Multi-Attribute Analysis for Sustainable Reclamation of Urban Industrial Sites: Case from Damascus Post-Conflict

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Abstract. The reclamation of urban industrial zones presents intricate challenges within urban planning, notably in post-disaster scenarios aimed at revitalizing urban landscapes. This study delves into the complexities and decision-making intricacies involved in reinvigorating the Al-Qaboun industrial area in Damascus following the conflict. It undertakes an assessment of optimal industrial zone placements by meticulously evaluating economic, social, land use, and environmental criteria via a robust combination of case study methodology and reconnaissance survey. The outcomes reveal participants' prioritization of economic criteria, followed closely by equally significant social and land use considerations, while the environmental criteria ranked comparatively lower in importance. Employing multi-attribute analysis, three reclamation alternatives for Al-Qaboun are examined: refurbishment within the same area (A1), relocation of heavy industries only to Adra industrial city (A2), and complete relocation to Adra industrial city (A3). Participant ratings favor A3 (0.386) followed by A1 (0.319) and A2 (0.294), highlighting the initial planning phase's reliance on streamlined methodologies yet emphasizing the necessity for an in-depth exploration of stakeholder influences on sustainable reclamation endeavors. This research underscores the pivotal role of meticulous decision-making in post-disaster urban planning and advocates for a nuanced understanding of stakeholder dynamics in ensuring the sustainability of reclamation initiatives.

Keywords: Post-disaster; Syria; Decision making; Industrial areas; Sustainability.

Conflicts of interests: The authors have no conflicts of interest to declare that are relevant to the content of this article.

1. Introduction and background

The revitalization of urban industrial areas has become a pressing concern within urban planning, particularly focusing on sites with high ecological value [1]. Redeveloping these areas necessitates a comprehensive approach that equally prioritizes social, environmental, and economic aspects of sustainability [2]. This inclusive approach is critical for sustainable urban development, especially in the recovery and preservation of industrial heritage.

Damascus, Syria's capital, faces significant challenges in urban planning, sustainability, and the built environment, particularly post-war. Among these challenges, the sustainable reclamation of urban industrial sites stands out as a major concern. Decisions concerning industrial locations in Damascus'

post-war urban development are crucial for the overall strategic reconstruction plan, aiming to tackle issues of regional imbalance and sizeable exclusivity [3]. However, the implementation of industrial decentralization policies faces obstacles due to conflicting interests, stemming from economic efficiency, political agendas, and equity objectives.

The Syrian conflict resulted in extensive destruction of buildings, infrastructure, and facilities, particularly in densely populated areas like Damascus. Addressing sustainability concerns becomes imperative in combatting unplanned urban development while grappling with the environmental and socio-economic impacts of war [4]. This conflict displaced over half of Syria's population, with approximately 8 million internally displaced individuals, severely impacting the country's GDP and employment rates [5].

Syria's industrial sector, comprising petroleum, textiles, food processing, among others, holds substantial importance, contributing significantly to the GDP and employment rates [6]. The industrial site reclamation process involves various criteria and stakeholders [7], demanding careful consideration of sustainability requirements, post-disaster challenges, and stakeholders' characteristics [3]. However, decision-making in practice may not always consider conflicting objectives, potentially leading to politically driven decisions [8]. To counter this, adopting Multi-Criteria Decision Making (MCDM) approaches becomes crucial, enabling more informed and objective decisions that encompass diverse stakeholders' needs [9].

MCDM emerged to relieve difficulties in accommodating diverse opinions and handling large amounts of complex information in the decision-making process [10]. MCDM involves distinct phases, encompassing objective identification, criteria development, alternative generation, evaluation, selection, and subsequent implementation and monitoring [11]. This method proves beneficial in navigating uncertainties within the housing market, managing diverse project requirements, and addressing conflicting stakeholders' interests [12]. Additionally, MCDM facilitates the application of value and weight concepts in assessing risk probability and impact [3]. Consequently, when applied to the context of post-disaster recovery and reconstruction projects (PRRP), MCDM offers a synthesized list of construction sustainability challenges (considered as negative risks), aiding in the development of criteria that influence decision makers' objectives and priorities, thereby promoting sustainability. Furthermore, the integration of stakeholders' emphasis on sustainability into MCDM processes amplifies the significance of sustainability core values and the management of sustainability risks [3].

Therefore, Damascus policy makers and planners have been paying more attention to sustainability in post-war re-construction to improve the quality of life in urban areas [13]. The industrial areas location requires complex knowledge management and analysis [12]. The urban industrial areas demolition vs renovation decision making main limitations are: rationality, economic constrains, development time, and competitive demand [14]. Also, Damascus metropolitan area post-war has its local characteristics that should be considered for such decision making. In fact, not all the stakeholders conflicting interests are always taken into consideration, which could lead to political or manipulative decisions [8]. To avoid this, decision makers and planners require a framework that considers the post-war challenges of Damascus City Metropolitan Region with reference to actor-network theory for achieving long term resource to community. MCDA approach aims to solve the variety of stakeholders conflicting interests that favour urban industrial sites renovation. This decision-making dilemma encourage this study to implement heterogeneous data via simplified multi-attribute approach considering various stakeholders' interest for more informed and less subjective decisions. Given the magnitude and urgency of the post-war urban industrial areas in Damascus, this paper aims to provide a simplified decision-making framework.

2. Research aim and objectives

This paper stems from a significant historical event – a forceful backlash against urban renewal policies, which not only devastated the historic cores of several industrial cities but also fell short in achieving envisioned social and economic objectives. Focusing on the specific case of the "Al-Qaboun industrial area" in Damascus, this paper scrutinizes the planning process, particularly emphasizing preservation and conservation strategies aimed at revitalizing the economic landscape. The research seeks to contribute empirically and theoretically to the emerging strategic planning approach for addressing issues related to urban industrial areas. To achieve this, the study aims to:

- Develop multi attribute prioritization for sustainable reclamation of urban industrial areas in post-disaster context.
- Evaluate the alternative approaches for the reclamation of the Al-Qaboun industrial site in the post-disaster context.

3. Damascus Post-war Exhausted Industrial Areas

Assessing the effectiveness of policies, plans, and strategies for reconstructing post-disaster construction projects is crucial for understanding their impact on the restoration of industrial sites. The Syrian industrial sector has been subject to criticism due to deficiencies in restructuring public firms, the absence of a comprehensive Small and Medium-sized Enterprises (SME) concept, and limited progress in the ongoing industrial upgrading plan [15]. The sustainable reclamation of urban industrial sites directly affects the overall environmental footprint of the city [3]. Various regulations have been introduced to bolster private investment and support newly established institutions such as the Syrian Investment Agency (SIA), the Export Development and Promotion Agency (EDPA), and the Syrian Enterprise Business Council (SEBC). Syria's industrial landscape is gradually transitioning from a traditional industrial policy to a more inclusive enterprise policy [15]. Notably, the industrial structure comprises a few large public enterprises alongside numerous small private enterprises, including self-employment, family-owned, and cooperatives [16].

In Syria, the private sector dominates, significantly contributing to the total production value, with micro and small firms playing a prominent role [17]. However, the private industrial sector faces escalating challenges from international, regional, and domestic competition without a comprehensive strategic framework to enhance its institutions, capabilities, skills, and essential infrastructure [13]. For expediting industrial modernization and ensuring implementation commitment, indicators related to sustainability transformation, credibility, transparency, and a structured framework need careful consideration [15]. The location predicament of post-war partially damaged urban industrial areas necessitates intricate knowledge management and analysis. Addressing the limitations faced by human decision-makers, including cognitive, economic, time-related, and competitive demands, is crucial for providing appropriate support [14]. Furthermore, the selection criteria indicators for decision-making vary across different metropolitan areas due to their unique local characteristics [12].

The post-war industrial sector in Syria has encountered significant destruction and a multitude of internal and external challenges, including labor shortages, currency devaluation, fuel crises, heightened production costs, a shrinking national market, closure of foreign markets due to sanctions, relocation of private industrial activities to neighboring nations, energy scarcity, and infrastructure damages [18, 3]. The Syrian government had a longstanding objective of industrial decentralization, aiming to relocate all industrial sites from major cities and establish an individual industrial city in each governorate. This initiative was initially proposed in 2004 through a decree permitting investments in industrial cities, leading to the establishment of councils for each city. However, the decree's partial implementation faced widespread criticism for its perceived intention to deplete urban industrial areas within cities.

Subsequently, in 2010, an industrial plan was unveiled, outlining the creation of four modernized industrial cities: Adra (adjacent to Damascus), Hasiya (near Homs), Alsheik Najar (near Aleppo), and Der-Alzoor (still under planning and design phase) [15]. These industrial cities adopted a standardized master plan, typically divided into zones catering to textiles, agri-food, engineering, and chemicals, accompanied by commercial sectors comprising banks, hotels, and other services, as well as residential and green areas.

Syria's post-war industrial modernization journey remains closely linked to the nation's economic recovery [16]. Efficient execution of these industrial areas necessitates an analytical methodology that comprehensively addresses the aforementioned aspects in a coordinated manner [14]. However, the conflict situation in Syria led to the postponement of the plan's implementation [16]. The significant disparity between proclaimed industrial modernization policies and their poor post-war implementation further emphasizes the mounting multi-attribute challenges encountered in sustainable industrial sites reclamation.

4. Previous research

Policies regarding the siting of industrial areas have become a prevalent strategy in lower-income countries to address issues related to regional disparities and excessive urbanization. Many countries have implemented measures either restricting industrial activities within major cities or relocating industries away from urban centers to mitigate the growth of primary cities. The feasibility and consequences of such policies have been extensively discussed in the literature [19, 20, 12].

Despite the existence of international charters and declarations aimed at defining and preserving industrial heritage globally, these initiatives have largely been disregarded in Syria. International charters typically define industrial heritage as encompassing historical, technological, social, architectural, or scientific value [7]. Research by Jarrar and Jaradat [7] examines modern industrial heritage in Jordan using a case study approach, employing a reconnaissance survey. The study primarily analyzes seven categories related to the phenomenon of deindustrialization in heritage sites, covering aspects such as ownership, location, design, structure, significance, deterioration, conservation attempts, and alterations.

With industrial decentralization policies likely to continue, a significant challenge arises from the lack of substantial knowledge concerning the sustainability impact of industrial location [20, 12]. The rapid pace of urbanization has prompted many industrial areas to relocate in pursuit of enhanced sustainable competitive advantage. However, deciding on industrial site locations involves complexities and depends on multifaceted factors that are challenging to quantify. Literature on industrial location often provides limited practical applications in decision-making scenarios due to the involvement of numerous qualitative and quantitative factors [21].

Evidence suggests that industrial decentralization policies may not necessarily align with economic efficiency but are pursued to fulfill various political, regional, and equity objectives supported by a wide range of interests [20, 21]. Industrial heritage conservation typically involves three primary approaches: demolition, occasional maintenance, and conservation with adaptive reuse [7]. Previous research on industrial site reclamation decisions has mainly focused on a single objective and often emphasized cost-related factors. However, since location selection inherently involves multiple criteria decision-making (MCDM), it requires a multi-attribute approach [3].

The utilization of MCDM methods, particularly in highly uncertain scenarios, is crucial for dealing with unknown variables, multiple interests, and conflicting perspectives [22]. This method involves various phases such as objective identification, criteria development, alternative evaluation and selection, implementation, and monitoring [3]. Evaluating suitable industrial areas becomes a critical multi-criteria decision problem involving socio-economic, technical, and environmental considerations.

MCDM enables an impartial integration of modern planning objectives, aiding in the identification and ranking of appropriate planning solutions [12, 21].

Furthermore, MCDM can play a vital role in assessing sustainability by incorporating value and weight concepts [11]. Enhancing the method for addressing the sustainability of industrial site relocation, managing multiple project requirements, and accommodating conflicting stakeholder interests is paramount. A synthesized list of industrial site reclamation criteria associated with post-disaster reconstruction can assist in developing MCDM criteria that influence decision-makers' objectives and priorities for promoting sustainability (see Table 1). These MCDM categories should reflect the diverse perspectives of stakeholders, including conventional industrial sectors, rational government decision-makers, and vulnerable workforce communities. Emphasizing the consideration of stakeholders with varying values is crucial in modern urban planning to mitigate political and manipulative decisions [21].

Table 1. Multi-attribute criteria for sustainable reclamation of urban industrial areas

Economic Category	Environmental category	Social category	Land use Category
Energy	Pollution (including post-war site contamination)	Public health, safety, and security	Brownfield development
Technology	Environmental standards	Work environment.	Neighbourhood plans (including labours accommodation)
Infrastructure	Climate change	Creating jobs	Policies and ownership laws and regulations
Funding	Waste management (including massive destruction)	Equal opportunities	
Suppliers		Human-change	
Time to market			
Transportation			

The recent proliferation of literature on industrial site reclamation towards quantitative approaches, such as MCDM techniques, has expanded the capacity to manage diverse data and accommodate different stakeholders' interests. This study highlights how MCDM can not only prioritize options and conduct scenario analyses but also offer insights into alternatives, particularly when shifts in urban planning policies grant local decision-makers considerable decision-making latitude (Mosadeghi et al., 2015). Table 1 provides a summary of the multi-attribute sustainability criteria for the sustainable reclamation of urban industrial areas drawn from existing literature. This research categorized list of sustainable industrial site reclamation criteria was developed based on relevant previous research and the input of local industry experts, practitioners, and professionals. These criteria elements associated with 20 papers were included and used to develop the synthesized list presented in Table 1. Previous

studies attempted to identify sustainability factors by conducting a literature review, while some studies adopted surveys or expert interviews to support MCDM identification.

MCDM enables the unbiased integration of modern planning objectives, facilitating the independent identification and ranking of the most suitable planning solutions [12, 21]. The adoption of a multi-attribute approach addresses the pressing need to develop methodologies capable of encompassing a wide range of factors, both objective and subjective, necessary for the comprehensive evaluation of industrial location decisions. This study will employ the Multi-Criteria Decision-Making (MCDM) approach, which consists of the following phases: (a) objective identification; (b) criteria development; (c) alternative generation, evaluation, and selection; (d) implementation and monitoring [3].

This requires a thorough examination of relevant categories in Table 1, ensuring a balanced consideration of multiple objective criteria for different stakeholders, including advantageous attributes, product market delivery timelines, location-related risks, labor quality, and product quality associated with each location alternative. Given the presence of conflicting perspectives among these considerations and conflicting stakeholders interests, this paper advocates for a multi-attribute approach aimed at evaluating alternatives regarding the recalibration of industrial sites, as elucidated in the subsequent section.

5. Methods & material

A mixed research approach is utilized to formulate a multi-attribute strategy aimed at promoting sustainable reclamation practices for urban industrial sites in post-disaster contexts. This study employs a design that integrates primary and secondary data and employs mixed methods, encompassing both qualitative and quantitative approaches. The mixed-method approach facilitates a comprehensive understanding of the research problem [23, 24].

According to Yin [25], the case study approach involves empirical inquiry that delves deeply into one or multiple cases within their real-world contexts. In this study, within the framework of a case study, both qualitative and quantitative approaches are applied to gain an in-depth understanding of the case of Al-Qaboun industrial site reclamation in Damascus post-conflict. This involves employing surveys as the primary data collection method, supplemented by informal discussions with experienced engineers, decision-makers, and officials involved in managing the surveyed site.

5.1 Al-Qaboun Case study

The case study encompasses a site survey, questionnaire survey, and discussions with experienced engineers, decision-makers, and officials involved in the management of the surveyed site. Al-Qaboun industrial area is situated at the northern entrance of Damascus, constituting a highly organized zone containing industrial and craft properties alongside various government buildings, including military and civil structures. Its boundaries extend from the Abbasi garages at the western end of Faris Khoury Street to the administrative borders of the Damascus governorate bordering Harasta in the east. The area extends from the international highway (Damascus - Homs) in the north to the Tora River, which serves as the southern boundary separating Qaboun and Jobar (see Figure 1). Consequently, many of its factories and workshops are aged, with inadequate infrastructure and a limited building lifespan, leading to unfavorable working conditions that impact productivity and product quality. The region comprises approximately 750 establishments employing around 20 thousand workers. Key factories include Al-Khomasia Industrial Commercial Company, the General Company for textile and clothing, the General company for the concierge and agricultural industry, Metal Constructions and Mechanical Industries Company, the General Company for Rubber and Plastic Products, Crash Factory for Soft Drinks,

Syronics TV Lab, Tariq Al Majdalani Wood Factory, and the main Soap Factory. Although the area suffered destruction, the extent varied among different facilities.

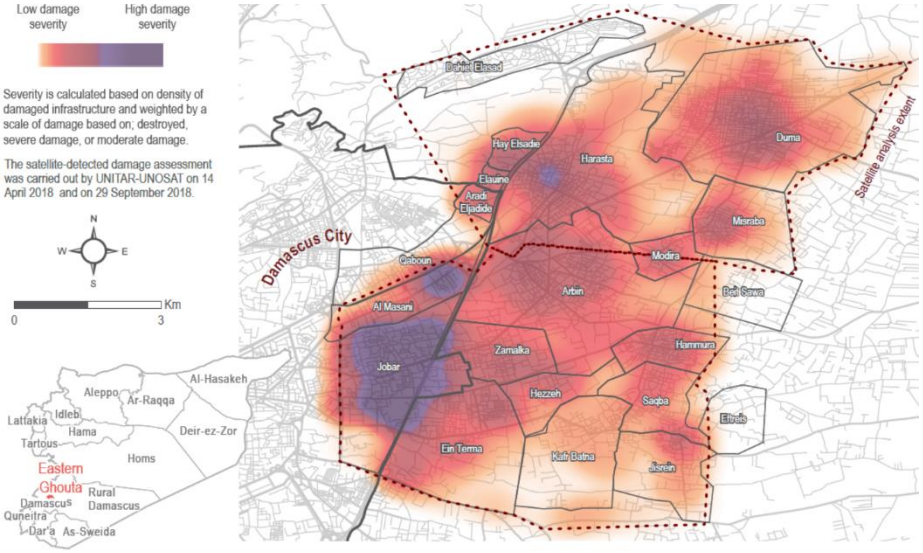

Figure 1. Al-Qaboun Damascus North Entrance (Eastern Ghota destruct)

The site survey reveals that the Al-Qaboun industrial area is divided into two parts, designated as Area (A) and Area (B), as illustrated in Figure 2:

- Area (A) comprises 46 factories with an overall damage percentage of 26.1%. Notably, there is a surface tunnel measuring 2 meters in depth and 2 meters in diameter connecting the Al-Dogali building with the Jano building, which requires backfilling and treatment.
- Area (B) consists of 133 factories, exhibiting an overall damage percentage of 59.4%. Additionally, there exists a network of deep tunnels constructed by terrorists, which could not be investigated due to security restrictions. These tunnels are situated beneath the entire area, impacting the infrastructure and structural stability of the buildings.

The total damage to buildings across the entire Al-Qaboun industrial area amounts to 45.25%. According to the Administration of the Industrial City in late 2013, the owners of the factories expressed devastation over the attacks on their buildings, equipment, and production lines during the battles, as well as the subsequent thefts.

The governmental planning authority has proposed two potential alternatives for relocating Al-Qaboun's industrial operations, either partially or entirely, to Adra, a location situated outside the borders of Damascus. These alternatives are justified on the basis that the current site of the Al-Qaboun industrial city does not meet the standards set for industrial cities, and the existing conditions are deemed inadequate from environmental, regional planning, and economic perspectives. Furthermore, the government expects that its decision will encourage international investment post-conflict, citing the reluctance of industrialists to rehabilitate their facilities despite being given permission to do so.

Three distinct courses of action have been outlined by the planning authorities for the higher government decision: the restoration of existing facilities at their current site (A1), the relocation of the heavily polluted industries exclusively to the Adra industrial zone (A2), and the complete transfer of the entire industrial enclave to Adra (A3).

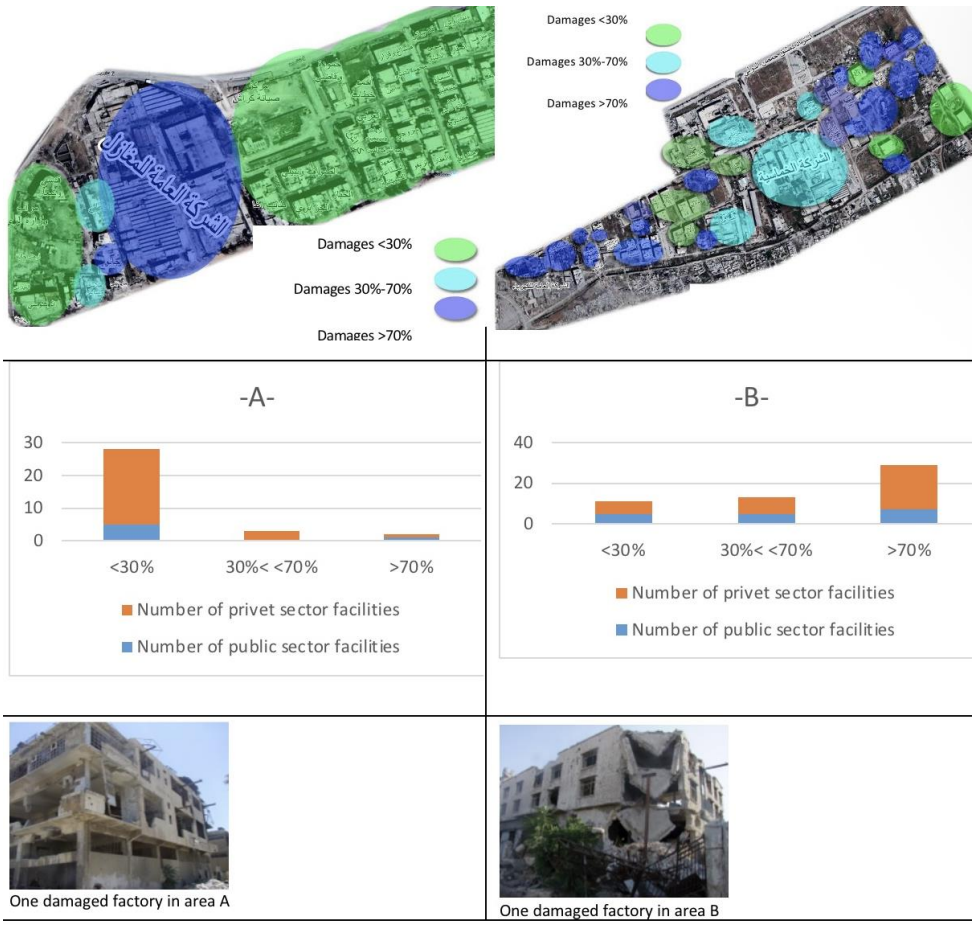

Figure 2. Damages in Al-Qaboun industrial area part (A) and part (B)

A s a result, objections have been raised against the decision to convert the Al-Qaboun area into a commercial district following the dismantling of its factories. The Federation of Industrial and Commercial Chambers has challenged this proposal, arguing that Al-Qaboun is subject to property regulations and requires refurbishment following the government's infrastructural reconstruction efforts in the region. This conflict of interests is evident in the government's criticism of numerous factory owners who have redirected their investments to neighboring nations such as Turkey or Jordan. Conversely, industrialists accuse the regime of including their assets in new investors' portfolios under contracts lacking specific durations, typically ranging from five to ten years, with the aim of maximizing the utilization of the industrial area.

5.2 The survey

The survey methodology is commonly employed in Multi-Criteria Decision-Making (MCDM) research [11]. Three primary rationales support the use of this data collection method: firstly, its non-invasive nature and cost-effectiveness compared to interviews; secondly, the respondents' familiarity with questionnaires; and thirdly, the ease of analyzing the returned responses, as emphasized by Jarkas and Humpt [26].

In this study, a questionnaire utilizing the multi-attribute approach for evaluating sustainable reclamation of urban industrial sites across economic, environmental, social, and land use categories

(as outlined in Table 1) was employed. The questionnaire comprised six sections: Section 1 gathered demographic information on respondents, including their professional roles and years of experience; Sections 2 to 5 were dedicated to assessing the economic, environmental, social, and land use categories and their respective subcategories using a Likert scale; and Section 6 aimed to evaluate three alternatives (A1, A2, and A3) based on the identified criteria, utilizing a five-level measurement scale to ensure response credibility.

The survey was conducted from early June to the end of July 2023, with a sample of 80 participants selected out of the annual list of construction companies provided by the Engineering Syndicate in Damascus. The selection was based on participants position and experience in Damascus' reconstruction planning, engineering, and manufacturing sectors. The survey was distributed via email to a selected list of construction, planning, and industrial professionals with experience in industrial site reclamation, supplemented by reminder emails to mitigate non-response. A total of 25 responses were collected within the survey timeframe, resulting in a useful response rate of 31.25%. This rate may reflect the potential time constraints, lack of incentive among respondents or concerns related to confidentiality among professionals under the current sensitive political circumstances, owing to conflicting interests between the government and the private industrial establishments on Al-Qaboun industrial recalcination. Despite the modest response rate, the credibility and representativeness of the results are sufficient due to the use of purposive sampling rationale. The sample was intentionally selected based on specific criteria (e.g., involvement in Damascus' reconstruction planning, engineering, and manufacturing sectors), ensuring that respondents were directly relevant to the research objectives. This targeted approach enhances the likelihood of obtaining insights from individuals with pertinent expertise and experience, suggesting that the response rate was adequate to capture the range of perspectives and experiences relevant to the research questions. Furthermore, qualitative insights and rich contextual information were gathered during the case study site survey, adding depth to the analysis and enriching the overall interpretation of the findings.

5.3 The evaluation criteria

MCDM can be leveraged to apply the concepts of value and weight in assessing sustainability [11]. This research implements the phased MCDM approach outlined by Khaddour and Wang [3], which involves: (i) defining the alternatives, (ii) selecting criteria to measure the objectives (as outlined in Table 1), (iii) specifying alternatives (A1, A2, and A3), (iv) assigning weights to the criteria, and (v) employing the appropriate mathematical algorithm for ranking alternatives. The evaluation criteria, including assigning weights to the criteria and ranking the alternatives, were adapted from Kahraman et al. [27]. Consequently, this multi-criteria and multi-expert evaluation enhances the handling of sustainability concerns in industrial site reclamation, addresses multiple project requirements, and navigates conflicting stakeholder interests. This evaluation method is selected due to its simplicity in generating a unique solution to the reciprocal comparison matrix. As the quality of the evaluation procedure hinges on experts' knowledge and experiences, this research team comprises experts from diverse backgrounds/disciplines, including construction management, real estate, quantity surveying, and site appraisal. The research team members reviewed all pertinent information related to urban planning systems and industrial strategies in Syria. The literature and the case study aids the experts in determining the evaluation criteria.

Table 1 delineates the criteria for measuring the sustainable reclamation of urban industrial areas, categorized into four groups and 19 subcategories. The first criterion is economic, considering the post-conflict challenges faced by public and private sector entities involved in the project. This category encompasses seven key factors: Energy, Technology, Infrastructure, Funding, Suppliers, Time to market, and Transportation. The second criterion is environmental, encompassing Pollution (with consideration for post-war site contamination), Environmental standards, Climate change, and Waste

management (including significant destruction). The third criterion is social involvement, comprising Public health, safety, and security, Work environment, Job creation, Equal opportunities, and Human change. The final criterion is land use, including Brownfield development, Neighbourhood plans (including labor accommodation), and Policies and ownership laws and regulations.

Google Forms questionnaire is utilized to construct pairwise comparison matrices, assisting in assigning weights to the criteria. For assigning weights to the selected criteria, sections 2 to 5 in the questionnaire present the variables that determine economic, environmental, social, and land use criteria, respectively. Participants were asked to compare the level of importance between pairs of variables using a Likert scale. All factors influencing the final decision were weighted by applying the appropriate mathematical algorithm. Computation of weights took place. After that, the alternatives were evaluated and ranked.

A pilot test was conducted on a sample of potential respondents to establish validity and assess questionnaire reliability. Subsequently, the survey was distributed to a national sample of professionals engaged in Damascus' reconstruction planning, engineering, and manufacturing sectors, including regulators/policy makers, project managers, contractors, industrialists (private, public, and PPP), engineering consultants, designers, and property developers/owners, who met the criteria of being Syrian and involved in the Al-Qaboun industrial area's reclamation.

6. Results & Discussion

This section presents the survey's findings in terms of the respondents' background, environmental, economic, social and planning and land use variables and categories ranking.

6.1 Participant Characteristics

This section presents the survey respondents' backgrounds, focusing on their work experience, organizational sector, size, and job titles, with the outcomes presented in Figure 3. Figure 3 (a) illustrates that 39% of the participants are construction professionals, 28% are industrial experts, 16% are decision-makers, and 17% are urban planning consultants. Other influential stakeholders, such as suppliers, end-users, and neighboring communities, fall outside the scope of this study. Figure 3 (b) shows the representation of the public, private, and Public-Private Partnership (PPP) sectors, which are 28%, 33%, and 28%, respectively. These three sectors have close representations in this survey, which are higher than the 11% representation of international associations. This discrepancy is attributed to the sanctions imposed on Syria by the USA that hindered international investment during the study period.

Figure 3 (c) indicates that 50% of the respondents have more than 20 years of experience, reflecting the phenomenon of immigration among young professionals during the conflict. Moreover, most institutions operating in the reconstruction and reclamation of industrial cities are large organizations, with 61% of the respondents working for such entities, as depicted in Figure 3 (d).

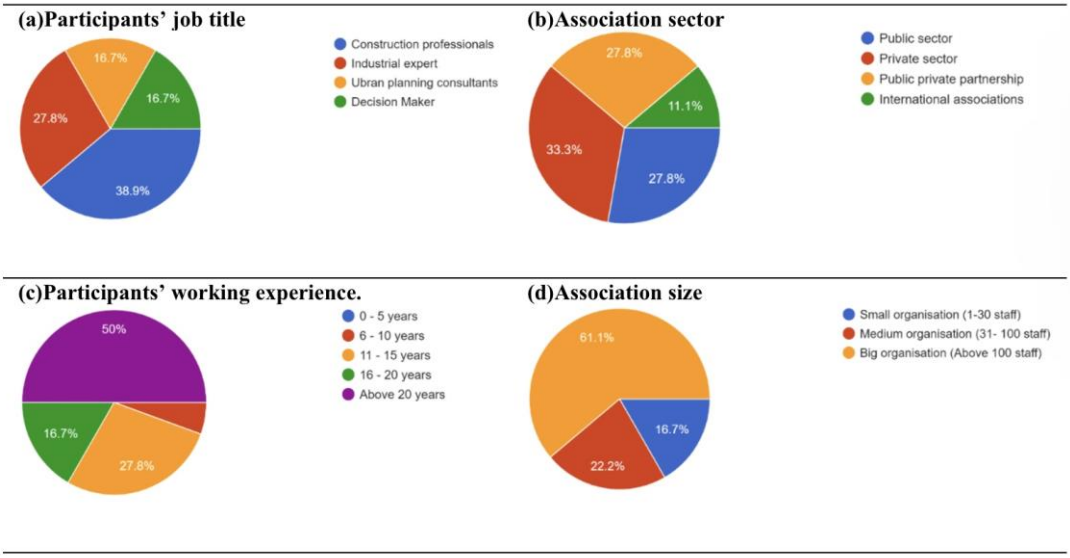

Figure 3. Participants characteristics

6.2 Economic Category

Section 2 of the questionnaire focuses on pairwise comparisons among variables determining economic criteria. Table 2 illustrates the respondents' weighting of these criteria. Funding receives the highest weighting, while suppliers and transportation are rated the lowest by respondents.

Table 2. Economic criteria weighting

Energy	Technology	Infrastructure	Funding	Suppliers		Time to market
0.148	0.149	0.149	0.152	0.125	0.143	0.133

In the context of post-disaster scenarios, the sustainable reclamation of urban industrial sites within the economic category necessitates several critical considerations:

- Energy: Post-disaster, prioritizing energy resilience is paramount. This involves integrating renewable energy sources such as solar or wind power to ensure a stable energy supply and reduce dependence on centralized grids susceptible to disruption.
- Technology: Adopting resilient and adaptable technology is essential. Implementing innovative, disaster-resistant systems and infrastructure can facilitate swift recovery of the industrial site and ensure operational continuity even in adverse conditions.
- Infrastructure: It is crucial to restore and reinforce infrastructure to withstand future disasters. This entails rebuilding sturdy physical structures, ensuring dependable utilities, and fortifying communication networks resilient to potential disruptions.
- Funding: Accessing funding for reclamation efforts is vital post-disaster. Securing funding through disaster recovery funds, international aid, public-private partnerships, or insurance mechanisms is essential for successful reclamation projects.

- Suppliers: Establishing resilient supply chains is imperative. Given current sanctions on Syria by the USA, engaging with local suppliers capable of rapid response, diversifying sources, and ensuring stockpiles or alternative supply routes can mitigate disruptions in critical supplies post-disaster.
- Time to Market: Minimizing downtime and swiftly restoring production capacity post-disaster is critical. Streamlining manufacturing processes, reducing bureaucratic hurdles, and ensuring efficient transportation networks can expedite recovery and re-entry into markets.

Transportation: Ensuring resilient transportation networks is essential for the efficient movement of goods and services. Rebuilding or reinforcing transportation infrastructure and implementing emergency logistics plans can facilitate the timely delivery of goods post-disaster.

6.3 Environmental Category

In Section 4 of the questionnaire, respondents engage in pairwise comparisons among variables determining environmental criteria. Table 3 provides an overview of respondents' ratings for these criteria, with pollution and environmental standards receiving the highest scores, while considerations for global climate change rank lowest.

Table 3. Environmental criteria weighting

Pollution (including post-war site contamination)	Environmental standards	Climate change	Waste management (including massive destruction)
0.265	0.269	0.211	0.255

In the aftermath of a disaster, particularly in the sustainable reclamation of urban industrial sites within the environmental category, several critical aspects merit consideration:

- Pollution (including post-war site contamination): With a weighting of 0.265, post-disaster industrial site reclamation necessitates a thorough assessment of pollution levels, particularly in conflict-affected areas. Remediation of contaminated soil, water, and air resulting from industrial activities or war-related pollutants is imperative. Implementing cleanup measures, deploying decontamination technologies, and ensuring proper waste disposal are essential to restore environmental integrity.
- Environmental Standards: Given the highest weighting within this category at 0.269, adherence to stringent environmental standards becomes imperative. Incorporating best practices, complying with local and international environmental regulations, and adopting eco-friendly technologies during the reclamation process are essential to prevent further environmental degradation and ensure sustainable practices.
- Climate Change: Despite receiving comparatively lower weighting at 0.211, considering climate resilience in site reclamation is crucial. Integrating climate adaptation measures such as flood protection, green infrastructure, and sustainable land use planning can mitigate risks associated with future climate-related disasters and ensure long-term site sustainability.
- Waste Management (including war-induced destruction): With a weight of 0.255, managing debris and waste resulting from the disaster or conflict poses a significant challenge. Implementing efficient waste management strategies, including recycling, proper disposal of hazardous materials, and establishing temporary waste treatment facilities, is crucial. Additionally, developing plans for handling the aftermath of massive destruction and repurposing materials wherever possible contributes to sustainable reclamation efforts.

Addressing these environmental aspects in the reclamation process is vital for restoring affected industrial sites in a manner that ensures safety and promotes environmental health and resilience in the face of future challenges.

6.4 Social Category

In Section 5 of the questionnaire, respondents engage in pairwise comparisons among variables determining social criteria. Table 4 provides an overview of respondents' ratings for these criteria, highlighting public health, safety, and security, as well as job creation, as top priorities, followed by equal opportunities for marginalized communities where industrial sites are situated.

Table 4. Social criteria weighting

Public health, safety, and security	Work environment	Creating jobs	Equal opportunities	Human-change
0.213	0.194	0.213	0.205	0.175

In the context of post-disaster sustainable reclamation of urban industrial sites, focusing on the social category entails considerations that directly impact communities and individuals:

- Public Health, Safety, and Security: Ensuring public health and safety takes precedence. Implementing measures to safeguard workers and nearby communities, conducting health assessments to address potential hazards resulting from the disaster or industrial activities, and establishing emergency response protocols are essential for sustainable reclamation.
- Work Environment: Creating a conducive work environment post-disaster is vital. Providing safe and healthy working conditions, including proper infrastructure, access to clean water, sanitation facilities, and protective equipment, contributes to the well-being of workers involved in the reclamation process.
- Creating Jobs: Stimulating job creation and economic opportunities post-disaster is crucial for community recovery. Involving local communities in reclamation efforts through skill development programs, vocational training, and employment initiatives aids in rebuilding livelihoods and promoting economic recovery.
- Equal Opportunities: Ensuring equal opportunities for all stakeholders, including marginalized groups, women, and minorities, is imperative. Implementing inclusive policies that promote diversity and provide equitable access to employment, training, and decision-making processes fosters social cohesion and reduces inequalities.
- Human Change: Addressing the psychological and emotional impact of the disaster is pivotal. Offering support services, psychological counseling, and community engagement programs can help mitigate trauma, promote resilience, and facilitate the social adaptation required during the reclamation phase.

By addressing these social aspects in the reclamation process, efforts can be made to restore a sense of community, safety, and well-being while fostering inclusivity, economic stability, and resilience among affected populations.

4.5 Land use Category

In Section 5, participants engage in pairwise comparisons among variables determining land use criteria. Table 5 illustrates the participants' ratings, with the highest rating attributed to improving neighborhood plans, followed by concerns regarding policies of ownership.

Table 5. Land use criteria weighting.

Brownfield development	Neighbourhood plans	Policies and ownership
0.315	0.349	0.336

In the post-disaster context of sustainable reclamation of urban industrial sites, focusing on the land use category entails several crucial considerations:

- Brownfield Development: It is essential to reclaim and repurpose brownfield sites, which are previously developed but abandoned or underutilized industrial areas. Implementing plans for the redevelopment of these sites ensures their productive use while mitigating environmental risks associated with contamination or pollution.
- Neighborhood Plans (including industrial site's workers' accommodation): Developing comprehensive neighborhood plans within reclaimed industrial sites is vital to avoid the slums growing around the industrial sites. This includes designing residential areas, communal spaces, amenities, and infrastructure while considering appropriate accommodations for laborers involved in the site's reclamation or subsequent industrial activities.
- Policies and Ownership Laws and Regulations: Establishing clear and effective policies, laws, and regulations governing land ownership and use post-disaster is critical. This involves defining ownership rights, setting land use regulations, and enforcing zoning laws to ensure sustainable and equitable development within reclaimed industrial areas.

Efforts in land use planning should aim to revitalize abandoned industrial spaces, create functional and harmonious neighborhoods, and ensure compliance with legal frameworks. This approach facilitates the transformation of previously disrupted industrial sites into vibrant, safe, and economically viable spaces conducive to community living and sustainable urban development.

6.6 Alternatives' ranking

The survey analysis unveiled that respondents assigned the highest ratings to economic criteria, followed by social and land use criteria, which were equally ranked in second place, and finally, environmental criteria. The multi-attribute analysis conducted for the sustainable reclamation of the urban industrial area in Al-Qaboun, Damascus, post-conflict, entailed evaluating three distinct alternatives aimed at addressing the complexities of industrial site reclamation in a post-disaster context. These alternatives sought to prioritize economic, environmental, social, and land use considerations. The three alternatives examined were as follows:

- A1: Refurbishment in the same location (Al-Qaboun): This entailed the restoration and refurbishment of existing industrial facilities within Al-Qaboun, with a focus on revitalizing current infrastructure without relocating industries.
- A2: Relocation of heavy industries only to Adra Industrial City: This proposed the demolition of heavy industrial factories in Al-Qaboun and their relocation to Adra Industrial City outside Damascus, consolidating heavy industries away from densely populated areas.
- A3: Demolition and relocation of the entire site to Adra Industrial City: This suggested the complete demolition of the Al-Qaboun industrial site and the relocation of all facilities to Adra Industrial City outside Damascus, evacuating the industrial zone entirely from its current location

Table 6. Alternatives ranking.

Alternatives	Description	Rating	Decision favoured
A1	Refurbishment of Al-Qaboun industrial site	0.319	2
A2	Relocation of the site heavy industries only to Adra industrial city	0.294	3
A3	Relocation of the whole industrial site to Adra industrial city	0.386	1

These alternatives were assessed based on predefined criteria weighting, including economic viability, environmental impact, social implications, and land use considerations. Examination of responses revealed that A3 received the highest ranking with a score of 0.386, followed by A1 with a score of 0.319, and A2 with a score of 0.294.

This evaluation favors the complete relocation of the industrial site (A3), suggesting perceived advantages in economic, environmental, social, and land use factors compared to refurbishment or partial relocation alternatives.

To ensure stakeholder satisfaction, it is recommended to prioritize maximizing safety and security, minimizing negative impacts on neighborhood communities, expenses, environmental harm, and enhancing the well-being of the workforce involved in the construction process and industrial area.

The data collected are considered reliable for this research, given participants' expertise and experience in relevant professional domains and direct involvement with industrial site reclamation. Despite the limited sample size, the findings align with existing literature and case study expert opinions, supporting the validity of the outcomes.

7. Benefits and limitation

The survey findings highlighted a prioritization of economic criteria by participants, followed by social and land use criteria, which shared the second position, with environmental criteria ranked the lowest. A multi-attribute analysis was conducted for the sustainable reclamation of Al-Qaboun, with three alternatives evaluated against predefined criteria: A1 involved refurbishment within Al-Qaboun, A2 proposed demolition and relocation of heavy industrial factories to Adra industrial city, and A3 suggested demolition and relocation of the entire site to Adra industrial city. The overall participant ratings for these alternatives were A3 (0.386), A1 (0.319), and A2 (0.294), as shown in Table 6.

These outcomes underscore the potential efficacy of simplified methods during initial planning phases, particularly in identifying development options. However, further investigation is warranted to understand the influences exerted by various stakeholders, including local authorities, developers, industrialists, neighboring communities, and end-users, in implementing sustainable reclamation of urban industrial sites. Understanding these dynamics, responsibilities, and interrelations among stakeholders is crucial for fostering the adoption and execution of such initiatives.

Regarding the proposed industrial refurbishment and expansion in Al-Qaboun, the plan is expected to significantly encroach upon remaining green spaces, with anticipated land use distribution of 70% industrial facilities, 15% green spaces, 10% general construction, and 5% infrastructure. However, the

region faces challenges such as building damages, a surface war tunnel, and underground tunnels constructed clandestinely by militants, posing structural threats to affected buildings and infrastructure.

Al-Qaboun's historical significance as a transportation hub is juxtaposed with its numerous polluting industries operating without adequate pollution control measures, leading to environmental degradation and heightened pollution levels impacting nearby residential areas.

The research advocates for policymakers, authorities, private organizations, and the public to address challenges and consequences of de-industrialization at such sites. Recommendations include establishing a legislative framework for preserving modern industrial heritage and preventing privatization of national facilities classified as modern industrial heritage. These efforts recognize their contribution to economic activities and national identity.

This study, serving as a pilot investigation, suggests replication to demonstrate the diversity of modern industrial heritage in various post-disaster contexts. Future research opportunities involve utilizing Geographic Information System (GIS) or Fussy Analytic Hierarchy Process (FAHP) analysis to further explore a structured technique for organizing and analyzing complex decision of industrial site recalcination with multiple factors, different stakeholders' interests and a number of alternatives. These distinctive disciplines, FAHP, GIS and MCDA, can benefit from each other. Investment in industrial areas is a decision-making problem, which includes multiple and conflicting criteria. Further research could use fuzzy analytic hierarchy process FAHP to take these criteria into account and to handle vague and incomplete data. According to Asfaw et al. [28], GIS has many weaknesses in spatial decision-making. Integration of GIS technology with MCDA is the solution to these limitations. Moreover, Olawumi and Chan [29] indicated that MCDA provides a comprehensive set of tools and approaches for organizing FAHP problems and designing, assessing, and ranking possible alternatives. The developed MDMC criteria for industrial site reclamation should provide comprehensive insights crucial for ecological and footprints of cities [30] along with practical management techniques for optimizing different stakeholders conflicting interests [31]. Therefore, it can be concluded that GIS, FAHP and MCDA, at its most basic level, is a tool for transforming and combining geographic data with value judgments (the decision-makers preferences) to acquire information for decision making.

8. Conclusion

The core focus of this study centers on applying multi-attribute analysis for the sustainable reclamation of urban industrial areas, with a particular focus on the post-conflict case of Al-Qaboun in Damascus. Through an assessment of damages and pre-existing issues in the urban industrial zones preceding the conflict, significant challenges have been identified. While the usual emphasis during reconstruction tends to lean towards urgent rebuilding and renovation, the Damascus case study sheds light on inherent deficiencies in the original built environment, necessitating fundamental alterations. However, the execution of the proposed framework may encounter potential hindrances, given ongoing conflicting interests and financial limitations.

The developed criteria provide comprehensive insights crucial for practical implementation in reclaiming urban industrial sites within the Damascus Metropolitan region. This approach mandates a holistic consideration of pertinent decision-making factors before initiating the reclamation process. Furthermore, critical factors influencing the adoption of this multi-attribute approach can serve as a consultative tool for project stakeholders, potentially guiding governmental and local authorities in framing conducive regulations for industrial site development and business beyond borders (BBB) in Syria post-conflict.

The successful adoption of the multi-attribute approach in decision-making promises to modernize the process of integrating sustainable industrial site reclamation in Damascus, actively engaging industrialists and their requirements at the project's outset, thereby streamlining decision-making. This

approach seeks to rationalize decision-making processes, creating avenues for international investment in post-war reconstruction and fostering a sustainable industrial economy. Additionally, it facilitates seamless communication and collaboration among various stakeholders, including building designers, owners, local authorities, project managers, and end-users.

In summary, the survey findings indicate a prioritization of economic criteria, followed by equally rated social and land use criteria, with environmental factors receiving the lowest ranking among participants. While streamlined methods exhibit potential in initial planning phases, a deeper comprehension of the multifaceted influences of diverse stakeholders, ranging from local authorities to industrialists and communities, is critical for successful sustainable urban industrial site reclamation initiatives. Tackling significant challenges, such as the proposed industrial expansion in Al-Qaboun, and preserving industrial heritage necessitate collective efforts from policymakers, authorities, organizations, and the public. This study propels future avenues for exploration, replication in diverse post-disaster contexts, leveraging advanced tools, and protecting industrial sites, recognizing their historical significance and economic potential.

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