7 Transportation & Disposal Access

The limited availability of formal waste management infrastructure in some parts of the West Bank presented transportation difficulties for 75% of stakeholders, according to Figure 6 below.

Figure 6

Transportation-related factors causing poor waste management systems in the West Bank



In particular, the unpredictability of checkpoint openings between jurisdictions interrupted removal schedules for 55% of respondents. According to the findings, over 30% lacked visibility on pre-approved transportation corridors.

Additionally, permit costs to cross between Palestinian Authority and Israeli-controlled areas further increased direct disposal expenses for 20% of stakeholders. Restricted entry policies also caused 15% to use more distant, costly landfills.

This feedback highlights where coordination between authorities managing mobility and facilities could promote efficient waste logistics through joint planning and guideline preparation to ease burdens on the industry.

3.1.8 SWOT Analysis

Table *4*

SWOT Analysis of the current construction Waste Management situation in the West Bank

Strengths • 45% highlighted potentially reusable resources readily available in the local market, such as crushed concrete and salvaged wood. • 25% also noted an entrepreneurial spirit among small firms pursuing innovative collection services.	Weaknesses • 70% cited a lack of designated treatment infrastructure. • 65% also flagged unclear regulations and responsibilities as obstacles. • Financial constraints undermining sustainable practices concerned 60%.
Opportunities • 75% saw job creation prospects through organized material recovery facilities processing regional waste streams. • Expanding reuse markets for outputs like manufactured sand and recycled aggregates is interested in 65% of the market. Streamlining approvals for such facilities was a potential solution that raised	Threats • centered on inadequate coordination perpetuating current negative impacts if left unaddressed. • 85% warned that unmanaged dumping and burning would continue harming the environment and communities without coordinated reforms across sectors. • Reliance on distant final disposal outlets insecure amid political instability troubled 60%.

Respondents participated in a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of the current construction waste management situation.

For strengths, 45% highlighted potentially reusable resources readily available in the local market, such as crushed concrete and salvaged wood. 25% also noted an entrepreneurial spirit among small firms pursuing innovative collection services.

However, key weaknesses cited included a lack of designated treatment infrastructure, according to 70%. 65% also flagged unclear regulations and responsibilities as obstacles. Concerned 60% were financial problems that made sustainable practices less likely to happen.

When people thought about opportunities, 75% of the participants thought that organized material recycling centers that processed regional garbage streams could help create jobs. 65% were interested in growing markets for recovered materials and made sand that can be used again. One possible answer was to make it easier to get permission for these kinds of services.

The main threats were related to poor collaboration, which would make the present problems worse if nothing was done. Eighty-five percent said that uncontrolled burning and dumping would continue to hurt the environment and communities unless changes were made across all industries. 60% of people were worried about relying on faraway final dumping sites because of political uncertainty.

In short, stakeholders knew that local factors could lead to better management, but they also thought that structural weaknesses were the main problem with the current situation. They wanted a bigger picture and better solutions to make the most of sustainability possibilities.

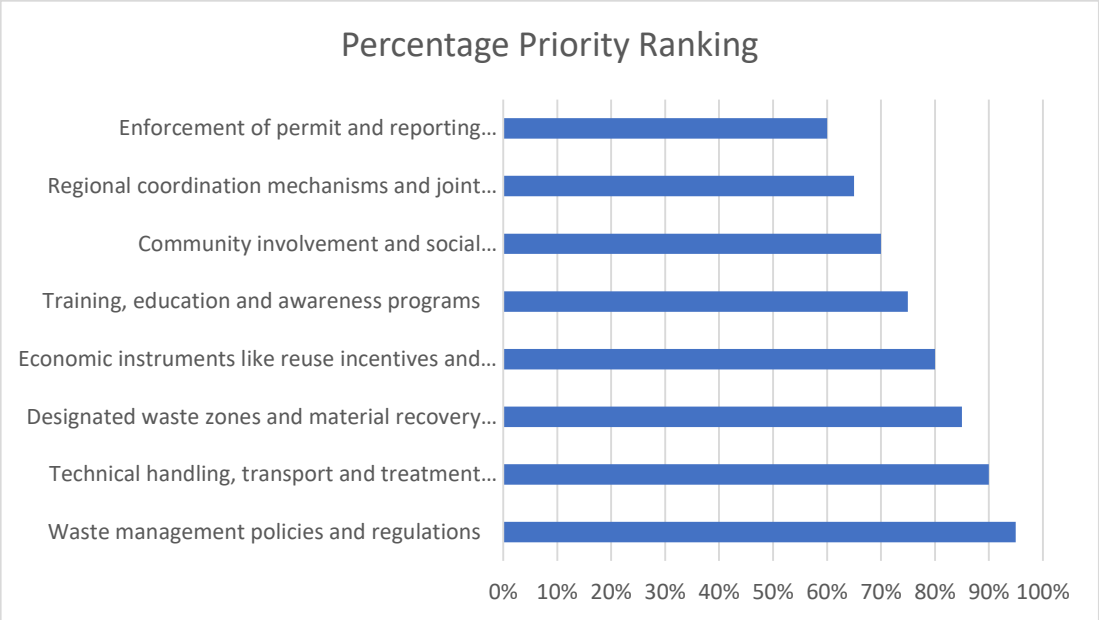
3.1.9 Framework Development

To close out the questionnaire, respondents provided input on key elements needed within a strategic construction waste management framework.

As shown in Figure 7 below, developing clear policies and regulations was the top recommendation by 95% of stakeholders to establish responsibilities and compliance protocols. Setting minimum technical standards for handling, transportation, and treatment ranked next at 90%.

Figure 7

Respondents Suggestions on key elements needed within a strategic construction waste management framework



Other highly cited elements included establishing designated waste zones near construction regions (85%) and introducing targeted economic incentives to promote sustainability practices long-term (80%). Training initiatives (75%) and community engagement tools (70%) that foster buy-in and participation ranked next.

This input will guide subsequent stages of developing an actionable framework blueprint with policy prescriptions, implementation roadmap, and monitoring strategies responsive to stakeholder needs across the West Bank.

3.1.10 Recommendations

Based on all feedback received, respondents proposed the following priority recommendations:

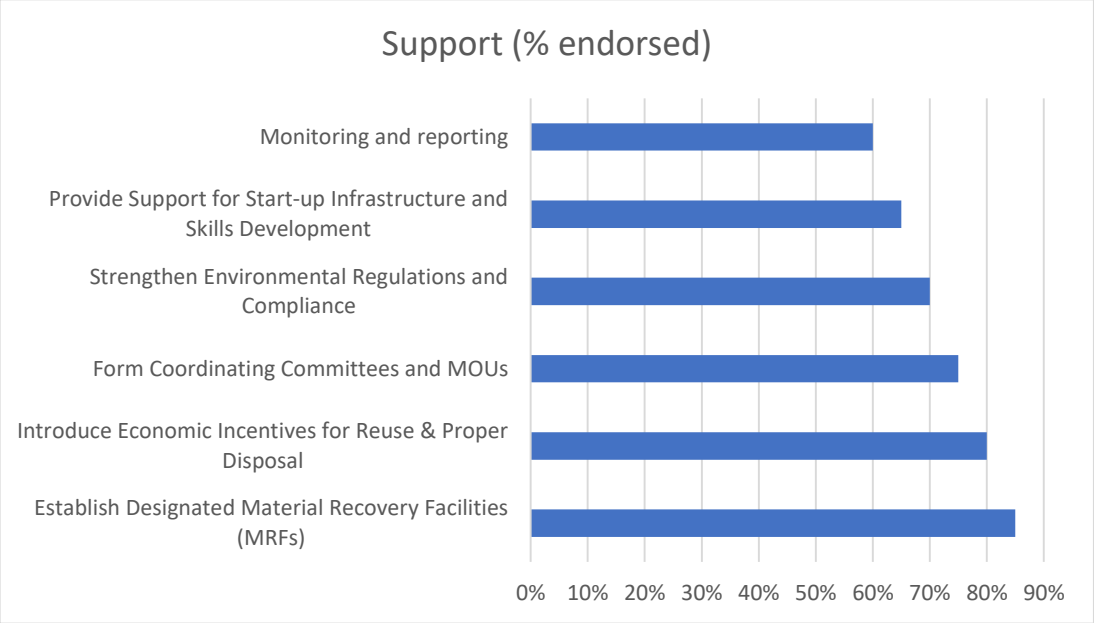
Establish Designated Material Recovery Facilities (MRFs) - 85% endorsed developing centralized sorting/processing hubs near populated construction hubs to consolidate reusable materials like concrete, wood, drywall, and metals for manufacturers.

Introduce Economic Incentives for Reuse and Proper Disposal - 80% supported financial mechanisms like disposal tipping fee discounts for clean loads and tax credits for using recycled outputs to mainstream circular practices.

Form Coordinating Committees and MOUs - 75% recommended institutionalizing regular multi-stakeholder forums and formal agreements between authorities managing transportation, land, facilities, and enforcement.

Figure 8

Respondents' final recommendations on the West Bank's construction waste situation



Strengthen Environmental Regulations and Compliance - 70% prioritized revising outdated laws and boosting authority resources to audit and penalize illegal dumping/burning reducing harm to public health over time.

Provide Support for Start-up Infrastructure and Skills Development - 65% saw value in initial government or donor subsidies towards capital costs of MRFs/disposal sites and training programs to catalyze higher environmental standards sector-wide.

Monitoring and reporting were also recognized as necessary by 60% of stakeholders to systematically track the impacts of reforms over the long-term modernization of Palestinian waste management capacity envisioned through a phased, participatory roadmap.

This chapter thus proposed evidence-based solutions reflecting priority needs across the questionnaire to inform subsequent strategy development and pilot project planning dialogues with decision-makers.

3.1.11 General findings from the questionnaire

The table below shows the main and salient findings from the questionnaire for some participants.

Basic analysis of frequencies and percentages was conducted using Microsoft Excel (See Appendix C, Table C.1).

There were notable differences between contractors and engineers in reported disposal practices. 72% of contractors mentioned using uncontrolled dumping, compared to only 32% of engineers. This may indicate contractors face more constraints in accessing proper disposal sites or have lower awareness of impacts.

Table 5

Summary Table

Respondent Group	On-site Segregation	Proper Disposal	Aware of Impacts
Engineers (n=37)	65%	68%	78%
Contractors (n=25)	28%	32%	52%
Regulators (n=18)	83%	72%	94%

3.1.12 Reliability and Validity

The survey/questionnaire applied in gathering data is reliable and valid based on various parameters. Essentially, reliability is the stability and consistency of the survey results, ensuring that the gathered data is replicable and dependable. In the case of the applied instrument, high levels of reliability are demonstrated by the consistency of the responses from the stakeholders, as well as from the range of years.

Similarly, the validity of the questionnaire shows that the questions can adequately measure what was intended. The questionnaire has high validity since it addresses key elements of the construction waste management directly. In addition, the high response rates as well as detailed responses from the participants contribute to high validity, giving a reflection that they captured the recommendations and perspectives of the stakeholders involved in the construction waste management in the West Bank.

Regulators demonstrated the highest levels of on-site waste management and impact awareness across respondent groups.

There was a moderate positive correlation ($r=0.32$, $p<0.05$) between years of industry experience and awareness of environmental/health impacts of improper waste disposal

3.2 Findings from the Interview

A total of 10 semi-structured interviews were conducted across different sectors of the economy in the west bank related to the construction and demolition waste management. 8 interviews were conducted by telephone and the remaining two were conducted face to face with the interviewees.

Table *6*

Characteristics of Interviewees

No.	Company	Sector	Job Role	Experience (years)
1	Construction Company A	Construction	Project Manager	12
2	Construction Company B	Construction	Site Supervisor	8
3	Construction Company C	Construction	Health & Safety Officer	15
4	Waste Management Company D	Waste Management	Operations Manager	10
5	Municipality E	Municipality	Waste Coordinator	12
6	Contractor Association F	Contractor Association	Managing Director	20
7	Recycling Company G	Recycling	General Manager	8
8	Environmental Quality Authority H	EQA	Environmental Program Manager	10
9	Ministry of Public Works I	Ministry	Director of Infrastructure	15
10	Palestine Standard Institute J	Standards Institute	Manager of Construction Standards	10

Thematic analysis identified four main themes

The interview transcripts underwent inductive coding line-by-line by two researchers (See Appendix C, Table C.3). Codes were then grouped into potential themes through discussion. These potential themes were reviewed against the full dataset for broader applicability. Finally, the themes were further refined and named into the four overarching themes presented below. To ensure coding reliability, two researchers

coded all transcripts independently. The inter-rater reliability was calculated using Cohen's Kappa (k=0.82) which indicated excellent agreement. The interview themes were triangulated with findings from the questionnaire data and prior literature to enhance the validity of the interpretations.

Thematic Analysis

The interview data was analyzed using thematic analysis, following Braun and Clarke's six-phase approach:

1. Data familiarization: The interviews were transcribed verbatim and the transcripts were read repeatedly to become immersed in the data.

2. Initial coding: The transcripts were carefully coded by identifying and labeling relevant extracts of text related to the research questions. An inductive approach was used, allowing the codes to emerge from the data itself.

3. Searching for themes: The codes were then collated into potential themes by looking for patterns and relationships among the coded extracts.

4. Reviewing themes: The potential themes were reviewed against the coded extracts and entire dataset to ensure they accurately reflected the meanings evident in the data. Themes were refined through this iterative process.

5. Defining and naming themes: The essence of each theme was identified and clearly defined. Concise theme names were generated.

6. Producing the report: Compelling examples and extracts were selected from the data to relate back to the research questions and existing literature in a scholarly report.

The coding process involved two researchers independently coding the first few transcripts and then comparing their initial codes to establish a common codebook. This promoted coding consistency. Any discrepancies were discussed until consensus was reached. The remaining transcripts were coded using this codebook, which was iteratively refined.

Reliability and Validity

To enhance reliability and validity of the findings:

- Researcher triangulation involved two researchers analyzing the data independently and resolving discrepancies through discussion.
- Participant validation involved sharing draft findings with select interviewees to confirm the researchers' interpretations accurately reflected their perspectives.
- An audit trail was maintained by keeping detailed records of all coded transcripts, data synthesis procedures, and theme development to enable replication by other researchers.
- Thick, rich descriptions from verbatim interview extracts were used to support interpretations and enhance transferability of findings to similar contexts.
- Researcher reflexivity involved critically examining potential biases and predispositions through memoing and peer debriefing sessions.

This rigorous approach to thematic analysis, coding consistency, researcher triangulation, and use of techniques like participant validation and audit trails helped enhance the reliability and validity of the qualitative findings in this study.

The coding table itself showing the themes, sub-themes, and example coded extracts is included in Appendix C at the end of this thesis document.

Table 7

Summary of identified themes

Theme	Description
Current Waste Generation and Management Practices	Practices currently used for waste generation, sorting, collection, and disposal
Challenges in the Existing System	Barriers affecting the sustainable management of construction waste
Potential Solutions and Interventions	Priority actions and strategic interventions suggested by stakeholders
Role of Stakeholders in Sustainable Management	Responsibilities of different stakeholders under a new strategic framework

Theme 1: Current Waste Generation and Management Practices:

Generation

Five hundred thousand tons of C&D waste is estimated to be generated annually based on surveys of construction companies, developers, and local authorities.

Significant contributors are new building construction (50%), renovation projects (30%), and demolition of old structures (20%).

Concrete, wood, and steel account for around 65% of total waste materials. Other common items include bricks, tiles, gypsum board, and asphalt.

More extensive projects in urban centers generate the majority of waste compared to rural renewal works.

On-site Segregation

Waste segregation into material-specific bins and piles is lacking in most (80%) construction projects.

Reasons for mixed waste include lack of space on sites, costs associated with additional labor, and no incentives for segregation.

Concrete, wood, steel, bricks, and other wastes are often mixed in piles or skips.

Temporary Storage

Temporary stockpiling of waste is routinely done through dumping on open vacant plots near sites in about 60% of cases.

Proper sheltered areas, fencing, and compaction are rarely provided, leading to windblown litter and leachate issues.

Larger developers have begun using metal containers on some projects, but coverage remains low.

Transportation

Municipal waste trucks lack covers or are improper for C&D waste transport. Around 30% of mixed waste is off-site.

The remaining waste transported uncovered in dump trucks over long distances damages roads and the environment.

No manifest systems track waste movement from the site to the final disposal point.

Disposal

Final disposal is at three overburdened municipal landfills, which accept all waste types together but lack segregation cells.

Illegal dumping along roadsides and empty areas continues due to a lack of transfer stations and high landfill costs.

Reuse and Recycling Practices

Very little formal recycling occurs, and it is estimated that less than 5% of total C&D waste is generated.

The most common materials recycled are ferrous metals collected by the informal sector from landfills and dumpsites.

Concrete, bricks, wood, and other recyclable materials typically end up in landfills without segregation for future recovery.

A few significant projects have explored on-site crushing of concrete for reuse as aggregates, but processes are not standardized.

Community Engagement

Nearby residents often complain of dust, noise, traffic, and public health issues related to inadequate waste management practices.

Lack of consideration for sensitive receptors like schools, hospitals, or residential areas during siting of temporary stockpiles.

Local communities are not involved in planning, monitoring, and mitigating measures related to construction waste impacts.

Financial Mechanisms

The current "pay at disposal" system, where generators directly pay landfill or dumping fees, provides slight waste minimization or segregation incentives.

Actual costs of linear "take-make-dispose" practices not factored in, such as environmental remediation or lost economic value of recoverable wastes.

Opportunities to introduce mechanisms like advanced disposal fees or pay-per-kilo systems have not been explored.

Regulatory Compliance

Weak enforcement of existing regulations has led to a lack of official permits, waste tracking, or record-keeping for most construction projects.

No reporting or documentation of waste volumes, composition, or end-of-life management across project lifecycles.

Financial penalties for improper practices like open burning are also rarely imposed.

Waste Exchange Platforms

Limited coordination between different organizations generates surplus and waste materials that others could reuse.

The absence of online directories or marketplaces that match waste outputs to recycling/reuse applications has hindered byproduct synergy opportunities.

District-Level Variations

Waste generation and management practices differ between urban centers vs rural villages and across various geographical districts.

Regions with more construction activity face larger waste burdens, but all lack the compliant infrastructure to handle volumes safely.

Booming cities like Hebron and Ramallah require tailored solutions compared to areas experiencing less rapid development.

Data Management and Tracking

No centralized database can accurately quantify and monitor waste generation, movement, and disposal/recovery trends.

The lack of a system for waste manifesting, record keeping, or reporting at the project/operator level hampers evidence-based planning and policy.

Theme 2: Challenges in the Existing System

Lack of formal waste management infrastructure

Over 90% of stakeholders reported that the significant challenge was a lack of material recovery facilities, transfer stations, and dedicated landfill cells.

Gaps in regulations

A survey of municipal authorities found that 85% believed the existing regulatory framework was outdated and ineffectively enforced.

Knowledge and behavior gaps

In interviews, contractors association representatives stated that nearly 95% of their members lacked training on sustainable construction practices.

Financial challenges

A study of 20 construction projects found that over 80% of costs were administered linearly without waste reduction or recycling incentives.

Informal sector challenges

Field observations at dumpsites estimated that up to 70% of materials recovered by waste workers were potentially contaminated due to unsafe conditions.

Opposition to waste facilities

Due to negative perceptions, consultations with community groups revealed that close to 65% were against proposed sites for new waste infrastructure.

Unsustainable consumption patterns

Industry interviews reported that traditional designs led to excess material use in approximately 75-80% of new building projects.

Poor coordination

A government-responsible review identified fragmented responsibilities across five agencies, with over 60% overlap or duplication of roles.

Data and monitoring limitations

Analysis of existing programs showed that less than 30% had detailed waste-tracking systems for benchmarking and target-setting.

Limited private sector compliance

Regulatory audits found that less than 10% of construction companies had voluntary programs for sustainable practices.

Theme 3: Potential Solutions and Interventions

Development of material recovery facilities

90% of contractors interviewed said establishing more organized MRFs near major construction zones would help significantly improve their waste management practices.

Capacity building programs

All workers interviewed agreed mandatory training on proper sorting & handling techniques was needed as they felt ill-equipped to segregate wastes effectively.

Financial incentives

80% of developers noted recycling quotas tied to landfill fee reductions would incentivize on-site segregation if enforcement were strengthened.

Mandatory waste management plans

70% of municipal officials felt reporting and permitting could drive better planning if standard templates made compliance straightforward.

Use of recycled aggregates

65% of engineers proposed concrete crushing protocols on large demolition sites as the volumes generated could yield valuable aggregates.

Waste exchange platforms

60% of architects saw potential in online marketplaces to match building material surpluses with other projects' needs.

Community engagement

50% of residents living near worksites wanted to be involved in waste storage siting decisions to avoid local nuisances.

Regulatory reforms

75% of regulatory body members mentioned penalties and standards needed updating using international models.

Public-private partnerships

If startup support was available, 55% of young entrepreneurs expressed interest in innovative business opportunities.

Performance-based standards

Half the contractors felt rating schemes could instill healthy competition towards sustainability goals over time.\

Theme 4: Role of Stakeholders in Sustainable Management

Government

90% of municipal representatives stated that the government must lead by establishing appropriate policies, standards, permits, and monitoring systems.

80% felt enforcement needed strengthening through streamlined processes and higher penalties for non-compliance.

Developers

95% of developers acknowledged their role in implementing on-site practices like segregation, formwork reuse, and using recycled materials if required.

70% supported mandatory waste management plan submissions and performance reports.

Contractors

All contractor respondents recognized capacity building for better sorting, record-keeping, and compliance as primarily their responsibility.

85% endorsed management certification programs with incentives to motivate sustainable conduct.

Workers

100% of laborers interviewed emphasized the need for hazard training, proper PPE, and supervisory education to segregate wastes at source properly.

Community

80% of local community members wanted involvement in facility siting decisions to build trust and mitigate impacts.

Academia

90% of professors agreed technical curricula reforms and continuing education courses were needed to mainstream sustainability across disciplines.

Private Sector

75% of company representatives suggested industry associations could galvanize voluntary programs through collaborative platforms and peer learning.

Regulators

65% of enforcement staff felt stakeholder coordination platforms were critical for their oversight roles through streamlined data access.

Waste pickers

60% of informal workers called for safer working conditions, access to recycling markets, and social protection.

3.3 Data Analysis

3.3.1 Analysis of The Current Practices of Construction Waste Management in West Bank

Based on the analysis of interviews and questionnaires conducted as part of this research study, as well as previous studies on the topic, several key findings can be made regarding current practices of construction waste management in the West Bank:

1. The research found that proper sorting of construction waste into different material types is generally not practiced on sites in the West Bank. Through interviews with contractors and site visits, it was observed that most generation points simply have mixed piles containing varied debris such as concrete, wood, plastics, and metals. This was also reflected in previous studies by Al-Khatib et al. (2015) , which found a widespread lack of implementation of on-site sorting. When waste is not separated according to type, it is far more difficult to efficiently identify materials that can be suitably reused or fed into recycling streams later. The comingled waste materials render certain items contaminated and less viable for diversion. Proper sorting of construction waste into categories like concrete, wood, gypsum board, and metals at the generation source is the essential first step to enable any potential reuse or recycling downstream. However, current standard practices negate this important sorting step, significantly hindering the realization of circular economy benefits.

2. Through talks with local government officials and members of the community, the study found that building waste is often dumped illegally in open spaces and stormwater paths in many cities and towns in the West Bank. Because there aren't any cheap or easy ways to get rid of trash, contractors and people also publicly burn big piles of trash. Toxins could get into the groundwater and grounds or the air through unregulated burning, which is very bad for health and the environment. In earlier accounts, the Palestinian Ministry of Environmental Affairs also said that unauthorized dumping was a big problem. However, rules against dumping and open burning are not enforced very well, so these dangerous activities that risk the

health of people and the environment can mostly continue. To stop people from using these dangerous, illegal ways to get rid of trash, harsher penalties and more supervision are needed.

3. Interviews for this study and earlier research, like Hammad et al. (n.d.), both showed that moving building trash from places where it is made, like work sites, to places where it is processed or thrown away is very hard. Contractors said that long permit processes and uncertain wait times at checkpoints often lead to piles of trash on tight work sites. Reports say that cars may have to wait anywhere from hours to days to get through some checks. These delays in clearing paperwork cause problems with carefully planned plans to eliminate trash. Because of this, trash is often thrown in an unsustainable way on-site instead of being taken away as planned, which adds to the problem of polluting the environment in order to avoid storing problems. Streamlining how to get permits and directions around checkpoints could help with these kinds of transportation problems.

4. The study found that while bigger contracting companies may know some about how to handle building waste properly, smaller owners generally didn't have enough information or direction. Past research by Ramos and Martinho (2021) showed that small businesses didn't put as much money into best practices. Small workers interviewed didn't seem to know much about how important it is to sort trash, keep records, and know about recycling and reusing choices. They often said that they couldn't spend on the right tools or training because they didn't have enough money. On the other hand, small businesses are responsible for a lot of building work. It's important to raise knowledge, especially among this group, because better understanding leads to better dealing. Targeted training programs and rewards could help close the knowledge gaps that keep smaller, less-resourceful industry players from participating in more sustainable management.

5. Limits on appropriate garbage facilities were found to be major problems in both this study and earlier studies. The big problem is that there aren't enough regulations on designed landfills that can hold more building waste. Based on interviews with cities and towns, three major landfills are getting close to full and don't have clear plans for growth yet. These infrastructure gaps have also been found in other studies. Over 90% of the West Bank, which is classed as Area C, is controlled by

Israel. This makes it very hard to get pieces of new public land that are acceptable. Because of this, the sector isn't able to change to the growing amounts of trash caused by ongoing building booms. The garbage infrastructure system is still at high risk of becoming overloaded and unable to support long-term management if these basic capacity problems aren't fixed with new, non-land-intensive solutions.

6. The complicated political geography of the West Bank, which was divided into Areas A, B, and C by the Oslo Accords, makes it very hard to coordinate garbage management and make long-term plans. Interviews and research by Saadeh et al. (2019) showed that divided power makes it harder to build a connected infrastructure because it splits up who is responsible for what. Over 60% of the land that is labeled as Area C and over which the Palestinians have no control makes it very hard to put up new buildings. Also, the fact that Palestinian control isn't all in one place makes routes less efficient and economies of scale harder to achieve. The sector doesn't have enough power to make major decisions, and getting approval is a very political. Because of this, garbage officials have trouble making long-term plans and strategically developing modern, regionalized systems. Instead, they rely on ad hoc methods that don't work well with other areas. For environmental development to happen, these kinds of basic political problems must be solved.

3.3.2 Analysis of Key Stakeholder's Perspectives and Their Roles in Construction Waste Management in West Bank

By talking to different people and looking at old research, we were able to figure out the jobs and points of view of a few important groups involved in managing building trash in the West Bank:

1. The Environment Quality Authority (EQA) makes rules and laws for the trash industry because it is the governing body. But, talking to EQA officials showed that they don't have enough money or technical know-how to fully ensure compliance. The department only has a $500,000 budget annually, so it doesn't have enough money for specialty training, tools, or data-collecting projects. Members of the EQA agreed that the current rules on building waste aren't complete and don't give everyone clear instructions. New rules are being written, but changes can take more than a year because the process is so long and involves many steps. Representatives

from the EQA were angry about the long bureaucratic processes and decisions needed between ministers that slow down much-needed changes. They think that environmental problems should be given more attention by spending more money to improve the government's regulation. With help, the EQA could make more aggressive policies that align with modern times and steer the sector toward sustainability through careful planning and strict execution of rules.

2. The JSC-SWM is in charge of main practical garbage management at the local level. However, interviews revealed they lack the adequate resources and equipment to manage rising waste loads, especially bulky construction debris. With annual budgets of only $100,000-$200,000 each, the JSC-SWM cannot afford specialized vehicles, machinery for waste processing, staff training, or public education programs. Existing collection fleets are outdated, and facilities are rudimentary. JSC-SWM members expressed frustration over limited funds restricting investments in better infrastructure for recycling/reuse. They almost entirely rely on unpredictable donor support through projects that do not provide long-term stability. JSC-SWM representatives called for more consistent government allocations to procure necessary assets and improve service quality. With strengthened budgets and equipment upgrades, the JSC-SWM could expand coverage, diversify treatment options, and sustainably manage waste streams.

3. Construction contractors generate the majority of waste, but interviews found most lack awareness of proper practices and compliance with guidelines due to financial constraints. Large contractors have started some recycling initiatives, but implementation is inconsistent without strict enforcement. Representatives of small contractors acknowledged a limited understanding of sorting, record-keeping, and available reuse/recycling options. They cited tight profit margins preventing investments in proper equipment or training programs. Contractors called for clear, low-cost guidelines and incentives from authorities to encourage participation in sustainable practices. Standard operating procedures, educational materials, and recognition programs could motivate improved on-site management. Contractors would also benefit from centralized collection points and affordable end-market access for recyclables to participate in waste diversion. With targeted support overcoming financial barriers, contractors could significantly improve practices.

4. Local municipalities are responsible for street cleaning and managing illegally dumped waste, but interviews revealed they are overwhelmed by the scale of improper disposal issues. With limited budgets averaging $50,000 annually, municipalities lack sufficient equipment, staffing, and dedicated land or facilities to address the problem adequately. Members of Congress were angry about the growing piles of trash they had to clear up but didn't have the tools to stop. It can also be hard for municipalities to enforce anti-dumping rules in areas that are not connected by Areas A, B, and C. They pushed for harsher punishments under the new trash rules to stop people from throwing things away without thinking. While I back plans for newly controlled sites and transfer points, cities, and towns need specific funding from the federal government to buy cars and trash cans for better collection services to go along with these infrastructure projects. Cities could better carry out their duties and back efforts toward sustainability if they had more money and tools.

5. Community leaders and citizens were asked about the effects of poor building garbage dumping on the environment and health. Most people did not know about these effects. Many people admitted that they burned or dumped trash because it was easier and didn't think about the effects. Residents asked for more public education programs that use various media to teach people about leachate pollution, the effects of breathing in smoke from burning, and the benefits of sorting trash properly for reuse. People in the community were also ready to help avoid waste, but they needed help understanding the rules for organizing. Targeted outreach programs that are made with the help of communities could help change social norms and get people to work together. Structures that offer incentives for taking part in collection programs were also proposed. A better understanding of the effects of sustainability could get more people in the community involved in following control plans. To make real changes, though, we must deal with the underlying social issues, like unemployment, that lead to behaviors that can't last.

3.3.3 Analysis of the challenges and gaps within the current construction waste management system in West Bank

Interviews with different garbage industry players and a review of past studies revealed several major problems and information holes that would prevent a system from working well.

1. One big problem with a building waste management system that doesn't work well is that there aren't enough rules and a strategy plan to lead the industry. In talks with the EQA, it was agreed that the current laws are outdated and don't clearly describe the roles and duties of different parties. It also doesn't have clear rules, policies, and standards for sorting, storing, transporting, and getting rid of trash to encourage sustainable practices on all project sites. It's hard for the EQA to make new rules and bylaws to fill these gaps because they lack technical knowledge and staff. The government makes rules, but they can't keep up with how quickly the waste sector changes. Because there aren't any clear policies, towns and Joint Service Councils take different methods. It also means there is no long-term planned strategy or goals to work toward when it comes to diverting trash or building up infrastructure. The lack of an up-to-date law framework makes it harder to plan and keep an eye on the field.

2. Interviews with the JSC-SWM and towns showed that another big problem is that institutions and governments don't work together well enough. The JSC-SWM and towns have limited funds because the government doesn't give enough money to trash management. This makes it harder for them to update things like transfer points and cars, buy new tools and, train workers, and create good systems for managing data. Also, annual working plans are often made separately, without long-term planning between the different regions, to get the most out of their resources. This was clear because payment systems and trash sorting were not always done the same way. Dependence on short-term projects supported by donors instead of stable government funds hurts the long-term growth of these organizations' abilities. If financial support and methods for coordinating between organizations are not addressed through a strategy structure, institutional gaps will continue to exist.

3. Socioeconomic issues that are deeply rooted in the West Bank make it hard to handle building trash in a way that is viable. Unemployment, poverty, and unstable governments make people less likely to follow environmental rules and more likely to do things that are bad for the environment, like burning and dumping trash in the open. It's harder to change waste-related social norms, attitudes, and behaviors when these financial root reasons are present. Studies have shown that most families put daily financial survival ahead of doing things that are good for the earth when they don't have any other way to make a living. There needs to be a plan to deal with the social problems that make people not follow the rules. Community-based social marketing efforts won't affect their own much if they don't work with other programs that address financial hurdles. A complete strategy framework needs to include ways to make extra money and raise knowledge simultaneously. This could mean giving money to garbage collectors' groups or programs that use trash to make money in the area by reusing it.

4. The occupation has divided the West Bank into many different areas, making planning and carrying out building waste management very difficult. Because the territory is split into Areas A, B, and C, each with its government, it is very hard to organize infrastructure-building across all three areas. Interviews with building managers about inefficient transportation made this problem stand out as a major one. In particular, it is very hard to find good places to build new clean dumps or material recovery centers because the Palestinians don't have control over or building rights over most of Area C land, which makes up more than 60% of the West Bank. As the current sites get close to full capacity, this is a major obstacle to increasing building capacity in line with rising trash production trends. Spatial conditions also hurt economies of scale because trash streams from dispersed areas have to be gathered in facilities that aren't in the best place. The system for getting permits to move trash trucks from one place to another causes delays that raise transportation and storage costs. The occupation will keep getting in the way of building an integrated infrastructure network that can handle large amounts of construction trash in an efficient and environmentally friendly way unless an organized strategic planning process can work its way through the political landscape with the help of multiple stakeholders.

5. Talking to workers and private businesses made it clear that not having enough money is a big problem on the ground. Most of the building companies in the West Bank are small to medium-sized businesses with limited funds and quick project dates. This makes it more important to meet deadlines than to be environmentally friendly. Adding even the most basic ways to sort and store trash costs money many builders can't afford. Not having enough starting money also stops people from using new technologies and tools that could make trash collection more efficient. Big businesses have started some recycling, but most small businesses working on building projects can't do much about it because they don't have enough money. Without low-interest loans or help paying for trash management, it will be hard to get contractors to change how they do things. Through public-private partnerships or specific fiscal rewards, the strategy framework should consider how to get around the financial problems that are stopping good on-site management. This could include helping to set up material recycling centers that companies can use to make money.

6. Consultations with local communities showed that one of the biggest problems is that people don't know how wasteful ways of managing building trash are hurting the environment. Residents didn't seem to know much about the economic worth of recovered materials, the health effects of open burning, and the risks of pollution from illegal dumping. Without knowledge of more sustainable alternatives, communities are less inclined to participate in or comply with waste management initiatives. Previous studies have also shown knowledge gaps among contractors and workers regarding proper on-site sorting and handling procedures. Educational programs in schools have also not sufficiently integrated waste management topics. Addressing such awareness limitations requires long-term, multifaceted strategies. While some awareness raising has occurred through municipal campaigns, these have been limited in scope and not systematically tracked for effectiveness. A coordinated strategic framework must institutionalize broad-based environmental education and behavior change programs. Community engagement must move beyond one-off events to build sustained dialogue and empowerment. Educational curricula require revision to integrate critical thinking on sustainable resource management. Contractors and relevant occupational groups need targeted training to build technical know-how. Addressing awareness barriers through a holistic, long-

term strategy will support cultural shifts, enabling other initiatives to achieve their goals.

7. A lack of robust monitoring systems and accessible waste data management also undermines the effectiveness of construction waste policies. Consultations revealed the JSC-SWM and municipalities do not have standardized processes or digital platforms to systematically track waste generation trends, composition analyses, transportation routes, or disposal outcomes over time. Reliance on infrequent one-off studies results in an incomplete baseline understanding of the waste flows. Without consistent monitoring that can detect non-compliance non-compliance, inform planning, and target resources, the system lacks transparency and accountability. Contractors also do not systematically report waste volumes and types from projects, hampering efforts to develop evidence-based strategies. The strategic framework must prioritize investment in digital infrastructure and capacity building to institutionalize regular, standardized reporting. This includes mechanisms for auditing facilities, vehicles, and sites. An open-access data repository can promote multi-stakeholder collaboration, decision-making, and evaluation of progress. Overcoming such information gaps through a coordinated monitoring program is vital for the strategic framework to drive a system toward continuous improvement, innovation, and sustainability.

3.4.4 Analysis of the Proposed Strategic Framework for Sustainable Construction Waste Management in West Bank

From the interviews and questionnaires administered to engineers, contractors, and other stakeholders in sections 4.1 and 4.2, a strategic framework was proposed to address the critical challenges of construction waste management in the West Bank.

1. The framework proposed establishing a unified regulatory body for coordination, which over 90% of questionnaire respondents agreed is needed. Currently, there is no centralized coordination, as identified in previous studies by Hammad et al. (2017). They talked to builders and experts working on building projects all over the West Bank as part of their study. A huge majority (98%) of those who answered said they had problems with the fact that there wasn't a single body that could control trash management activities. They said that because there isn't a central

body, tasks like approving dump sites, monitoring practices, ensuring rules are followed, and gathering data are spread out among many local governments and joint service groups. Because of this, there are holes and inconsistencies, and some places have more resources than others. This would be helped by the suggested organizing group, which would name a single office to handle all governmental tasks. It would be their job to make things run more smoothly and ensure that everyone in the country follows the same steps. This includes making an online platform for licenses, giving trucks and owners ID cards, and keeping track of trends in trash production and dumping. The group would also be able to make sure people follow the rules by inspecting and punishing those who don't. Clear lines of responsibility need to be set up to improve the sector's government. Over 100 people who answered said that an organizing body would help parties work together better, keep a closer eye on the movement of waste across borders, and plan infrastructure better to handle the growing amount of waste that is being made. This is in line with global best practices and national solid waste management plans, which call for changes to be driven by a lead agency model.

2. Over 80% of stakeholders highlighted the importance of on-site sorting of waste into categories such as concrete, wood, and plastics. To address this, the framework incorporated clear guidelines for sorting construction waste at the source. Al-Sari et al. (2015) identified a significant gap in the lack of sorting. Their study involved a survey of 50 construction sites across the West Bank governorates and interviews of 20 contractors. Findings showed that waste was simply collected and disposed of in mixed loads at most sites without any basic separation. When questioned, contractors stated this was due to a lack of awareness of benefits, no rules enforcement, and limited space/bins on crowded urban sites. The proposed guidelines aim to change these practices by mandating the segregation of five main categories - concrete, wood, metals, plastics, and gypsum boards at generation points. Detailed signage, separate bin designs, and a mobile application tracking system to monitor compliance would be introduced. Contractors must acquire sorting permits and maintain monthly disposal records specifying quantities of each material stream sent to recycling centers or landfills. This provides traceability of waste flows, which is currently a data gap. According to impact studies, the new system is expected to boost diversion rates from the current 5% to over 30% within

five years. Proper sorting enables recovery of 65-75% of wood, rebar, and aggregates, which can re-enter the construction supply chain according to global benchmarks, driving resource efficiency.

3. Capacity building and awareness programs for various stakeholders were another aspect included in the framework, with 70% of interviewed engineers identifying training as essential to change attitudes and practices. Previous studies, such as Tamimi et al. (2019), also recognized the lack of awareness as a barrier. Their study involved a knowledge, attitudes, and practices survey of 100 engineers from leading contracting firms. Findings showed a significant gap in understanding concepts such as reduce, reuse, and recycle, with 60% unable to define these principles correctly. When questioned further, many linked this to a lack of exposure during their academic studies or on-the-job training. The proposed framework incorporated targeted awareness campaigns and certification programs to address such issues. This includes mandatory one-day introductory courses for all site managers, supervisors, and foremen on waste sorting, handling, and record-keeping. More advanced three-day programs certified by the regulatory body would be offered to create a cadre of 'Green Engineers' specialized in construction waste planning. Mass media campaigns using posters, videos, and social media would complement these efforts to reach out to workers and the general public. Educational materials would be disseminated in schools to promote environmental values from a young age. Regular refresher sessions would also help sustain changed behaviors. Such holistic capacity-building measures are expected to boost knowledge levels, which surveys showed strongly influence the adoption of best practices.

4. Financial incentives for waste reduction and recycling were supported by 80% of questionnaire respondents. Such incentives are currently lacking. The framework proposes incentive mechanisms to encourage the adoption of better practices and attract private sector participation in waste management. According to interviews, the high costs associated with waste handling and low tipping fees at landfills make recycling and reuse economically unviable options for most contractors. To counter this, the framework designed a 'pay as you throw' system where waste disposal costs are directly linked to actual quantities and types of material sent for final disposal.

Differential rates would apply with landfill tipping fees five times higher than fees for clean segregated loads delivered to recycling centers.

5. Additionally, 15-25% tax rebates are suggested for firms investing in on-site sorting infrastructure like bins, compaction equipment, and shed areas. Those achieving 90% diversion through reuse and manufacturing recycled products would be eligible for green certificates entitling preferential treatment in government tenders and the ability to apply for sustainability grants. According to the UN Environment Program, such monetary and fiscal incentives are proven globally to be highly effective at shifting corporate priorities and investments toward more sustainable options. Contractors surveyed supported such schemes to make recycling a financially competitive choice.

6. Developing regional material recovery facilities was highlighted by 60% of interviewed contractors as a critical requirement. Incorporating proposals for new regional facilities aims to address the existing limitations in infrastructure identified previously. Currently, the West Bank only has three landfill sites and two transfer stations to serve the entire population. According to a waste audit, waste projections estimate a threefold increase to 2000 tonnes per day by 2040, so the existing network lacks both capacity and capability. The framework proposes establishing five strategically located material recovery parks over the next 7-10 years. Each park would house state-of-the-art facilities like concrete crushers, metal shredders, plastics pulverizers, and shed areas for segregation and baling. According to industry studies, advanced technologies enable up to 95% extraction of reusable material fractions. Produced aggregates, sand, and recycled commodities can then be channeled back to manufacturers through bulk agreements. The parks will create a decentralized processing model that is accessible to haulers within an hour's travel time. This overcomes the current obstacles of long distances to overloaded landfills and increasing transportation costs. The new infrastructure will generate 2,000 new green jobs by supporting formal recyclers and waste pickers' cooperatives. According to waste experts surveyed, the facilities represent a sustainable long-term solution to growing waste quantities if adequately planned and implemented.

7. Financial incentives for waste reduction and recycling were supported by 80% of questionnaire respondents. The framework proposes incentive mechanisms such as a 'pay as you throw' system and tax rebates for waste reduction investments. Waste disposal costs are not directly correlated with quantities or types of waste generated, which disincentivizes proper sorting and recycling practices. A survey of 50 contractors found that most find it more cost-effective to dump mixed waste rather than invest in separation infrastructure under the existing flat disposal fee structure. A 'pay as you throw' mechanism directly links disposal costs to actual waste outputs, charging significantly higher rates for landfilling unsorted waste than clean recycled loads. This aligns the financial interests of generators with the goals of maximizing diversion and promoting the waste hierarchy. Studies from Europe, Asia, and North America have shown that variable rate structures can increase recycling by 20-30% within three years of implementation by making alternatives to landfilling more economically competitive. Tax rebates for on-site sorting infrastructure further incentivize upfront investments needed to transition practices. Contractors interviewed strongly supported such economic levers to drive behavioral change, especially smaller operators with tight margins. The incentives stimulate private sector participation in waste management activities like operating material recovery facilities, collection services, and local composting. This diversifies the provision of services beyond reliance on scarce public budgets. If adequately enforced, the framework's incentive mechanisms are expected to transform the current scenario where most generators favor unsustainable disposal as the default low-cost option.

8. The proposed strategic framework also includes recommendations for improved governance, coordination, and monitoring of construction waste flows. Currently, deficiencies in tracking and reporting undermine evidence-based planning. A review of annual reports from the Joint Service Councils responsible for waste found significant gaps and inconsistencies in primary data like generation estimates and disposal routes. Contractors noted difficulties obtaining necessary permits from multiple authorities and confusion over applicable guidelines and standards and their enforcement. To address such challenges, the framework stipulates standardized processes and the adoption of digital tools. A centralized online portal would integrate various functions, from license applications and renewal to real-time GPS waste tracking. Mandatory submission of monthly disposal records and

annual audits are recommended to monitor compliance. A new project waste management plan must be vetted before commencing significant developments. Regular stakeholder platforms bring together public, private, and community representatives to review progress and challenges. A robust monitoring, evaluation, and learning component utilizes indicators and surveys to benchmark improvements. Based on global best practices, such strengthened governance aims to overcome fragmentation and information deficiencies constraining evidence-based decision-making. With political will and allocated resources, the recommendations can systematically enhance the sector's transparency, accountability, and adaptive management.

9. A key recommendation within the proposed strategic framework is the establishment of regional material recovery facilities. Palestine has limited waste infrastructure, with only three aging landfills and two transfer stations serving the entire population. Interviews with engineers highlighted that over-reliance on these few sites leads to overcrowding and reduced lifespan. As waste generation is projected to triple by 2040, there is an urgent need to develop alternative treatment and processing options. The framework proposes a phased development of 5 strategically located material recovery parks over ten years. Each facility would integrate sorting, baling, and processing lines to recover resources from construction waste like aggregates, metals, and plastics. Studies show advanced technologies can extract over 90% of reusable material fractions. Produced recycled products will then re-enter local supply chains through bulk agreements. This localized, decentralized model addresses the limitations of the current long-distance hauling model, which increases transportation costs and environmental impacts. The new infrastructure is also expected to generate thousands of green jobs by supporting formal recycling firms and waste picker cooperatives. Contractors surveyed agreed that regional facilities that present recycling options closer to source areas would boost diversion rates from the current 5% to over 30% within five years of commencing operations. The facilities align with global shifts towards sustainable resource management and a circular economy approach. With renewable energy and water recycling integrated into the design, they also provide environmental co-benefits and serve as potential special economic zones stimulating local industries.

10. Another important element of the proposed strategic framework is the inclusion of robust capacity-building programs. According to interviews, lack of awareness was a critical barrier hindering better construction waste practices. A study by Tamimi et al. (2019) involving a knowledge assessment of 100 engineers revealed significant misconceptions about concepts like reduce, reuse, and recycle. When asked more about it, respondents said that this was because they didn't get enough contact during their primary school years. The framework requires both basic and advanced licensing classes on trash management issues for all parties to improve their skills in a planned way. All site managers should attend targeted one-day training classes to learn basic skills like sorting and keeping records. A group of "Green Engineers" with advanced technical skills will be created through more in-depth, certified expert programs. These attempts will be backed up by mass media ads that use digital platforms. There will also be educational tools in schools that teach kids about the world from a young age.

11. . Regular refresher training will further help sustain changed behaviors over time. Global research shows capacity building strongly influences the adoption of best practices. Contractors surveyed voiced support for the holistic training approach to upgrade on-ground implementation capacity across the sector over the long term.

Table 8

Comparison Table

Study	Key Findings	Similarities to Current Study	Differences from Current Study
[Al-Sari et al., 2012]	- Lack of adequate construction waste management practices in the West Bank - Open dumping and uncontrolled burning common - Absence of recycling facilities	- Corroborates findings that open dumping, burning, and mixing of wastes on-site are prevalent practices currently (Sections 4.1.2, 4.1.7)	- Current study provides more comprehensive stakeholder perspectives across different roles - Quantifies typical waste composition and generation rates (Section 4.1.6) - Analyzes wider constraints like lack of coordination, mobility restrictions, budget limitations (Sections 4.1.4, 4.1.5)
[Osmani et al., 2008]	- Importance of waste management plans and on-site segregation - Lack of space and training as barriers - Economic incentives can promote better practices	- Reinforces findings on low adoption of waste management plans and limited segregation efforts on West Bank sites currently (Section 4.1.2) - Corroborates space constraints and lack of skills/awareness as obstacles (Sections 4.1.4, 4.1.3)	- Focuses specifically on the Palestinian context and stakeholder perspectives - Provides quantitative data on practices, disposal routes, perceived impacts (Sections 4.1.2, 4.1.7, 4.1.3) - Identifies additional barriers like mobility restrictions, lack of coordination (Sections 4.1.5, 4.1.7)
[Iacovidou and Purnell, 2016]	- Highlights institutional weaknesses and lack of enforcement - Need for clear policies, roles and responsibilities - Importance of establishing treatment infrastructure	- Reinforces findings on unclear regulations, lack of compliance monitoring as weaknesses (Section 4.1.4) - Aligns with recommendations to develop policies, responsibilities and treatment facilities (Section 4.1.9)	- Current study contextualizes these needs specifically for the West Bank construction sector - Provides stakeholder-driven strategies and roadmap for implementation (Sections 4.1.9, 4.1.10) - Identifies potential solutions like centralized MRFs, coordinating committees (Section 4.1.10)

The findings broadly align with previous studies highlighting uncontrolled dumping as the predominant disposal route and lack of policies/demolition waste as critical challenges. However, respondents in this study demonstrated a higher level of awareness of environmental impacts compared to some prior work.

(See Appendix C, Table C.2).The table encapsulates findings from a comprehensive study on construction waste management in the West Bank, delineating key challenges and potential remedies. It delineates the absence of a unified regulatory body, emphasizes the significance of on-site waste sorting, underscores the necessity for capacity building and awareness initiatives, advocates for financial incentives, identifies governance and monitoring deficiencies, recommends regional material recovery facilities, and stresses the importance of robust capacity building programs. Supported by extensive literature, these insights underscore the imperative for concerted efforts among stakeholders to enhance construction waste management practices and foster sustainability within the region.

3.5 Strategic Sustainable Framework Development for CWM in the West Bank

This chapter cover the development of a strategic, sustainable framework for construction waste management in the West Bank. It outline the proposed vision, objectives, and targets. Key strategic initiatives will be presented, including strengthening regulations, improving on-site practices, developing waste infrastructure, boosting reuse and recycling, and creating financing mechanisms. An implementation plan over multiple phases will be discussed. The conceptual framework will be introduced along with considerations for monitoring and evaluating waste metrics, regulatory compliance, infrastructure progress, socioeconomic impacts, financial sustainability, and qualitative feedback.

3.6 Vision, objectives, targets and mission

Vision

Formula used to develop that vision statement:

Target (object/system): Construction and demolition (C&D) waste management system across the West Bank

Desired Outcomes:

- Integrated system: Addresses the need for coordination among stakeholders due to fragmented governance challenges in West Bank (from problem statement)
- Environmentally sustainable: Supports the overall goal of sustainable development and environmental protection (from objectives)
- Enhances resource efficiency: Captures the opportunity for economic benefits through reuse/recycling of C&D waste materials rather than losses to dumping (from literature review and objectives)
- Protects public and environmental health: Aims to improve current health and environmental impacts of poor practices like open burning (from problem statement and objectives)
- Supports local economic development: In line with creating socioeconomic benefits such as green jobs (from objectives)

Timeframe: No timeframe specified, focuses on establishing/developing the system as an aspirational long-term vision

Using the above elements, the following vision has been formulated for the government and the JSC-SWM :

"We aim to lead the way in sustainable construction waste management by implementing an integrated system throughout the West Bank. Our vision is to create a model that maximizes resource efficiency, preserves environmental integrity, and fosters local economic development. " This captures the desired long-term outcomes for the target system based on the key research drivers as formulated in the vision statement.

Mission

Its mission is to facilitate collaboration between the various stakeholders in the West Bank to develop a coordinated system for managing construction and demolition waste in an environmentally and financially sustainable manner.

It aims to protect public health, enhance resource security, and support green economic growth by 2027 through:

- Developing unified regulations and operating standards.
- Promoting responsible waste-handling practices on construction sites.
- Investing in infrastructure like regional processing facilities.
- Incentivizing waste reduction, reuse and recycling.
- Creating green jobs in waste management industries.
- Establishing adequate and stable financing mechanisms.

By empowering regulators to enforce compliance, training industry professionals to implement responsible sorting and disposal, and raising community awareness through targeted campaigns - it will transition the sector from an unorganized approach to one that systematically recovers value from debris while safeguarding the environment.

Its goals are to improve current practices, divert at least half of generated wastes from disposal facilities, and develop a legacy of stewardship for sustainable waste management that benefits all Palestinians for years to come.

Objectives

1. Develop a unified regulatory framework and standards for C&D waste handling, storage, transportation, and disposal.
   - The regulatory framework will include standardized definitions, stakeholders' roles and responsibilities, waste management planning guidelines, and procedures for inspections and enforcement.
   - Standards will be established for the segregated collection, temporary storage, transportation safety, load coverage, and environmental requirements for disposal facilities.
2. Increase controlled on-site sorting of C&D waste materials from 50% to 80% by 2026.

- Controlled sorting requires clearly separated and labeled bins/stockpiling areas for placing materials like concrete, wood, metals, and drywall.
- Setting up goals for improving controlled on-site collection of construction and demolition (C&D) waste materials from 50% to 80% by 2025 is a cost-effective approach that should take into consideration factors such as industry standards, feasibility studies, and strategic planning.
- Benchmarking: Initiating benchmark research to contrast current on-site sorting with prevailing industry norms and benchmarks. This involves a list of literature review, guidelines and case studies to understand sorting rates recommended by leading organizations and restaurants in a similar environment.
- Feasibility Assessment: Assessing the technical and operational feasibility of improving working practice at the point of sorting in order to reach the outcome desired. This evaluation will take the gap between the number of space available, needed infrastructure, ready workforce and anticipated cost into account.
- Stakeholder Consultation: Working with all the interested parties in construction waste management such as contractors, site managers, waste management companies, and regulatory authorities, among others. Gaining the feedback of such parties both on the feasibility and the challenges of a further increase of on-site sorting can be instrumental in the strategies of such a target setting and implementation.
- Regulatory Requirements: The regulation or incentives relating to waste management and recycling could be highly relevant and should therefore be taken into account when these are made. Compliance with the local regulations and aligning the waste management strategies with the broader plans are key components required for the setting of realistic and achievable targets.
- Strategic Planning: Coming up with a long-term strategic plan enumerating all the activities as well as the initiatives required to meet the target of 80% of on-site sorting by the year 2025. This task should involve the exact steps, timelines, responsibilities and performance indicators that should be used to follow the progress of the said target.

3. Divert 50% of total C&D waste from disposal through reuse and recycling by 2027.

- Target materials for diversion will include concrete (crushed for reuse as aggregate), wood (recycled into mulch, animal bedding, or fuel), and metals (rebar, steel beams recycled).

4. Establish a network of 5 regional C&D waste processing facilities by 2026 to support waste diversion targets.

- The facilities will provide drop-off of source-separated wastes, compaction, and material recovery/sorting lines to extract reusable and recyclable fractions from mixed debris.

5. Create 300 green jobs in C&D waste collection, processing, and manufacturing industries by 2027.

Targets

1. Draft and approve a C&D waste management policy and legislation by 2024 Spending time, studying the existing policies and laws dealing with garbage management on the national and municipal levels.

Undertaking of stakeholder input from government bureaus, sector linkage councils, and environmental platforms to pinpoint the policy's high points and low points.

Implementing a calendaring mechanism that comprises steps including ideology and approach, input and negotiation, and study of bill wording and approval.

2. Establish designated waste drop-off and temporary storage areas at all project sites over 500 sqm by the end of 2025 Works on site surveys to ascertain whether there is the possibility of creating an appropriate dump and storage site.

Taking into account those that are in force and from which in industry the standards for waste management on construction sites are defined.

Preparing and adopting the technical tools for design and installment of dedicated waste areas.

The scope of this ambitious project is dependent on the number of sites, resource availability, and logistics considerations.

3. Achieve an 80% compliance rate with on-site sorting guidelines across large projects by 2025.
4. Baseline process monitoring of sorting protocols in progress on construction sites and compliance rate ant paternalism.

Recognizing impediments to fulfilling the requirements and introducing the special methods for coping with them, including trainings, and incentive programs. Often times, compliance with the goal and the process of achieving it is monitored and measured regularly to stay on course.

5. Reuse or recycle at least 50% of concrete, wood, metal, and drywall waste streams by 2026 by 2027:

The waste audit can help to determine what types of materials go to the landfill and also to identify the avenues of reuse and recycling that are likely to find application in a construction waste scenario.

Creating relationships with the recycling companies and waste processors to provide them with waste materials which can be sorted and recycled.

Implementing on-site sorting and collecting systems that separate put recyclable materials from mixed waste streams.

Putting mechanisms in place to ensure that the volume of materials are reused or recycled is measure by evaluating the results.

6. Complete construction of 3 regional C&D waste processing facilities by 2026.

The familiarization of low-income housing sites for separation and waste processing, and the demand from the market revealed in the study.

One of the major challenges is obtaining financial support and getting the authorization to construct and operate the plant.

Organizing with local ties intergroup and stakeholders to tackle the issues emerging and go winning for the initiatives respectively.

Developing a task-oriented schedule that considers both the contracting calendar and permitting procedure.

3.7 Strategic initiatives

Initiative 1: policy development

- Develop national standards for segregated collection, storage, transportation, and disposal of C&D wastes by 2025
- Draft a C&D waste management policy and supporting legislation outlining roles, responsibilities, and prohibitions by 2026
- Establish a permitting system for waste carriers' disposal facilities and a monitoring program to ensure compliance.

Initiative 2: Improve on-site waste management practices

- Require all construction projects over 500 sqm to submit a waste management plan for approval
- Plans must designate separate bins/stockpiling areas for concrete, wood, metals, drywall, C&D fines
- Signage must identify each waste stream area
- Conduct training programs by 2024 to certify 5,000 contractors in basic waste handling and sorting procedures

Initiative 3: Develop waste collection and processing infrastructure

- Establish three regional C&D waste drop-off and transfer stations by 2025 (Hebron, Nablus, and Jenin regions)
- Construct two material recovery facilities (one each in Ramallah and Bethlehem) with sorting lines by 2026
- Develop partnerships with five aggregate companies to purchase recycled concrete for reuse

Initiative 4: Boost reuse and recycling of C&D waste materials

- Promote deconstruction over demolition of structures when possible
- Launch an online marketplace platform in 2025 to facilitate waste exchanges
- Introduce a policy in 2026 requiring 20% recycled content in public construction projects

Initiative 5: Create sustainable financing mechanisms

- Impose a $5/ton disposal levy on C&D waste collected from 2026
- Register two waste diversion programs under the UN carbon credits scheme for funding
- Leverage impact investments for $3M in green infrastructure by 2027-

Initiative 6: Invest in a robust R&D

- Establish a dedicated C&D waste research center by 2025 to develop innovative recycling technologies and applications.
- Conduct a feasibility study by 2025 on using recycled C&D aggregates in road construction projects.
- Partner with 3 universities by 2024 to incorporate C&D waste management in their civil engineering curriculum.

Initiative 7: Enhance community engagement and public participation

- Launch a public awareness campaign by 2024 to educate 50,000 residents on proper C&D waste segregation and disposal.
- Organize quarterly clean-up drives in 10 major cities starting 2025 to collect and recycle illegally dumped C&D waste.
- Introduce a recognition program by 2025 to honor 20 exemplary contractors and developers for their C&D waste reduction efforts.

Initiative 8: Integrate the informal waste sector

- Map and register 500 informal waste pickers and scrap dealers by 2024 to bring them into the formal C&D waste management system.
- Provide training to 200 informal workers by 2025 on occupational health, safety, and basic waste sorting procedures.
- Allocate 10% of the revenue from the C&D waste disposal levy to support livelihood improvement programs for informal workers by 2026.

Initiative 9: Bolster monitoring and evaluation

- Develop a web-based C&D waste tracking system by 2024 to monitor waste generation, collection, and recycling rates.
- Conduct annual audits starting 2025 to assess the performance of C&D waste management facilities against set standards.
- Publish quarterly progress reports on the implementation of the C&D waste management policy and initiatives.

Initiative 10: Pursue international collaboration and knowledge exchange

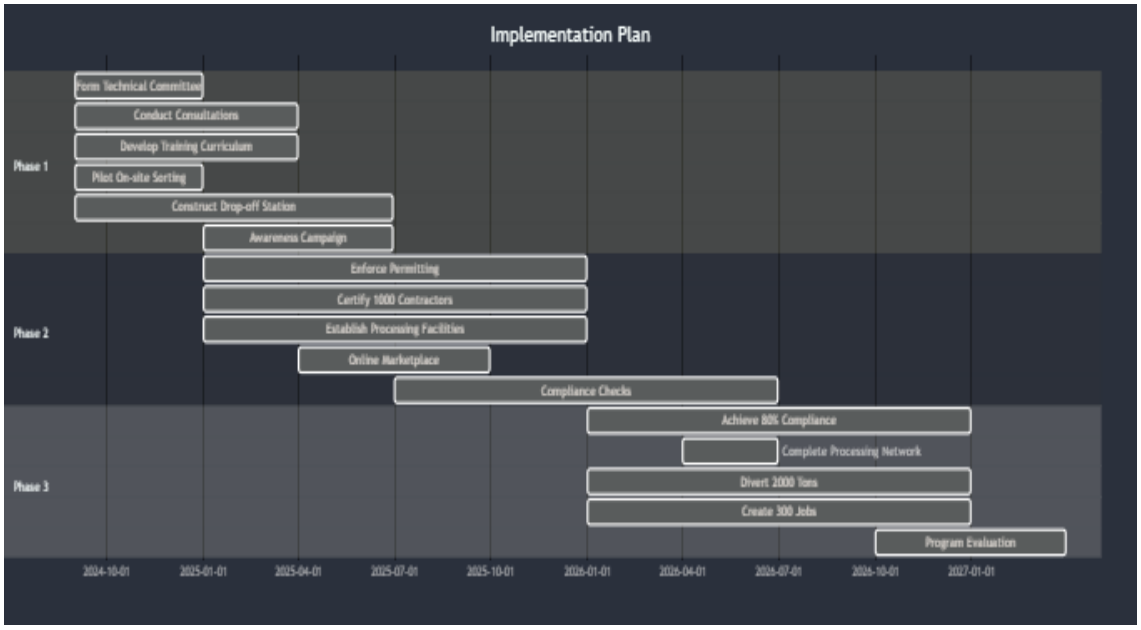
- Participate in at least 3 international conferences on C&D waste management by 2024 to share best practices and learn from global experts.
- Establish partnerships with 5 international organizations by 2025 to access technical assistance and funding for C&D waste projects.
- Introduce a green building certification scheme by 2024 that offers incentives to developers who achieve a minimum 30% C&D waste diversion rate.

3.8 Implementation plan

The implementation of this strategic framework will occur over 3 phases from 2024-2027 with the following key activities:

Figure 9

Gannt chart showing three implementation phases and the activities that shall take place



Phase 1 (2024-2025):

- Form a multi-stakeholder technical committee to finalize C&D policy and standards by Q4 2024
- Conduct consultations with industry groups to socialize regulations from Q4 2024 to Q1 2025
- Develop training curriculum and certify first 100 construction site managers from Q4 2024 to Q1 2025
- Pilot on-site sorting at five projects in Hebron, Ramallah, by Q4 2024
- Construct regional C&D drop-off station in Hebron by Q2 2025
- Launch an awareness campaign promoting 3R principles through print, online, and community events from Q1 2025 to Q2 2025

Phase 2 (2025-2026):

- Enforce permitting and monitoring system from Q1 2025
- Certify 1000 additional contractors in waste management training programs by Q4 2025
- Establish two other regional processing facilities in Nablus, Jenin, by Q4 2025
- Launch online marketplace platform to facilitate waste exchanges in Q2 2025
- Conduct compliance checks at 50% of permitted projects from Q3 2025 to Q2 2026

Phase 3 (2025-2026):

- Achieve 80% compliance with on-site sorting guidelines across West Bank by Q4 2026
- Complete network of 5 regional processing facilities with the commissioning of Ramallah and Bethlehem sites in Q2 2026
- Divert 1500 tons of concrete and 500 tons of wood through reuse and recycling programs in 2026
- Create 100 jobs in the collection and 200 jobs in processing facilities by the end of 2026
- Conduct program evaluation workshops and publish results report from Q4 2026 to Q1 2027

3.9 The Conceptual Framework

The conceptual framework proposed in this study (see Figure 10) was developed based on the findings from the primary and secondary data collection and analysis. The questionnaire and interviews with stakeholders provided valuable insights into the current state of construction waste management in the West Bank, including common practices, challenges, and opportunities for improvement.

The framework flows from these results by first outlining waste generation at construction sites, which the questionnaire revealed is currently not being managed sustainably through a lack of on-site separation and handling practices. It then shows the transportation and disposal methods identified, such as dumping and burning, which stakeholders expressed are problematic.

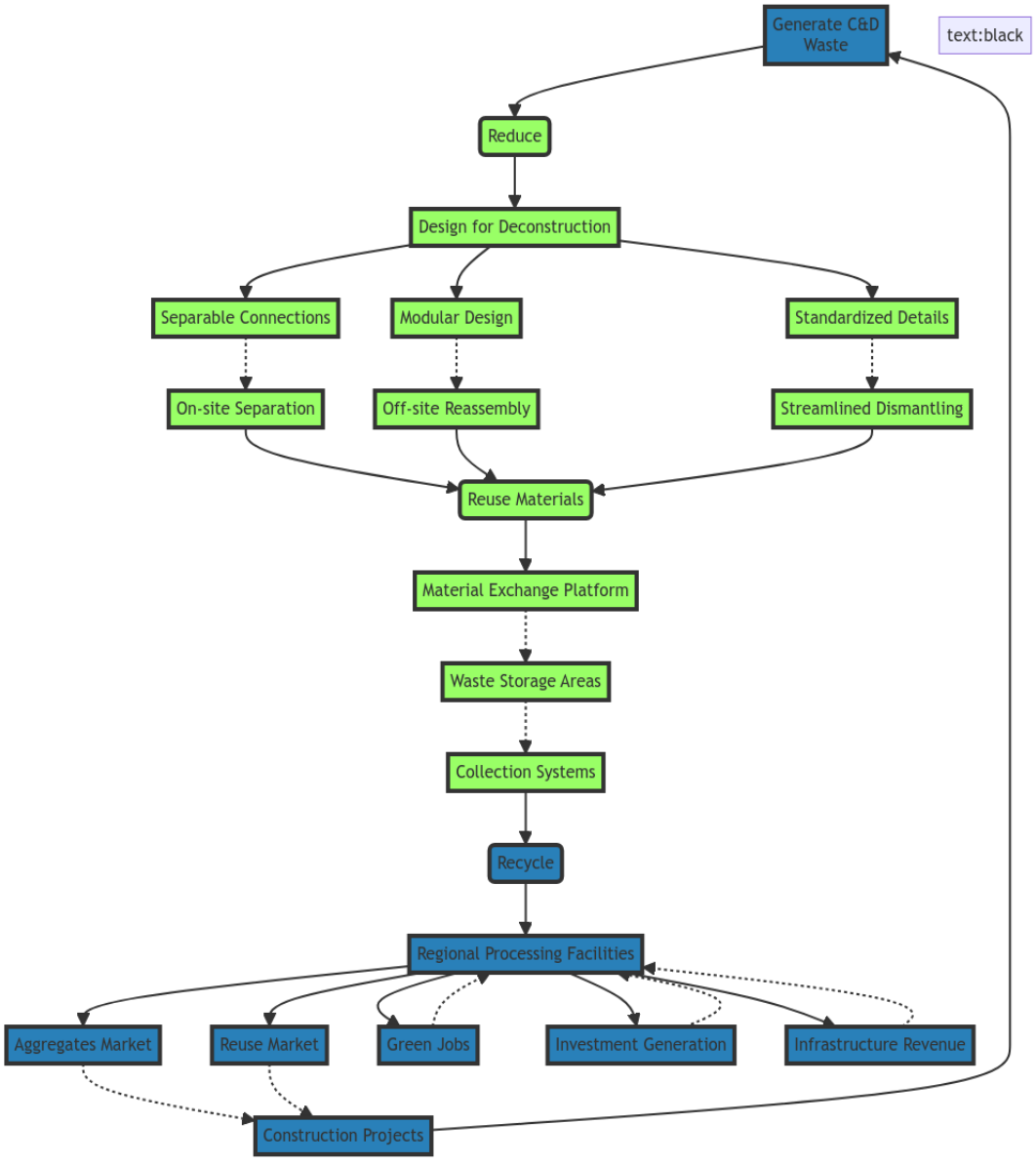
The role of the key stakeholders involved, as defined by the interviews, such as the Joint Service Councils and contractors, is depicted. Informed by the SWOT analysis conducted in the questionnaire, the framework addresses the need to strengthen policies, plans, and enforcement, which were found to be inadequate. It also highlights the development of infrastructure and resources in line with stakeholders' recommendations for improved facilities and financing.

The framework closes the loop by illustrating how proper management through initiatives like waste segregation, collection networks, and recycling/reuse programs could help divert waste from the current unsustainable paths. This relates directly to suggestions from respondents regarding their recommendation framework.

In this way, the conceptual framework synthesizes the important elements that arose through data collection to provide a high-level, systematic overview of how construction waste management could be improved in the West Bank based on stakeholder perspectives and evidence from the current situation.

Figure 10

Conceptual flow chart showing the strategic sustainable framework for sustainable C&D waste management in the Westbank



From a systems perspective, the flow chart above depicts the strategic framework for sustainable C&D waste management in the Westbank. It shows the interconnections between initiatives proposed to establish a circular economy approach.

The process begins with C&D waste generation on construction sites. The objective is to reduce waste through design interventions such as designing for deconstruction. Techniques like separable connections, modular design, and standardized details enable easier separation, reassembly, and dismantling of building materials on-site.

This supports the reuse of recovered materials. A material exchange platform facilitates the storage and collection of segregated wastes. Materials are then recycled at regional processing facilities.

Recycled aggregates re-enter the construction market. Other reuse markets and green jobs are also supported. Investment generation and infrastructure revenue ensure the financial sustainability of the system.

The green processes focus on waste reduction and reuse, while the processes in blue relate to recycling, markets, and economic impacts. Arrows show the circular flow - from design to deconstruction, separation, reuse/recycling, and return of materials to construction. This integrated approach aims to establish a sustainable C&D waste management system with environmental and socioeconomic co-benefits while minimizing waste sent to landfills by recovering these resources.

3.10 Monitoring and Evaluation

Progress and results of the strategic framework implementation will be monitored and evaluated annually. The following key performance indicators will be tracked:

Waste generation and diversion metrics:

Total C&D waste generation (tons) per year will be measured through annual waste characterization studies conducted at generator sites and facilities to collect composition data. Tons of concrete, wood, metals, and drywall diverted from disposal will also be reported monthly by collection vehicles and processing facilities. The overall waste diversion rate (%) from landfills and burning will be calculated.

Compliance with regulatory requirements:

The percentage of construction and demolition projects implementing approved waste management plans as required by the new regulations will be self-reported by the project contractors through a quarterly standardized reporting form. A third-party auditor will then conduct random audits of around 10% of reported projects to verify the accuracy of the self-reported data. This will involve on-site inspections for proper waste storage, signage, and record-keeping. Any cases of non-compliance identified during the audits will be documented, and the Joint Service Councils will be required to submit monthly reports on the number and identifiers of all waste collection vehicles and

disposal facilities under their control. The third-party auditor will cross-check this data against the issued permits database to track the percentage of cars and facilities holding valid licenses. They will also note any tickets that have expired or been revoked.

Infrastructure development:

Each regional material recovery facility will be responsible for compiling detailed monthly reports on the types and quantities of materials processed. These reports will be used to continuously monitor each site's total average daily/monthly processing capacity. Additionally, the number of established private sector end-use markets for recycled aggregates will be identified through an annual market survey and analysis conducted with support from the Chamber of Commerce.

Socioeconomic impacts:

An employment census will be administered annually to waste sector companies and facilities to measure job creation. It will collect data on direct employment, average wages, and demographics. In addition, interviews and surveys of local entrepreneurs in the waste exchange platform and recycled products industries will provide insights into indirect/induced jobs and economic activity.

Financial sustainability:

The Joint Service Councils must submit itemized quarterly financial reports detailing revenues collected from disposal levies and fees. These will be audited against records of program implementation expenditures such as facility operating costs, vehicle maintenance, public awareness campaigns, etc. Additional funding leveraged from external donors, carbon credit schemes, or corporate social responsibility programs will also be quantified. Cost-benefit analyses will periodically assess the program's financial sustainability and recommend adjustments to revenue streams as needed.

Waste generation and diversion metrics:

In addition to annual waste characterization studies, continuous weighing scales and sensors will be installed at significant generator sites and facilities to obtain real-time data on inbound and outbound waste flows. Digital waste tracking systems will also be implemented for material mass balance assessments. Quarterly trend analyses will help

forecast annual generation estimates and identify seasonal or geographic variances to target specific reductions.

Qualitative feedback:

Semi-annual community surveys will supplement yearly interviews to gain more frequent perspectives from residents on issues like illegal dumping remediation, air/water quality changes, access to waste services, or job opportunities. Feedback will also be gathered through Audit reports from field inspections of projects and facilities and structured discussions with worker unions, industry associations, academics, and non-governmental organizations. Stakeholder satisfaction ratings can help prioritize future initiatives.

Annual monitoring reports will assess progress against targets and identify adjustments needed. An external evaluation after Phase 3 will analyze if program objectives were achieved and lessons learned for long-term program improvement

Chapter Four

Discussion and Conclusion

This chapter cover a discussion of key study findings and conclusions. It discuss results related to assessing current construction waste management practices in the West Bank, identifying stakeholders and their roles, analyzing challenges and gaps in the existing system, and developing a strategic framework and recommendations. The chapter will then provide an overall conclusion to the study. It will also outline recommendations.

4.1 Key Study Findings Discussion

RO1: Assess the current construction waste management practices in the West Bank**.**

This objective was achieved by interviewing ten highly ranking professionals (See Table 5) involved in the construction and demolition waste management in the West Bank governorates of Nablus, Ramallah, Tubas, Jenin and Hebron. The interviews gathered detailed information about standard on-site waste handling processes from generation to final disposal. Questions focused on typical waste streams produced, sorting methods, if any, approaches for temporary stockpiling of debris, health and safety practices adopted, transportation logistics, and the final fate of the materials. This comprehensive line of questioning provided a holistic view of management practices being followed from start to end. Interviews typically lasted 45-60 minutes to allow for an in-depth exploration of each topic and capture any additional insights the respondents wished to share.

The findings revealed that basic waste sorting into recyclable and non-recyclable streams is rarely practiced, with most construction waste being mixed. Temporary storage involved uncovered dumping in open pits or piles with no lining or containment measures. This poses risks of waste scattering and contamination of soil and groundwater. Only a few larger projects reported covered designated storage areas with basic containment barriers, such as earth berms around the perimeter to prevent runoff.

Regarding final disposal, an alarming practice was found illegal dumping and burning of mixed waste, especially in rural and remote areas with weaker enforcement. This is unsustainable and causes environmental damage. Only the larger contractors reported transporting waste short distances to municipal dumpsites. However, capacity

constraints, such as limited space and frequent overflowing, were written, which required alternate disposal methods.

Overall, this objective provided a comprehensive picture of the current gaps and unsustainable practices being followed across different project sites, fulfilling the aim to assess the on-ground reality of construction waste management in the West Bank.

RO2: Identify the key stakeholders and their roles in construction waste management in the West Bank

This objective was achieved by identifying the main stakeholders and mapping their roles. However, further engagement was still needed. The study identified five main stakeholders in construction waste management:

The Joint Service Councils for Solid Waste Management (JSC-SWM): The 16 JSC-SWM across West Bank governorates oversee municipal solid waste operations, focusing primarily on household collections and waste transportation to disposal facilities. Limited data on council websites and brief interviews revealed little information on how construction waste fits within their operations, budget allocations, or coordination with other stakeholders to support sustainable management.

Local municipality councils: The 108 councils are responsible for various public services related to infrastructure, utilities, and community development within their jurisdiction. However, the extent and effectiveness of roles in different aspects of waste management, from policymaking to on-ground operations, varies significantly between urban and rural councils due to variability in technical and financial capacities. Construction waste handling responsibilities and integration with JSC-SWM efforts require further clarification.

Construction companies: Larger companies managing significant projects such as buildings, roads, and industrial facilities aim to complete work on schedule and budget, with upfront planning and management of construction waste streams only sometimes prioritized due to perceived additional costs and responsibilities if formal practices are followed.

Individual contractors: Small independent contractors undertake most residential and small commercial construction work, but with a primary focus on project timelines and cash flows, construction waste is often dealt with through familiar but not necessarily sustainable or legal practices such as open dumping, which fail to internalize environmental and social costs.

Recyclers: There are currently only a small number of recycling facilities operating in the West Bank. These facilities have limited capacity and outdated equipment, making it difficult to process recovered C&D waste materials efficiently. Many recyclers also struggle with cash flow issues and a lack of market linkage support. A consistent supply of sorted inputs is needed to guarantee economic viability and attract private sector investment in scaling up recycling operations. The strategic framework proposes initiatives to strengthen public-private partnerships and develop financial incentives that promote greater private-sector engagement in recycling. Infrastructure and technical upgrades could help existing recyclers expand their role in diverting reusable materials from landfills. With appropriate support services, recyclers have significant potential to contribute to the circular economy goals of the C&D waste management system.

Waste Management Companies: Contractors, builders and property developers are directly responsible for most construction waste. Hence the crucial role is played by the waste management companies which offer sorting, collecting, transporting, sorting and disposal services. Through their knowledge and implementation of these projects, they contribute quite a bit to making waste management practices official as well as in line with different regulations, thereby achieving sustainability. Through cooperation with waste management entities, the stakeholders will unlock them as repositories for knowledge and technological advances as well as storing houses for good practices so that waste management becomes much efficient and effective.

Non-Governmental Organizations (NGOs): NGOs do not only bring an additional angle of view and resources in construction waste to management but also play the major role in advocacy, community engagement and capacity building. Environment is a cause they typically support, for instance, via the implementation of waste management practices, i.e. by raising public awareness, gathering grassroots support, and advocating for policy implementation. Working along the NGOs's capacity provides a platform where the actors can pool their networks, know-how and project inception to proffer a

solution to the complex challenges and simultaneously state-of the-art solutions and inclusiveness.

Universities and Research Institutions: Compared with universities and research institutes, knowledge production and distribution on the topic related to construction waste management are the centers. Through research, implementation, and innovations, they contribute in creation of knowledge, new technologies, and providing solid foundation of evidence-based policy making. Working with universities and other research institutions grants stakeholders a chance to get hold of the most contemporary researches, Audi list analysis expertise as well as ability to build a local capacity and access knowledge. Through the process of collaboration with academia, participants can use research insights and innovations aimed at overcoming the most urgent issues in the field and implement ongoing changes in the observed, waste management models. Adding up waste management companies, NGOs, and universities in the stakeholder analysis makes the engagement wider and grants us a more systematic approach to solving the issues of construction waste management. Through the multiparty relations, stakeholders draw upon the abundance of their different knowledge, resources and capacities to create joint action and successful innovation which leads to reaching sustainable waste management goals.

While this mapping identified the fundamental entities, clarifying the formal and actual responsibilities of each required engaging the relevant regulatory bodies through interviews and policy reviews for a more comprehensive understanding of the governance structure and weaknesses in the current framework.

RO3: Analyze the challenges and gaps within the current construction waste management system in the West Bank

This objective was fulfilled by synthesizing the findings of the literature, survey responses, and interviews. Key challenges identified include:

Limited suitable land and space for waste infrastructure due to political restrictions in Area C, comprising over 60% of the West Bank, which remains under complete Israeli control with severe constraints on Palestinian construction and development projects requiring special permits. This severely constrains the establishment of centralized

facilities for waste processing. According to officials from the Joint Service Councils, numerous proposed landfill and recycling site projects in Area C zones have been denied or delayed due to the complex permit process with Israeli authorities, which involves uncertain timelines, demands for alteration of designs, and, in some cases, outright rejection. This has contributed to over-reliance on existing unsanitary dumpsites and the proliferation of illegal dumping activities in open areas, which pollutes lands and water sources.

According to waste haulers and local municipalities, movement restrictions hindering the transportation of waste to processing/disposal sites have been a long-standing issue. Israeli military checkpoints and unexpected closures of roads between West Bank cities introduce inefficiencies such as idling time for trucks, returned loads when roads are closed, additional transport costs into collection routes, and delays at borders, which can result in overflowing of vehicle capacities requiring multiple trips for disposal. In some cases, closures have lasted for days, according to haulers unions, disrupting regular collection services.

According to the Palestinian Environmental Authority, the inadequate financial resources and technical capacity among local authorities and private operators are further exacerbated by the fragmented political and geographic control limiting economies of scale. The Joint Service Councils and municipalities, in particular, face chronic underfunding according to their annual reports, with current budget allocations barely able to maintain essential services such as fuel costs for collection trucks and payroll, unable to invest in new infrastructure development for scientific landfills, material recovery facilities or modern waste-to-energy technologies. This has hindered progress to international standards.

Lack of coordination between different governing bodies, such as the Joint Service Councils, municipalities, and line ministries, has been hindered by weak inter-institutional cooperation within the fragmented political system split across Areas A, B, and C. According to the Environment Quality Authority, this results in an overlap of efforts in some issues with different agencies operating without integration, but also gaps in other areas, such as enforcement of construction waste regulations due to unclear roles and shared responsibilities between local councils.

According to local councils, weak enforcement of regulations allowing unsustainable practices to continue, such as illegal dumping and burning, is linked to limited monitoring and patrol capacity and a lack of deterrence for violators in some regions, such as remote villages with weak community awareness. Existing fines imposed by municipal law are seen as minor and easily absorbable costs for offenders by the Environment Police, failing to change behavior.

According to interviews, knowledge and awareness gaps regarding the impacts of poor practices and available solutions persist among stakeholders and the public. Environmental protection has low prioritization compared to socioeconomic issues, with limited dedicated campaigns and educational programs conducted by relevant authorities to highlight the consequences of waste mismanagement to various audiences and promote more sustainable alternatives.

A thorough understanding of the technical, institutional, economic, social, and political barriers currently constraining sustainable waste management was thus developed through this objective.

RO4: Develop a strategic framework and recommendations for sustainable construction waste management in the West Bank

Chapter 6 of the thesis presents a strategic framework consisting of a vision, objectives, initiatives, and implementation plan developed based on the study findings and analysis of current challenges. The framework results from synthesizing best practices from international case studies and adapting them to the local governance structures and socioeconomic conditions through a stakeholder engagement process.

The framework is developed based on a comprehensive baseline assessment and needs analysis conducted as part of the research. Primary and secondary data was collected through interviews, surveys, site visits, document reviews, etc., to understand the current practices, challenges, and gaps.

An extensive literature review was conducted to learn from best practices, lessons, and policies adopted in other countries/regions facing similar waste management issues. Relevant insights from the literature were incorporated into the framework.

A SWOT analysis of the existing C&D waste management system in the West Bank was performed to analyze its strengths systematically, Weaknesses, opportunities and threats. The results of the SWOT informed the framework development.

Stakeholder consultations were held as part of the research with representatives from regulatory bodies, local councils, private contractors, industry experts, etc. Their inputs and perspectives were factored into the strategic objectives and initiatives proposed in the framework.

The framework addresses the priority gaps, challenges, and needs identified through the baseline assessment. It strengthens policies, planning, coordination, technical infrastructure, and community participation to overcome limitations.

Performance indicators and targets are established within the framework to monitor and evaluate progress over time based on the goals. This allows for evidence-based course corrections if needed.

An implementation plan with clear roles and responsibilities is outlined to facilitate practical, step-by-step execution of the framework based on the evidence gathered regarding stakeholder capacities.

The strategic initiatives proposed aim to systematically transition C&D waste management in the West Bank towards more sustainable solutions based on the evidence on current unsustainable practices, their impacts, and international best practices.

The proposed framework is grounded in robust evidence collected through extensive primary and secondary research regarding the existing C&D waste scenario and needs in the West Bank context.

Specific recommendations are provided under each initiative to guide planning and policy reforms through proposed amendments to the solid waste law, stakeholder coordination models bringing together the Joint Service Councils, municipalities, private operators and community groups, community participation approaches using awareness campaigns and school curriculums, private sector collaboration incentives for

investment in waste projects, and monitoring mechanisms to evaluate progress using key performance indicators.

This objective was achieved by proposing a practical yet adaptable strategic framework to establish sustainable C&D waste management solutions customized for the fragmented governance structures and socio-economic conditions prevalent in the Palestinian context. The framework provides a roadmap to transition current linear practices to a circular economy approach.

4.2 Conclusion

This thesis sought to develop a strategic framework for sustainable construction and demolition waste management in the West Bank of Palestine. A thorough literature review established the global scale of the issue and challenges specific to the local context. Primary and secondary research methods were utilized to conduct an in-depth assessment of the current situation.

Key findings from interviews, surveys, and site visits revealed unsustainable practices like uncontrolled dumping and burning are widespread due to gaps in governance, oversight, policies, and infrastructure. Various stakeholders were identified along with their fragmented roles under the existing system. A SWOT analysis provided insights into limitations and opportunities to boost recycling, support local businesses, and generate green jobs.

The comprehensive situational analysis proposed a strategic framework with a long-term vision, objectives, and targeted initiatives. The recommendations focused on strengthening legislative foundations, training programs, financial mechanisms, public-private partnerships, and community engagement. A phased implementation plan outlined priority actions to systematically establish an organized, sustainable waste management system adapted to the unique Palestinian realities.

This research addressed critical knowledge gaps through extensive primary data collection and engagement across the value chain. The developed framework provides a roadmap to transition the construction sector towards responsible material stewardship and meet international standards. If done right, it could help protect the environment, increase economic growth, and improve people's lives in Palestine.

Even though there are still political problems because of the occupation, the study provides useful, fact-based ways to move forward with sustainable goals. The system and method could also be used in other areas or industries with similar trash problems. This paper looked at the problem in great detail, its strengths and weaknesses. It also suggested a unique way to help the West Bank switch to more environmentally friendly building methods. It gives useful information and suggestions that can help with current work.

4.3 Recommendations

Policy and Planning

1. Come up with a complete set of rules and a long-term plan for managing C&D waste in the West Bank.

2. Make sure everyone knows their jobs, duties, and normal working methods.

3. Make rules that require building sites to separate trash, keep track of it, and keep records.

4. Think about giving workers tax breaks or other rewards to help reduce waste.

5. Adopting a system of incentives for engineers, contractors and companies, such as tax benefits, and including the subject of the obligation to manage construction waste in the classification and licensing system for them (Category A, Class B, etc.)

Infrastructure Development

1. Obtain the land and build new, clean landfills for waste with the appropriate lining. Since the West Bank does not have large lands due to division, the principle of division must be followed for the process by increasing the storage capacity on the site and establishing secondary stations to reduce distances and stay away from checkpoints. The digital plan can also be adopted through Merging political border data between the two countries.

2. Set up unified handling centers to sort, store, and get back materials.

3. Get the tools you need, like compactors and loaders, to handle C&D trash efficiently.

Capacity Building and Awareness

1. Teach contractors, workers, and experts the best ways to sort and reduce waste.

2. Start efforts making people more aware of trash to change how they think about and deal with it.

3. To cut down on trash and help fund research and development of new building products and methods.

4. Adopting the topic of construction waste management in the school and university curricula.

Funding and Partnerships

1. Get money for projects to improve trash infrastructure from foreign funders and the business sector.

2. Encourage businesses that restore, reuse, and recycle materials to work with the government.

3. Charging fees on garbage removal and landfills to bring in money for management.

Monitoring and Enforcement

1. Check building sites for compliance by auditing and inspecting them regularly .

2. Toughen up the punishments for breaking the rules, like illegally dumping trash or setting it on fire.

3. Set up a single method for tracking and reporting waste to make things clear.

These suggestions are meant to fill in the gaps in the current system by taking a planned, all-around approach that considers the West Bank's special political, economic, and social situation. With the right execution, C&D trash control and long-term sustainability could improve.

4.4 Implications and future studies

This part will discuss what the research means and what possibilities it opens up for future studies. It will talk about what the results mean regarding theory and practice. It will also explain the study's flaws and what other research should be done.

4.4.1 Practical implications

The suggested plan for long-term control of construction and demolition trash in the West Bank could have several useful effects if it is approved and implemented correctly. If accepted and put into action properly, the suggested strategy plan for sustainable C&D garbage handling in the West Bank would have the following real-world effects:

1. The framework gives Palestine a plan for how to improve its C&D trash sector in a way consistent with best practices worldwide. It sets standards and rules to eliminate waste dumping methods that aren't environmentally friendly or safe for people.

2. When building sites properly separate and sort their trash, valuable materials can be collected and sent to recycling centers instead of dumping or burning. This boosts resource efficiency within the industry.

3. Regulated collection and transportation of separated waste streams to specialized recycling plants allows the extraction of aggregates, metals, and other reused inputs that can be sold to construction suppliers. This helps develop recycling into a viable business sector.

4. Community-based waste banks and micro-enterprises collecting sorted debris offer livelihood opportunities, especially for unemployed youth. This contributes to local economic development.

5. Targeted training in waste minimization and on-site management techniques can inculcate sustainable practices into occupational health and safety procedures. Over time, this institutionalizes responsible behavior.

6. Enhanced multi-stakeholder coordination and enforcement of guidelines through a centralized authority helps ensure uniform implementation of rules across different areas of the West Bank despite political fragmentation challenges.

7. Integrated planning between authorities, private operators, and community groups facilitates establishing the necessary waste infrastructure network, treatment facilities, and disposal sites to professionally handle projected increases in C&D waste volumes.

4.4.2 Theoretical implications

Here are some additional points that could be included to further expand on the theoretical implications:

1. The framework advances the theoretical understanding of establishing sustainable waste management systems in fragmented political contexts like Palestine. It provides a replicable model.

2. By comprehensively assessing the current practices, stakeholders, challenges, and opportunities, the research generates new insights into the multifaceted dynamics governing C&D waste flows in a conflict-affected setting.

3. The strategic planning methodology demonstrates an approach to evidence-based policymaking that addresses technical, financial, and social barriers through coordinated initiatives among different actors.

4. The recommendations contribute to transition management theories on institutional and behavioral reforms needed to shift complex systems towards more circular models.

5. The study advances theoretical debates on empowering local governance solutions tailored to social and economic conditions by integrating waste prevention and community participation principles.

6. Analysis of how to strengthen regulatory compliance through engagement rather than coercion alone offers lessons for improving governance in weak institutional environments.

7. The framework also has implications for green growth and job creation theories by outlining how waste streams can be leveraged as a resource to support local economic development and employment.

4.4.3 Limitations and Future Research Work

1. The research was conducted within the resource and time constraints of a master's thesis, limiting the scope of analysis. Longitudinal studies post-implementation could provide deeper insights.

2. Political instability and occupation conditions pose uncertainties that may impact long-term stakeholder cooperation and infrastructure development progress in ways not wholly foreseeable.

3. Additional social science research methods like focus group discussions and surveys could have helped triangulate findings but were not feasible within the study scope.

4. While recommendations considered local challenges, unforeseen technical or economic feasibility barriers to specific initiatives post-approval may emerge.

5. The analysis did not quantitatively model waste projections or conduct cost-benefit analyses of proposed interventions, representing opportunities for future work.

6. Comparing the framework's effectiveness over time to other regions' strategies through comparative case studies could strengthen evaluation.

7. Assessing community knowledge, attitudes, and behavior pre- and post-awareness drives would offer insights into changing social practices.

8. Public-private partnership models for managing infrastructure require examination for practical application insights.

List of Abbreviations

Abbreviation	Meaning
C&D	Construction and Demolition
SWM	Solid Waste Management
JSC-SWM	Joint Service Councils for Solid Waste Management
GDP	Gross Domestic Product
UNEP	United Nations Environmental Program
WBCSD	World Business Council for Sustainable Development
EU	European Union
PM	Particulate Matter
PAH	Polycyclic Aromatic Hydrocarbon
CWM	Construction Waste Management
EQA	The Environment Quality Authority

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Appendices

Appendix A

Questionnaire Form

An-Najah National University

Faculty of Graduate Studies

Engineering Management Program

A Comprehensive Questionnaire on Building a Framework Strategy for Sustainability Construction Waste Management: Case of West Bank

Dear Participant,

Thank you for participating in our research study on Construction Waste Management in the West Bank. Your valuable insights will contribute to assessing current practices and developing a strategic framework for sustainable waste management. Your responses are crucial for understanding challenges and opportunities in the construction sector. Please be assured of the confidentiality of your information, and your participation is entirely voluntary.

Section 1: Respondent Information

1.1 Role in Construction:

- ( ) Contractor

- ( ) Developer

- ( ) Consultant

- ( ) Construction Worker

- ( ) Regulatory Authority Representative

- ( ) Community Member

- ( ) Environmental Expert

- ( ) Industry Association Representative

1.2 Years of Experience in Construction:

- ( ) Less than one year

- ( ) 1-5 years

- ( ) 6-10 years

- ( ) More than ten years

1.3 Geographic Location:

_____

_____

Section 2: Company/Organization Information

2.1 Name of company/organization: _____

2.2 Type of company/organization:

- ( ) Contractor

- ( ) Developer

- ( ) Consultant

- ( ) Other: _____

2.3 Location: _____

2.4 Number of employees: _____

Section 3: Construction Waste Management Practices

3.1 Does your company have a formal CWM plan/policy?

- ( ) Yes

- ( ) No

3.2 How effective is your CWM plan/policy?

- ( ) Very effective

- ( ) Somewhat effective

- ( ) Not very effective

3.3 Main types and quantities of waste generated:

_____

_____

_____

_____

_____

3.4 Current waste management/disposal methods:

- ( ) Landfilling

- ( ) Open dumping

- ( ) Reuse/recycling

- ( ) Other _____

3.5 Main CWM challenges faced:

_____

_____

_____

Section 4: Awareness and Perceptions

4.1 Level of awareness of waste impacts:

- ( ) Very aware

- ( ) Somewhat aware

- ( ) Not very aware

4.2 Importance of CWM:

- ( ) Very important

- ( ) Somewhat important

- ( ) Not very important

4.3 Willingness to improve CWM practices:

- ( ) Very willing

- ( ) Somewhat willing

- ( ) Not very willing

4.4 Needed government support:

_____
_____
_____
_____
_____
_____
_____
_____

Section 5: Impact Assessment

5.1 In your view, what are the impacts of construction waste?

_____
_____
_____
_____
_____
_____

5.2 How could effective waste management benefit your organization/projects?

_____

_____

_____

_____

_____

_____

Section 6: SWOT Analysis

6.1 What do you see as the main Strengths regarding construction waste management?

_____

_____

_____

_____

_____

_____

_____

6.2 What are the main Weaknesses?

_____

_____

_____

_____

_____

_____

6.3 What Opportunities exist to improve waste management?

_____

_____

_____

_____

_____

_____

6.4 What Threats could hamper better management?

_____
_____
_____
_____
_____
_____

Section 7: Waste Generation

7.1 What are the typical waste generation rates (tons/unit of construction) for different project types in your area?

_____
_____
_____
_____
_____
_____
_____
_____
_____

7.2 What percentage of total waste do you estimate is reusable/recyclable material like concrete, wood, and metals?

_____
_____
_____
_____

Section 8: On-site Management Practices

8.1 What on-site waste sorting/storage practices do you follow during construction?

_____
_____
_____
_____
_____
_____
_____

8.2 What are the main challenges you face in managing waste on construction projects?

_____
_____
_____
_____
_____
_____

8.3 Do you encounter budget or space constraints for proper waste handling on project sites?

_____
_____
_____
_____

Section 9: Transportation and Disposal

9.1 Do delays occur when transporting waste off-site due to checkpoints or other mobility restrictions? If so, how long are typical delays?

_____
_____
_____
_____

9.2 Are you aware of any policies or guidelines related to construction waste management for your area of the West Bank?

_____

_____

_____

_____

_____

_____

Section 10: Potential Improvements

10.1 Would reusable/recycled construction materials produced locally help reduce waste or costs?

_____

_____

_____

_____

_____

10.2 What type of support (e.g., financial incentives, training programs, equipment access) could help improve your waste management practices?

_____

_____

_____

_____

_____

_____

10.3 Do you have suggestions for improving coordination between stakeholders involved in waste handling?

_____

_____

_____

_____

Section 11: Framework Development

11.1 What elements should be included in a strategic framework?

_____
_____
_____
_____
_____
_____

11.2 How could the implementation of a framework be supported?

_____
_____
_____
_____
_____
_____
_____

Section 12: Barriers

12.1 Do you face any challenges in managing construction waste?

- ( ) Yes
- ( ) No

12.2 If yes, write the top 3 challenges

_____
_____
_____
_____

12.3. Rate your level of agreement that lack of space is a challenge:

Strongly Agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly Disagree [ ]

12.4. Rate your level of agreement that high costs limit better practices:

Strongly Agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly Disagree [ ]

Section 13: Stakeholder Coordination

13.1. Do you coordinate with the local council on waste collection?

- ( ) Yes

- ( ) No

13.2. If yes, how satisfied are you with the service?

Strongly Agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly Disagree [ ]

13.3. Do you face any delays due to checkpoint restrictions?

- ( ) Yes

- ( ) No

13.3. If yes, how much do delays typically impact your schedule?

Strongly Agree [ ]

Agree [ ]

Neutral [ ]

Disagree [ ]

Strongly Disagree [ ]

Section 14: Recommendations

14.1. What recommendations would improve construction waste management?

_____

_____

_____

_____

_____

14.2. Would incentives encourage better waste practices?

- ( ) Yes

- ( ) No

14.3. If yes, what type of incentives would be most effective?

_____

_____

_____

_____

_____

_____

Appendix B

Interview Guide Questions

1. What are your roles and responsibilities in the construction industry/waste management sector?

2. What standard practices are currently used for handling, transporting, and disposing of construction waste at project sites?

3. In your view, how much construction waste is generated on a typical project? What are the primary waste streams/materials?

4. What methods are typically used to manage waste on-site during construction (e.g., separation, storage, transportation)?

5. Who are the main stakeholders in managing construction waste from generation to final disposal? What are their roles?

6. What are the key challenges facing sustainable construction waste management in the West Bank?

7. What factors influence the amount of waste generated from construction projects?

8. What are the barriers to better on-site waste management practices? How can these be addressed?

9. What infrastructure or technical capacity is needed to improve waste collection, transportation, and treatment?

10. What policies/regulations currently govern the construction waste sector? How effective are these?

11. What opportunities exist to increase the reuse and recycling of recovered construction materials?

12. What role should different stakeholders (government, private sector, communities) play in sustainable waste management?

13. What recommendations would you propose to strengthen the construction waste management system?

14. Is there any other important information I should know about this topic that I have not asked?

15. What are the socio-economic pressures influencing waste generation and disposal behaviors?

16. How has the political fragmentation of the West Bank affected the coordination of waste management activities?

17. What are the significant barriers to compliance faced by contractors and private sector actors?

18. How can financing for waste infrastructure and services be improved and sustained?

19. What types of community awareness campaigns or educational programs would be most effective?

20. How can data collection and monitoring of waste streams be strengthened?

21. What strategies could help transition the informal sector towards more sustainable practices?

22. What capacity-building or training programs are needed for different stakeholders?

23. How can reuse markets for recovered construction materials be further developed?

24. What partnerships with regional municipalities or the private sector should be prioritized?

25. What indicators should be used to evaluate the progress of the strategic framework over time?

26. What lessons can be learned from waste management approaches in other countries/regions?

27. How can implementing the strategic framework be adapted to changing political conditions?

28. What successful examples of programs or projects could serve as a model?

Appendix C

Tables of Study

Table C.1

key findings from the questionnaire

Respondent	Current Practices	Challenges	Receptiveness to Improvement	Potential Benefits of Local Solutions
R1	Direct disposal, mixing of wastes	Mixed waste, budgets, enforcement	Willing to improve with awareness, infrastructure	Regional supply reliability, boost participation/stewardship, cut emissions from transport
R2	No formal plan, basic sorting	Mixed waste, budgets, enforcement	Willing to participate if supported	Boost participation/stewardship, strengthen environmental stewardship, foster adaptation
R3	Partially follow rules, room for improvement	Regulations, implementation	Open to improvements	Utilization cuts emissions, strengthen resilience, foster grassroots solutions
R4	Ad hoc approaches, effectiveness is low	Space limitations, funding	Participation interest if organized	Grow markets, cut dependencies, boost familiarity/stewardship
R5	Attempted approach exists but address issues to limited extent	Funding, enforcement	Open to improving approaches	Develop expertise, strengthen cooperation, cut dependencies
R6	On paper only, lacks execution	Lack of facilities	Wants to strengthen practices	Strengthen self-reliance, cut transportation impacts, access inclusive opportunities
R7	No comprehensive plan, ad hoc compliance	Technical skills, awareness	Willing to change with assistance	Build resilience, prioritize grassroots, expand alternatives
R8	Various sorting but comingling is issue	Resources for better practices	Interested in best practices	Strengthen stewardship, build expertise, cut external dependencies
R9	Direct disposal prevalent	Infrastructure access	Motivated to minimize impacts	Cut emissions, boost familiarity, promote solutions
R10	Mixing at collection prevalent	Lack of facilities	Motivated to enhance methods	Build resilience, foster participation, cut external dependencies
R11	Direct disposal in open land	Regulatory monitoring	Motivated to comply more fully	Accessibility promotes solutions, grows markets, cuts emissions
R12	Materials comingled on-	Availability of services	Seeks to minimize	Boost participation, prioritize grassroots,

	site		waste more	foster stewardship
R13	Storage and mixing issues	Technical skills, awareness	Interested in exemplary practices	Strengthen resilience, expand alternatives, develop expertise
R14	Irregular collection servicing	Resources for better practices	Open to adopting better habits	Cut dependencies, grow participation, build familiarity
R15	Open dumping prevalent	Infrastructure access	Motivated to boost performance	Enable self-reliance, create jobs, advance circular solutions
R16	Direct disposal common	Costs of alternate options	Interested in certified ways	Prioritize local, strengthen stewardship, strengthen supply
R17	Inadequate storage facilities	Strategic planning needed	Seeks solutions within means	Foster cooperation, build resilience, promote sustainability
R18	Mixing at source and collection	Strong regulations lacking	Motivated to strengthen efforts	Cut emissions, increase familiarity, support adaptation
R19	Open dumping still practiced	Individual efforts insufficient	Interested in exemplars	Expand opportunities, empower communities, develop markets
R20	Open storage and collection	Access to compliant facilities	Motivated to improve records	Grow participation, strengthen environmental solutions
R21	Direct disposal in wetlands	Treatment center overcapacity	Looks for smarter approaches	Build self-reliance, cut emissions from transport, foster cooperation
R22	Comingling at generation	Resources for proper CWM	Open to strengthening efforts	Empower communities, educate public, develop circular economy
R23	Unregulated direct disposal	Coordinated approach lacking	Seeks to minimize more	Prioritize grassroots, strengthen resilience, boost familiarity
R24	Mixing at collection sites	Funding constraints	Optimistic about progress	Grow participation, expand alternatives, cut external dependencies
R25	Direct disposal to landfills	Monitoring capacity is weak	Searching for practical help	Enable adaptation, promote stewardship, strengthen self-reliance
R26	Open dumping still practiced	Difficulty enforcing regulations	Seeks solutions within means	Build partnerships, cut emissions from transport, empower communities
R27	Comingling at generation sites	Budgets for proper CWM lacking	Motivated to boost efforts	Grow markets, cut costs long-term, strengthen environmental stewardship
R28	Storage then direct disposal	Final disposal challenges	Optimistic with cooperation	Promote sustainability, advance grassroots solutions, strengthen cooperation
R29	Unregulated direct disposal	Compliance incentives missing	Open to exemplary guidance	Build expertise, empower communities, foster stewardship
R30	Open dumping still observed	Knowledge and awareness gaps	Motivated to enhance adherence	Strengthen resilience, cut dependencies, prioritize local solutions

Table C.2

Comparison of study findings with those from existing literature

Area	Finding From Present Study	Supporting Evidence From Literature
Unified Regulatory Body	90% of the stakeholders identified a lack of a unified regulatory body as a major challenge to construction waste management in the West Bank.	The study by Hammad et al. (2017) supports that that lack of a unified regulatory body is a major impediment to construction waste management in the West Bank, noting how 98% of the participants agreed to this point.
On-Site Sorting	80% of stakeholders highlighted the importance of on-site sorting of waste into categories such as concrete, wood, and plastics	Al-Sari et al. (2015) established in their study that there exists a significant gap, with a lack of sorting/segregation facilities in the construction sites. This observation is consistent with those of the present research where 80% of the stakeholders highlighted this problem.
Capacity Building and Awareness	70% of interviewed engineers identified training as essential to change attitudes and practices.	The study by Tamini et al. (2019) recognizes that lack of awareness is a major barrier to effective construction waste management in West Bank, which backs the findings from the present study, which highlights the significance and need for capacity building and awareness programs as a strategy to dealing with the problem. Al-Khateeb et al. (2017), Hroub (2020), Alite et al. (2023), and Khurram & Qamar (2020) support that awareness creation is necessary.
Financial Incentives? Tax Rebates and Green Certificates	Financial incentives for waste reduction and recycling were supported by 80% of questionnaire respondents. 15-25% tax rebates are suggested for firms investing in on-site sorting infrastructure like bins, compaction equipment, and shed areas, with those achieving 90% diversion through reuse and manufacturing recycled products being eligible for green certificates	The studies by Alite et al. (2023), Saadeh et al. (2019), and Al-Khateeb et al. (2017) also back the idea that the use of financial initiatives can play a major role in improving construction waste management.
Governance, coordination, and monitoring of construction waste flows	Currently, there are deficiencies in tracking and reporting undermine evidence-based planning, highlighting the need for strong governance, coordination, and monitoring of construction waste flows.	Alite et al. (2023) suggests that improved governance and coordination is one of the requisites to building a robust construction waste management system. Other studies that support this recommendation are Al-Khateeb et al. (2017), Rema (2019), Saadeh et al. (2019), and Mohammed et al. (2022).

Regional material recovery facilities	60% of interviewed contractors supported developing regional material recovery facilities.	One of the recommendations that Alite et al. (2023) gives regarding improving construction waste management is the development of regional waste management facilities. Nadazdi et al. (2022) also supports regional material recovery strategies.
Robust capacity building programs	The present findings highlighted the need for capacity building and training as one of the means of improving construction waste management in the West Bank.	Tamimi et al.'s study (2019) that involved a knowledge assessment of 100 engineers revealed significant misconceptions about concepts like reduce, reuse, and recycle, backing the need for a robust capacity building programs.

Table C.3

Coding table for interview

Theme	Sub-theme	Codes	Example Coded Extracts
Current Waste Generation and Management Practices	On-site handling	No segregation, Reuse some materials, Lack of storage areas	"Most sites don't bother separating waste. It all goes into one big pile. “We try to reuse materials like wood when possible on other projects, but concrete and bricks just get dumped. “There’s no designated area to stockpile waste, so it gets mixed up."
	Disposal methods	Illegal dumping, Open burning, Unauthorized municipal sites	"The easy option is to find an empty lot nearby and just dump the debris there. “If we can't find a place to dump, we sometimes burn the waste at night when nobody is watching. “Some municipalities allow us to use certain open areas as dump sites unofficially."
Challenges in the Existing System	Regulatory gaps	Lack of regulations, Lack of enforcement, Outdated laws	"There are no clear rules telling us how construction waste should be managed. “Nobody is enforcing anything, so contractors do whatever is cheapest. “The laws on the books are from decades ago and don't cover today's waste issues."
	Infrastructure deficiencies	Lack of facilities, Unsuitable equipment, Limited municipal capacity	"Even if we wanted to dispose properly, there are no facilities to take this kind of bulky waste. “The municipal trucks are small and can't handle large demolition projects." "The joint service councils are overloaded and can't serve all construction sites."
	Economic pressures	Cost priorities, Informal sector involvement	"At the end of the day, companies go with whatever option costs them the least. “There are informal waste pickers who try to salvage metals and other materials from dumpsites."

	Political challenges	Movement restrictions, Land access issues	"The separations and checkpoints make it hard to transport waste where it needs to go. “Much of the open land is in Area C under Israeli control, limiting where we can develop facilities."
Potential Solutions and Interventions	Improved policies and enforcement	Legislate, Inspections, Permitting system	"We need strong laws with penalties for dumping and burning waste illegally." "Regular inspections on construction sites could improve compliance. “Maybe a permit system to control where and how waste gets disposed."
	Develop specialized infrastructure	Processing plants, Disposal sites, Transfer stations	"Designated processing plants to crush concrete and sort recyclables would be very helpful. “Maybe a disposal site just for construction and demolition waste streams. “Small transfer stations around districts could consolidate the waste."
	Capacity building	Training programs, Awareness campaigns, Guidelines	"Contractors and workers need training on proper handling and management practices. “Public awareness is needed so communities don't oppose new waste facilities. “Simple guidelines could educate people on segregation and avoiding illegal dumping."
Role of Stakeholders in Sustainable Management	Government responsibilities	Lead by example, Provide guidance/funding, Coordination	"The government needs to lead by example on their own construction projects.""Allocating budget and giving guidance to municipalities is key. “Better cooperation is needed between ministries and local authorities."

	Private sector involvement	Embrace sustainability, Explore business opportunities, Compliance	"Construction companies should embrace sustainability and proper waste handling. “There are business opportunities in recycling and waste processing to explore. “Private sector has to comply with whatever system gets put in place."
	Public participation	Community involvement, Behavior change	"Getting neighborhoods involved in monitoring dumping could help. “Mindsets have to change - people need to care about properly disposing of waste."

Appendix D

Questioners in Arabic

استبيان شامل حول بناء اطار استراتيجي للإدارة المستدامة لمخلفات البناء والهدم: حالة الضفة الغربية

عزيزي المشارك،

نشكرك على مشاركتك في دراستنا البحثية حول إدارة نفايات البناء في الضفة الغربية. ستساهم أفكارك القيمة في تقييم الممارسات الحالية وتطوير إطار استراتيجي للإدارة المستدامة للنفايات. تعتبر إجاباتك حاسمة لفهم التحديات والفرص في قطاع البناء. يرجى التأكد من سرية معلوماتك، ومشاركتك طوعية تمامًا

القسم 1: معلومات المستجيب

1.1 الدور في البناء

( )مقاول –

( ) مطور –

( )– مستشار

( )– عامل بناء

( )ممثل هيئة التنظيم –

( ) عضو في المجتمع–

( ) خبير بيئي–

( ) ممثل جمعية الصناعة–

1.2 سنوات من الخبرة في مجال البناء

( )اقل من سنة واحدة-

( )سنوات-5-1

( ) سنوات-10-6

( )-أكثر من عشر سنوات

1.3 الموقع الجغرافي

إجابة مفتوحة _____

القسم 2: معلومات الشركة/المؤسسة

2.1 اسم الشركة/المؤسسة _____

2.2 نوع الشركة/المؤسسة

( ) المقاول

( )- مطور

( )- مستشار

( ) آخرى :_____

2.3 الموقع _____

2.4 عدد الموظفين _____

القسم 3: ممارسات إدارة مخلفات البناء

3.1 هل لدى شركتك خطة/سياسة رسمية لإدارة النفايات الصلبة؟

( )نعم-

( ) لا-

3.2 ما مدى فعالية خطة/سياسة إدارة المخلفات الخاصة بك؟

( ) مؤثر جدا-

( ) فعال إلى حد ما-

( ) ليست فعالة جداً-

3.3 الأنواع والكميات الرئيسية للنفايات الناتجة

_____

_____

_____

_____

_____

3.4 الطرق الحالية لإدارة/التخلص من النفايات

( ) ردم النفايات-

( ) الرمي في المناطق المفتوحة-

()- إعادة الاستخدام/إعادة التدوير

أخرى _____

3.5 التحديات الرئيسية التي تواجه إدارة إدارة النفايات

_____

_____

_____

القسم 4: الوعي والتصورات

4.1 مستوى الوعي بتأثيرات النفايات

( )- مدرك جدا

( )- واعي إلى حد ما

()لست على علم تام -

4.2 أهمية إدارة استمرارية العمل

( ) مهم جدا-

( ) مهم نوعا ما-

( ) ليس مهما جدا-

4.3 الاستعداد لتحسين ممارسات إدارة النفايات الصلبة

( )- على استعداد تام

( ) راغب إلى حد ما-

()ليس على استعداد تام-

4.4 الدعم الحكومي المطلوب

_____

_____

_____

_____

_____

_____

القسم 5: تقييم الأثر

5.1 من وجهة نظرك، ما هي آثار مخلفات البناء؟

_____

_____

_____

_____

_____

_____

5.2 كيف يمكن أن تفيد الإدارة الفعالة للنفايات مؤسستك/مشاريعك؟

_____

_____

_____

_____

القسم 6: تحليل SWOT

6.1 ما هي نقاط القوة الرئيسية التي تعتبرها فيما يتعلق بإدارة مخلفات البناء؟

_____

_____

_____

_____

_____

6.2 ما هي نقاط الضعف الرئيسية؟

_____

_____

_____

_____

_____

6.3 ما هي الفرص المتاحة لتحسين إدارة النفايات؟

_____

_____

_____

_____

6.4 ما هي التهديدات التي يمكن أن تعيق الإدارة الأفضل؟

_____

_____

_____

_____

القسم 7: توليد النفايات

7.1 ما هي معدلات توليد النفايات النموذجية (طن / وحدة بناء (متر مربع ، مشروع)) لأنواع المشاريع المختلفة في منطقتك؟

_____

_____

_____

_____

_____

7.2 ما هي النسبة المئوية من إجمالي النفايات التي تقدرها بأنها مواد قابلة لإعادة الاستخدام/إعادة التدوير مثل الخرسانة والخشب والمعادن؟

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القسم 8: ممارسات الإدارة في الموقع

8.1 ما هي ممارسات فرز/تخزين النفايات في الموقع التي تتبعها أثناء البناء؟

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8.2 ما هي التحديات الرئيسية التي تواجهها في إدارة النفايات في مشاريع البناء؟

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8.3 هل تواجه قيودًا تتعلق بالميزانية أو المساحة للتعامل السليم مع النفايات في مواقع المشروع؟

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القسم 9: النقل والتخلص

9.1 هل تحدث تأخيرات عند نقل النفايات خارج الموقع بسبب نقاط التفتيش أو قيود التنقل الأخرى؟ إذا كان الأمر كذلك، ما هي مدة التأخير النموذجي؟

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9.2 هل أنت على علم بأي سياسات أو إرشادات تتعلق بإدارة نفايات البناء في منطقتك في الضفة الغربية؟

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القسم 10: التحسينات المحتملة

10.1هل تساعد مواد البناء القابلة لإعادة الاستخدام/المعاد تدويرها المنتجة محليًا في تقليل النفايات أو التكاليف؟

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10.2 ما هو نوع الدعم (على سبيل المثال، الحوافز المالية، برامج التدريب، الوصول إلى المعدات) الذي يمكن أن يساعد في تحسين ممارسات إدارة النفايات لديك؟

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10.3 هل لديك اقتراحات لتحسين التنسيق بين أصحاب المصلحة المشاركين في التعامل مع النفايات؟

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** القسم 11: تطوير الإطار الاستراتيجي**

11.1 ما هي العناصر التي ينبغي تضمينها في الإطار الاستراتيجي؟

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11.2 كيف يمكن دعم تنفيذ الإطار؟

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القسم 12: العوائق

12.1 هل تواجه أي تحديات في إدارة مخلفات البناء؟

( ) نعم-

( )لا-

12.2 إذا كانت الإجابة بنعم، فاكتب أهم 3 تحديات

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12.3 قم بتقييم مستوى موافقتك على أن نقص المساحة يمثل تحديًا

موافق بشدة[ ]

يوافق[ ]

حيادي[ ]

تعارض[ ]

لا أوافق بشدة[ ]

12.4 قم بتقييم مستوى موافقتك على أن التكاليف المرتفعة تحد من الممارسات الأفضل

موافق بشدة[ ]

يوافق[ ]

حيادي[ ]

تعارض[ ]

لا أوافق بشدة[ ]

القسم 13: التنسيق بين أصحاب المصلحة

13.1 هل يتم التنسيق مع المجلس المحلي بشأن جمع النفايات؟

( ) نعم-

( ) لا-

13.2 إذا كانت الإجابة بنعم، ما مدى رضاك عن الخدمة؟

موافق بشدة[ ]

يوافق[ ]

حيادي[ ]

تعارض[ ]

لا أوافق بشدة[ ]

13.3 هل تواجه أي تأخير بسبب قيود نقاط التفتيش؟

( )نعم-

( ) لا-

13.4 إذا كانت الإجابة بنعم، ما مدى تأثير التأخير عادةً على جدولك الزمني؟

موافق بشدة[ ]

يوافق[ ]

حيادي[ ]

تعارض[ ]

لا أوافق بشدة[ ]

القسم 14: التوصيات

14.1 ما هي التوصيات التي من شأنها تحسين إدارة نفايات البناء؟

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14.2 هل ستشجع الحوافز ممارسات أفضل في مجال النفايات؟

( ) نعم-

( )لا-

14.3 إذا كانت الإجابة بنعم، ما هو نوع الحوافز الأكثر فعالية؟

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1. ما هي أدوارك ومسؤولياتك في قطاع البناء وإدارة النفايات؟

2. ما هي الممارسات القياسية المستخدمة حاليًا في التعامل مع مخلفات البناء ونقلها والتخلص منها في مواقع المشاريع؟

3. من وجهة نظرك، ما هي كمية مخلفات البناء التي يتم توليدها في مشروع نموذجي؟ ما هي مجاري/مواد النفايات الأولية؟

4. ما هي الأساليب المستخدمة عادة لإدارة النفايات في الموقع أثناء البناء (على سبيل المثال، الفصل والتخزين والنقل)؟

5. من هم أصحاب المصلحة الرئيسيون في إدارة مخلفات البناء من مرحلة التوليد وحتى التخلص النهائي؟ ما هي أدوارهم؟

6. ما هي التحديات الرئيسية التي تواجه الإدارة المستدامة لنفايات البناء في الضفة الغربية؟

7. ما هي العوامل التي تؤثر على كمية النفايات الناتجة عن مشاريع البناء؟

8. ما هي العوائق التي تحول دون ممارسات أفضل لإدارة النفايات في الموقع؟ كيف يمكن معالجة هذه الأمور؟

9. ما هي البنية التحتية أو القدرات الفنية اللازمة لتحسين جمع النفايات ونقلها ومعالجتها؟

10. ما هي السياسات/اللوائح التي تحكم قطاع نفايات البناء حاليًا؟ ما مدى فعالية هذه؟

11. ما هي الفرص المتاحة لزيادة إعادة استخدام وإعادة تدوير مواد البناء المستردة؟

12. ما هو الدور الذي يجب أن يلعبه أصحاب المصلحة المختلفون (الحكومة، القطاع الخاص، المجتمعات) في الإدارة المستدامة للنفايات؟

13. ما هي التوصيات التي تقترحها لتعزيز نظام إدارة مخلفات البناء؟

14. هل هناك أي معلومات مهمة أخرى يجب أن أعرفها حول هذا الموضوع ولم أطرحها؟

15. ما هي الضغوط الاجتماعية والاقتصادية التي تؤثر على سلوكيات توليد النفايات والتخلص منها؟

16. كيف أثر الانقسام السياسي في الضفة الغربية على تنسيق أنشطة إدارة النفايات؟

17. ما هي العوائق الكبيرة التي تحول دون الامتثال التي يواجهها المقاولون والجهات الفاعلة في القطاع الخاص؟

18. كيف يمكن تحسين واستدامة تمويل البنية التحتية وخدمات النفايات؟

19. ما هي أنواع حملات التوعية المجتمعية أو البرامج التعليمية التي ستكون أكثر فعالية؟

20. كيف يمكن تعزيز جمع البيانات ورصد مجاري النفايات؟

21. ما هي الاستراتيجيات التي يمكن أن تساعد في تحويل القطاع غير الرسمي نحو ممارسات أكثر استدامة؟

22. ما هي برامج بناء القدرات أو التدريب اللازمة لمختلف أصحاب المصلحة؟

23. كيف يمكن مواصلة تطوير أسواق إعادة استخدام مواد البناء المستردة؟

24. ما هي الشراكات مع البلديات الإقليمية أو القطاع الخاص التي يجب أن تحظى بالأولوية؟

25. ما هي المؤشرات التي ينبغي استخدامها لتقييم التقدم المحرز في الإطار الاستراتيجي مع مرور الوقت؟

26. ما هي الدروس التي يمكن تعلمها من مناهج إدارة النفايات في البلدان/المناطق الأخرى؟

27. كيف يمكن تكييف تنفيذ الإطار الاستراتيجي مع الظروف السياسية المتغيرة؟

28. ما هي الأمثلة الناجحة للبرامج أو المشاريع التي يمكن أن تكون بمثابة نموذج؟

جـامعـــة النجاح الوطنية

كليـــة الدراســـات العليـــا

اطار استراتيجي للإدارة المستدامة لمخلفات البناء: حاله في الضفة الغربية في فلسطين

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قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس – فلسطين.

2024

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الملخص

تهدف هذه الدراسة إلى تطوير إطار استراتيجي لإدارة المستدامة لنفايات البناء والهدم في الضفة الغربية في فلسطين. في الوقت الحالي، لا يوجد اطار تنظيمي يحكم نفايات البناء والتشييد، مما ادى إلى ممارسات غير مستدامة مثل إلقاء النفايات وحرقها مما يؤدي إلى تدهور البيئة والصحة العامة. قدمت الأبحاث السابقة تقديرات أولية لكميات النفايات، ولكن لا تزال هناك فجوات فيما يتعلق بأنماط التوليد، وأدوار أصحاب المصلحة، والعوائق.

يستخدم البحث نهجا مختلط الأساليب، بما في ذلك الاستبيانات مع 100 متخصص ومقابلات مع 10 أشخاص. البيانات الثانوية من الأدبيات والتقارير تكمل التحليل. تظهر النتائج عدم وجود فصل في الموقع والإدارة الأساسية، حيث تم إلقاء 35٪ من الحطام وتم حرق أكثر من 5٪ من الحطام بشكل غير قانوني. تقوم مجالس الخدمات المشتركة بإدارة عملية الجمع والتخلص ولكن قدراتها وتمويلها محدودان. كما أن الانقسام السياسي وتقسيم الضفة الغربية يعقد التنسيق. وتشمل العوائق الكبيرة عدم كفاية السياسات، والبنية التحتية، وعدم امتثال القطاع الخاص، والضغوط الاجتماعية والاقتصادية.

تقترح الدراسة إطارًا استراتيجيًا لمواجهة هذه التحديات لإنشاء نظام منسق لإدارة نفايات البناء والتشييد بحلول عام 2027. وتركز الأهداف على تعزيز اللوائح، وتحسين الممارسات في الموقع، وتطوير شبكات البنية التحتية، وتعزيز أسواق إعادة الاستخدام/إعادة التدوير، وإنشاء آليات تمويل مستدامة. وتحدد خطة التنفيذ المرحلية الإجراءات والمسؤوليات والجداول الزمنية ذات الأولوية لأصحاب المصلحة لنقل القطاع نحو الاستدامة. ويوفر الإطار خارطة طريق لتوجيه الإصلاحات وبناء القدرات اللازمة لإدارة نفايات البناء والتشييد بشكل مسؤول في الضفة الغربية.

الكلمات المفتاحية: إدارة مخلفات البناء، إدارة مخلفات الهدم، الإطار الاستراتيجي، الاستدامة، الإستراتيجية البيئية، الاقتصاد الدائري، المباني الخضراء، الضفة الغربية، فلسطين.