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Sustainable Reconstruction in Gaza Through Rubble Recycling*

A Methodological Approach

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***Abstract*— During the recent fighting in the Gaza Strip, an enormous amount of demolition debris was produced. This poses serious environmental, economic and social problems to the affected community. The enormous volume of rubble is clogging streets and open public spaces, and removal of the debris will take several years, which will further delay any rebuild efforts to construct critical services like roads, health facilities, and schools. This affects people's lives in dangerous ways (Al-Mabhouh et al., 2009). This paper discusses the rubble removal problems in Gaza, describes a debris manual excavation methodology using a large scraper loader, and presents practical results obtained in Gaza. 2021).**

Developing a sustainable approach to building by reusing building materials and re-cycling waste into resources is a practice that is ecologically, socially and economically beneficiaL and healthy for the community. Reusing the massive amount of debris from the war in Gaza is an excellent opportunity to work maximally with local resources and to avoid importing unnecessary materials.

This research aims at identifying the environmental, economic and social dimensions of the debris recycling process in Gaza, within the framework of possibilities for reconstruction on the basis of Cittaslow principles. Cittaslow is a movement to promote human scale development that encourages sustainable tourism, local production and consumption, and fosters livable urban environments. At the same time, the research seeks to identify the potential of using debris for immediate reconstruction needs and for long-term social objectives. The research thus seeks to locate the frameworks of reconstruction efforts in Gaza within a wider vision that is based on sustainability and local environment, and empower local efforts for development.

***Keywords*— Sustainable reconstruction; Rubble recycling; Post-conflict architecture; Recycled concrete aggregate (RCA); Architectural model; Gaza.**

I. INTRODUCTION

Few urban disasters in recent memory have produced destruction on the scale now visible across the Gaza Strip. Successive waves of bombardment have torn through neighborhoods, leaving behind not just rubble but the collapse of an entire urban system — the roads, water lines, buildings, and spatial relationships that make a city function. Estimates from geospatial and environmental surveys put the debris generated by the conflict somewhere between 42 and 61 million tons, a figure so large it defies easy comprehension and has no real modern parallel (OCHA, 2025). Scholars studying the deliberate targeting of urban infrastructure have called this kind of destruction "urbicide" — the killing of a city as a political act, one that erases not only buildings but the collective memory and civic identity embedded in them (Zoubi & Hawari, 2025).

What makes Gaza's situation particularly intractable is that the conventional playbook for post-war clearance simply doesn't apply here. The standard approach — haul the rubble out, dump it elsewhere, start fresh — would require millions of truck trips and release upward of 55,000 tonnes of CO_2 equivalent in the process, all in a territory already stripped of basic resources (University of Edinburgh, 2024). Logistically and environmentally, it's a non-starter. Planners are therefore being pushed toward a fundamentally different framing: rather than treating the debris as something to be removed before reconstruction can begin, they must treat it as the starting point — the raw material from which recovery is built.

This is where the material science becomes genuinely interesting. Research into war-generated Recycled Concrete Aggregate (RCA) suggests that crushed rubble can replace up to 50% of virgin aggregate in structural concrete applications, and can substitute entirely for natural aggregate in non-structural uses like paving and fill (Ali et al., 2020; Alfaqawi, 2018). On the ground in Gaza, this has already taken a tangible form: locally developed "Green Cake" bricks made from recycled rubble have shown real promise as a lightweight, thermally efficient masonry unit (Mashharawi, 2017).

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Institutional recognition is beginning to follow — the Palestine Higher Green Building Council has started formally incorporating RCA into its standards, a signal that this approach is moving from improvisation toward policy (PHGBC, 2024).

None of this is straightforward, however. The rubble isn't clean concrete — it's laced with an estimated 800,000 tons of asbestos, heavy metals, and unexploded ordnance, meaning that processing it carries serious public health and safety risks that demand careful, systematic protocols before any material can be reused (UNEP, 2024). There's also a dimension to this question that goes beyond engineering. The ruins of buildings are not neutral objects; they carry the weight of lived experience, and decisions about what to preserve, what to process, and what to memorialize are bound up with questions of trauma, identity, and Palestinian steadfastness (Fadel & Sender, 2026).

This article sits at the intersection of all these concerns. Its central argument is that recycling structural debris is not simply a practical workaround for Gaza's reconstruction — it is, in fact, the most coherent path toward sustainable recovery. By examining the social, economic, and environmental dimensions together, This article lays out a set of strategies for circular reconstruction — practical, grounded approaches that reframe Gaza's rubble not as an obstacle to recovery, but as the very material from which it can be built.

II. Theoretical Framework

This study is underpinned by a Triple Bottom Line (TBL) sustainable development paradigm when assessing the performance of different approaches to manage and utilise structural war-debris in post-conflict zones. The traditional and linear approach to managing the large amounts of structural war-debris left over in the Gaza Strip following the recent rounds of conflict concentrates solely on the removal and disposal of waste in a bid to sanitise the environment and allow for rebuilding. This study seeks to evaluate a recycling model of war-debris management, applying the three TBL sustainability 'pillars' within a circular economy framework (environmental pillar) and within the context of local economic resilience (economic pillar). In addition, the study examines the socio-spatial memory associated with the reuse of conflict remnants (social pillar).

The environmental basis of this research stems from an understanding of the potential of the Circular Economy (CE). Rather than the 'take-make-dispose' (linear) economy model decoupling economic growth from the finite availability of natural resources (Kirchherr, Reike, & Hekkert, 2017), the circular economy prevents the loss of materials and products, keeping them in continuous use loops. In the post-war city, C&D waste viewed as 'urban cancer' is rethought as raw materials to be re-circulated back into the construction process. Theoretically using Recycled Concrete Aggregate (RCA) in construction projects can address two of the worlds most serious environmental problems (land degradation and resource depletion). Recycling a large amount of rubble for use as a material in construction can reduce the consumption of virgin aggregates that are needed for construction, which will help in preventing the exhaustion of natural resources and reduce carbon emissions due to the process of quarrying and import of raw and costly materials from far places. In the territorial confined area of Gaza Strip, millions of tons of debris can be diverted from landfills where this toxic waste will land, permanently toxifying and consuming limited available agricultural and ecological lands and wastes. The recyclable material can be reused in sustainable development projects.

The economic analysis adopted in the study is based on an economic approach broader than cost-benefit analysis and is aimed at measuring local economic resilience. The research hypothesis is based on a well-established analysis of the situation in the Gaza Strip that describes the situation as one of de-development; i.e. the stripping of the Gaza Strip of the possibility of sustainable development. The study also considers several alternative uses for the allocated funds for importing cement and virgin construction aggregates for concrete production, but examines these alternatives within the specific context of the geopolitical situation that prevails in the Gaza Strip and which affects any solution for lifting the constriction of the border and ban on importing "dual-use" materials.

Recycling of structural demolition waste can empower the building construction supply chain by providing an alternative to politically restricted imported timber. The recycling system will be decentralised, organised from debris sorting, removal of hazards to crushing of waste into reusable material. The process will generate participatory micro-economies where large number of people will be involved. It will therefore generate much needed employment and inject money into the impoverished communities. The process will be labour intensive, but it will replace an import-dependent process with an indigenous, locally-generated economic stimulus package.

Even more problematic to the discourse around reconstruction, however, is its social dimension. The geography of trauma left by Israel's assault on Gaza cannot be ignored in discussions about what kind of reconstruction might be required in the aftermath. Gaza was subject to urbicide when most of its built environment was reduced to rubble in a matter of days and it takes more than just building new houses to recreate the social space. Reconstruction requires the preservation of a particular socio-spatial memory. This paper maps the impact of the destruction of the built environment and attempts to explore

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what is meant by the reconstruction of Gaza's housing stock post-war.

'Waste' from the war rubble is difficult to recycle, stigmatised locally as 'poor' or 'deficient' buildings. However, these structures could be 'reincarnated' into 'empowering' spaces. Using a participatory design approach, the reconstruction of 'material' 'scapes' can be a powerful process of healing and of remembering. Drawing on theories of psychosocial repair, the damaged building is not demolished or erased but incorporated into the new construction – a 'living monument' to survival, physically durable and spatially connected to the past.

The paper develops a theoretical argument between the theory of the Circular Economy (re-cycling of rubble for construction) and the economics of Local Resilience (making recycling of rubble economically viable and de-blockading resources) and further tests these theories against the complex and variable issue of Socio-Spatial Memory (the memory of communities of spaces affected by war and the issue of materials that cause them psychological trauma). The paper argues that these three theories provide the most coherent and sustainable methodology of urban regeneration in post-conflict cities and suggests that they are the most fitting for current urban crises management.

III. METHODOLOGY

This study is based on a qualitative approach to explore alternatives for sustainable rebuilding by using Recycled rubble in the Gaza Strip. It focuses on three important themes related to sustainable reconstruction from the perspective of natural and built environment. These themes address three important dimensions of the reconstructive process of post conflict zones; environmental constraints, socio-economic needs and the use of local resources. A qualitative analytical approach was utilized through a critical analysis of available resources such as academic articles, reports and reconstruction models. The three themes addressed in the study are: Recycled Concrete Aggregate (RCA) products and their uses; The circular construction concept; Salvaging construction and building materials for sustainable reconstruction. *(Table I)*

The research is primarily based on case studies to explore in depth a relevant reconstruction experience where debris recycling was managed successfully. Instead of comparing all possible experiences, a focused case study is used to examine the experiences and lessons learned from the different ways material recovery and reuse / recycling strategies have been practiced and transferred to identify relevant principles and strategies that can be applied in the Gaza context. Given the current conflict in Gaza, no fieldwork can be conducted. The research relies solely on secondary sources of information including academic and technical research papers, reports, satellite imagery and assessments of the extent of damage to housing in Gaza. Analysis of this contextual information will enable the research to draw relevant conclusions. *(Table I)*

Rather than developing a site-specific architectural design, the study synthesizes the qualitative findings from the existing literature and case studies related to disaster context and examines their potential to inform strategic directions for incorporating recycled rubble into an overall architectural or urban planning design from an environmental, efficient and social centered perspective. The analytical framework is established from the literature review and the community-centered rebuilding strategies, as well as the findings from the case studies on circular construction and material reuse. *(Table I)*

The evaluation of the project is based on an assessment from an environmental, economic and social perspective. The environmental aspect considers the potential for waste reduction, embodied energy and the opportunities for material re-use and recycling. The economic aspect considers efficiency of use of resources, the use of indigenous materials and the cost of localised recycling practices. The social aspect considers the factors that affect liveability, community and trauma post-disaster. These aspects are interpreted in relation to sustainable settlement principles and used to identify the opportunities and limitations for rubble re-use and recycling.

This research applies an integrated approach of qualitative methods to investigate the potential of using recycled structural debris in order to aid sustainable architectural regeneration of war-affected territories. Rather than producing a design solution for a specific site, the research aims to develop a strategy for such post-conflict areas. *(Table I)*

TABLE I. METHODOLOGY SUMMARY TABLE

Component	Description
Research Approach	Qualitative Analytical Research
Research Strategy	Case Study Analysis
Data Sources	Peer-reviewed literature, international reports, secondary data, satellite imagery
Study Context	Post-conflict reconstruction with a specific focus on the Gaza Strip

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Analytical Scope	Rubble recycling strategies within architectural and urban reconstruction
Analytical Method	Synthesis of qualitative findings into strategic reconstruction principles
Evaluation Framework	Environmental, Economic, and Social sustainability dimensions (Triple Bottom Line)
Research Output	Strategic framework for integrating recycled rubble into sustainable reconstruction practices

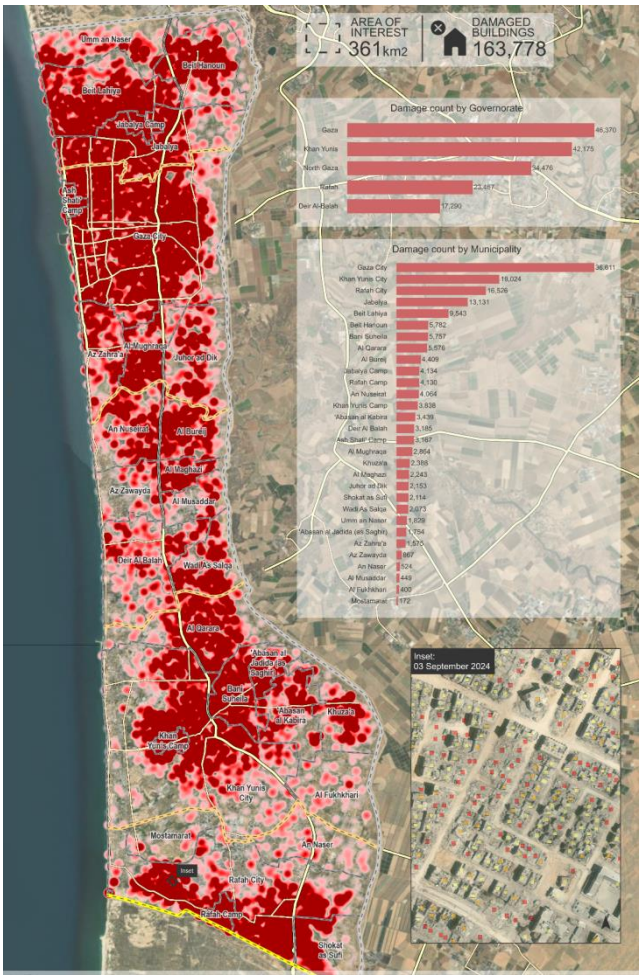
IV. CASE STUDY: GAZA

The Gaza Strip, also known simply as Gaza, is the smaller of the two Palestinian territories (the other being the West Bank) that make up the State of Palestine in the Southern Levant region of West Asia. Gaza is bordered by Egypt on the southwest, Israel on the east and north, and the Mediterranean Sea to the west. Its capital and largest city is Gaza City.*(Fig 1)*

Fig. 1. Geographical Location of the Gaza Strip and its Border Constraints

Months of bombardment have left a trail of massive amounts of rubble and construction material through the territory, much of it requiring special handling and not suitable for landfill dumping. The territory is 365 square kilometers in scale. Attempting to clear the territory of the massive amounts of rubble and shift it to a landfill would require the permanent loss of all agricultural land, virtually all of which is currently less than 5% (FAO, 2025). In-situ re-cycling of the rubble therefore becomes a necessary option from an environmental perspective. *(Fig 2)*

Fig. 2. UNOSAT Gaza Strip Comprehensive Damage Assessment



There is no rubble recycling industry in Gaza yet, but previous experiences during 2014 war proved a concept to manage C&D waste. During that war, international organizations, mainly UNDP, attempted in many locations to crush the rubble to be used as sub-base materials for backfilling and constructing streets. Besides that, many initiatives were undertaken by local initiatives. Some of them proposed a method to deal with crushed concrete to be transformed into 'Green Cake' bricks. Those bricks consist of 75% of crushed concrete and 25% of coal ash. The bricks are very light, environment-friendly and low-cost to be produced. Palestine Higher Green Building Council (PHGBC) introduced recently the concept of circular

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material flows and defined criteria to recycle aggregates as stated in (PHGBC, 2024). Therefore, Gaza has the needed technology and social capital to establish a cost-effective construction and demolition (C&D) waste management system mainly through recycling.

Gaza Project Environmental Imperative: The main environmental challenge for the project team is the high level of toxicity of the war ruins containing metal, potentially hazardous materials such as asbestos and unexploded ordnance (UNEP, 2024) within the rubble to be processed for recycling. A controlled decentralised recycling process is combined with a screening process that controls the potential risks to the workers. The clean concrete is then recirculated into the process as Recycled Concrete Aggregate (RCA).

Economic Resilience Gaza is a small place. It is bordered by restrictive walls, monitored by the international community, and crucial construction materials such as cement and virgin aggregates are frequently banned or restricted and labeled "dual-use". However, through localized recycling micro-economies and the use of neighborhood- level mobile crushers, the reconstruction sector can reduce its heavy reliance on closed and unpredictable border- crossing points. This also immediately creates a labor-intensive cash-for- work opportunity for a very impoverished population.

Socio-Spatial Recovery. The traumatic experience of the Gaza inhabitants during and after the war can be described as one of displacement from their homes and familiar social environments. The neighborhood where they lived was a residential area which was dramatically and destructively affected and even flattened. The method chosen to clear the rubble from the area was that of external contractors who lifted the whole area and left a vast empty space. This paper examines the loss of spatial memory for this space and the method chosen to deal with its remnants. A contrast is proposed between the common approach in post-disaster situations of clearing the site for new construction and an alternative methodology that would involve the people in sorting, reusing and reassembling the building materials. The public space thus created will consist of fragments of the affected neighborhood. The approach proposed here emphasizes reuse and recovery of the damaged environment within the newly created public open space. The design methodology is participative and gives priority to the affected inhabitants, encouraging them to feel proud of the rebuilt space and transform the stigma of "living in the rubble of war" into a badge of honour.

In order to translate this case study into a "sustainable reconstruction paradigm," several operational challenges would need to be addressed. Firstly, there is a need to move beyond a "bigger is better" approach to designing and executing megaprojects, and towards the development of decentralized networks of small, flexible, locally-owned projects. Secondly, the typical strategy of using large crushing plants to process materials, whilst consuming massive amounts of diesel fuel, and then undertaking further unsustainable transport over long distances, could be turned on its head by establishing a small, mobile, neighborhood-level fleet of small crushing units. In addition, local engineering syndicates and municipalities must formalize and publicize the correct technical application of RCA, moving from an ad-hoc emergency approach to a broader urban-regeneration program through a process of quality assurance in structurally sound construction using RCA.

V. FINDING

The extent of the damage in Gaza is beyond the current capacity of established methodologies for the explosive ordnance disposal, weapons release assessment and munitions clearance required in post conflict zones. The projected 42 to 60 million tons of rubble is increasingly recognised to have buried the map of Gaza, creating a new reality of up to six storey deep ruins that need technical and operationally effective approaches. This paper seeks alternative technical and operational solutions and assesses them through the Triple Bottom Line (TBL) sustainability framework to inform sustainable rebuilding practices from an environmental, economic and social perspective.

The environmental finding of this research is paradoxical. The construction waste generated by the collapse of hundreds of building is an environmental catastrophe at the same time it is a valuable building material. From an ecological perspective taking all of this rubble to external landfill sites would require millions of barrels of oil to be consumed in the engines of trucks now used in Gaza and would release millions of tonnes of carbon dioxide into the atmosphere locking off supplies of fuel running out in Gaza (University of Edinburgh, 2024). From an environmental perspective, the space required to deposit this rubble permanently would be hundreds of square kilometres of land to dispose of building waste, a country under siege that has already lost nearly 95% of its agricultural land and what is remaining is under threat from toxic leachate from waste dumped by families and businesses polluting Gaza's coastal aquifer, a resource under threat (Food and Agriculture Organization [FAO], 2025; World Bank, 2025).

Technical application of Recycled Concrete Aggregate (RCA) can make great environment contribution by saving natural resources to produce new concrete and save from pollution caused by waste concrete dumped in landfills. The use of 50% RCA in ordinary building construction and 100% for non-structural uses like paving etc. is safe for environment and promising for sustainable construction (Ali, Rahman, Dev, &

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Singh, 2020; Alfaqawi, 2018). However, extreme toxicity of construction and demolition waste hampers the use of recycling for environmental benefits. There is around 800,000 tons of carcinogenic asbestos fiber and toxic heavy metals present in the construction and demolition waste of old buildings. Thus, recycling construction and demolition waste can be environmentally friendly only when technologies are applied to mitigate these hazards. Dust suppression technologies, UXO clearance technologies and technical segregation at the source are some of the solutions which can be applied to overcome such problems (United Nations Environment Programme [UNEP], 2024; United Nations Office for the Coordination of Humanitarian Affairs [OCHA], 2025).

Localised rubble processing emerges as an economic panacea to breach geo--political obstacles. An 83% contraction of local economies due to the conflict, has resulted in paralysis of formal construction sector. Post conflict border restrictions further added to the predicament, as cement and natural aggregates were classified as “dual-use” items. A locally available supply chain of indigenous secondary resources can now assist the built environment to breach these politically mediated bottlenecks and alleviate the present economic crises.

Technology is empowering economic independence. Although high capacity jaw crushers, as commonly used in large-scale aggregate processing, are still barred under the blockade (University of Edinburgh, 2024), the operating parameters of existing systems can easily be transformed into neighbourhood-level, mobile operations with minimal transportation requirements (OCHA, 2025). Research into indigenous material engineering (Mashharawi, 2017) has found that crushed aggregate and coal ash can be mixed with conventional masonry materials to produce sustainable masonry units that are up to 30% cheaper than imported ones. Optimally designed mixes incorporating demolition materials, particularly reclaimed and otherwise destroyed concrete (RCA) from war-damaged buildings, which exhibit increased porosity, are also being researched (Peiris, Gunasekara, Law, & Setunge, 2025). These new construction processes are being channeled through structured cash-for-work programs and have the potential to generate thousands of green jobs and pour money into the economy.

The paper investigates into architectural strategies and socio spatial implications that go beyond the physical and the economic dimension of challenges that relate to inhabiting war ruins. In Gaza, the physical destruction of hundreds of thousands of houses, in a targeted dismantling of crucial civic infrastructure, can be read as urbicide, an attempt to erase communities and their histories. However, the findings of the study reveal a widely recognised social stigma within Gaza related to inhabiting reutilised war ruins. What the participants within the study perceived as symbols of poverty, they also viewed the war ruins as traumatic grave sites that require commemoration rather than inhabitation.

For Halabi (2024), rebuilding can and must be psychosocial. This is achieved through technical means; most importantly, the very participative design process in which local inhabitants participate in sorting out and zoning of the land on which they live. Architecture is used to heal the psychosocial wounds; physical transformation is channeled and celebrated in order to confront, process and memorialize physical and emotional wounds, thus creating what can be called ‘living monuments’. The surface of the destroyed building is not erased, it is not vanished into the vast rubbish dump of the ruins of the city, rather it is painstakingly recovered and gradually reconstituted into the thresholds and façades of the new building. Thus, the destruction is not erased, but is gradually metabolized into the new space, turning the site of the destruction into a positive palimpsest of memory and resilience.

Moreover, the institutional formalisation of this approach to architectural intervention technically legitimize the community’s involvement in the mass of rubble since 2008 is gradually transformed into an affirmative and dignified archive of the Palestinian people’s struggle and determination to build a dignified life. This approach is emerging within the newly formed Palestinian architecture. The Palestine Higher Green Building Council (PHGBC, 2024) for example has introduced sustainability certification within which a minimum of 15% of the materials used in construction should be recycled materials, such as recycled aggregate.

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TABLE II. QUALITATIVE SYNTHESIS OF CHALLENGES, STRATEGIES, AND OUTCOMES FOR POST-CONFLICT RUBBLE RECYCLING

Category / Theme	Extracted Codes	Reference	Challenges & Constraints	Extracted Strategy	Impact & Outcomes
1. Environmental	60 million tons of rubble. Loss of 95% of agricultural land. 800,000 tons of asbestos and UXO. Concrete porosity & high water absorption (Technical).	(UNDP, 2025) (FAO, 2025) (UNEP, 2024) (Peiris et al., 2025)	Comprehensive destruction and massive rubble accumulation. Mass transportation is logistically impossible. High toxicity of ruins risks depleting the remaining 5% of viable agricultural land through traditional landfilling.	Prioritize rigorous risk mitigation protocols (UXO clearance, dust suppression, precise segregation). Abandon the "Tabula Rasa" approach. Utilize nanomaterials to address rubble vulnerabilities for up to 50% RCA structural substitution.	Prevents total toxification of the territory and protects the coastal aquifer. Transforms debris from a disposable obstacle into a primary in-situ resource, exceeding the 15% green building baseline.
2. Economic	83% economic contraction. "Dual-use" material restrictions. "Cash-for-work" programs. Decentralized mobile crushers (Technical). Institutional vacuum (Technical).	(World Bank, 2025) (OCHA, 2014) (UNDP, 2025) (University of Edinburgh, 2024) (Israa University, 2019)	Economic collapse and strict border blockades on essential materials. Prohibitions on importing heavy industrial crushers and severe fuel shortages. Absence of legally binding post-disaster structural codes.	Transition to a localized RCA supply chain. Pivot toward agile, decentralized networks relying on small mobile crushers at the neighborhood level. Locally formulate standardized technical guidelines and formalize "cash-for-work" recycling operations.	Achieves "material sovereignty" from politicized border crossings. Produces local masonry units at up to 30% lower costs. Generates thousands of green jobs and injects vital liquidity into impoverished communities.
3. Social	Urbicide. Stigma. Living monuments.	(Zoubi & Hawari, 2025) (Fadel & Sender, 2026) (E-flux Architecture, 2025)	The "double erasure" of spatial memory. Severe social stigma and psychological distress associated with inhabiting spaces built from conflict detritus.	Move away from top-down masterplans toward community-led "participatory design" frameworks. Integrate scarred stones and recognizable architectural fragments into the facades of new buildings.	Facilitates deep psychosocial repair. Transforms sterile reconstruction into "living monuments" that serve as a continuous, dignified archive of Palestinian steadfastness and survival.

Note. This table synthesizes the extracted codes, strategic interventions, and projected outcomes of circular reconstruction in Gaza, categorized by the three pillars of sustainable development.

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VI. DISCUSSION

The findings of this analysis indicate that the unprecedented scale of destruction in the Gaza Strip—characterized as an intentional "urbicide" (Zoubi & Hawari, 2025)—fundamentally invalidates traditional post-conflict reconstruction models. The accumulation of up to 61 million tons of debris (United Nations Development Programme [UNDP], 2025) renders conventional *tabula rasa* approaches mathematically and logistically obsolete. Instead of treating this debris merely as a waste management crisis to be cleared, the reconstruction framework must undergo a radical paradigm shift. The ruins must be conceptualized as the indispensable topographical baseline and primary material resource for localized recovery. Moving away from import-reliant megaprojects (University of Edinburgh, 2024), this study discusses the implications of an adaptive, in-situ circular urbanism through the Triple Bottom Line (TBL) framework.

The most critical environmental tension identified in this study is the dual nature of the war ruins: they are simultaneously a severe ecological hazard and a vital secondary resource. From a land preservation standpoint, preventing the mass landfilling of debris is an existential imperative. Diverting waste is the only way to preserve the territory's remaining 5% of viable agricultural land and protect the underlying coastal aquifer from toxic leachates (Food and Agriculture Organization [FAO], 2024). To achieve this, the technical validation of utilizing recycled concrete aggregate (RCA) in structural applications (Ali et al., 2020; Peiris et al., 2025) must be viewed primarily as an ecological defense mechanism rather than just an engineering feat. Meeting future humanitarian environments agendas is rendered very challenging by the presence of hundreds of thousands of tonnes of asbestos, tons of heavy metals and millions of items of unexploded ordnance (UXO) scattered over the built environment (Mines Advisory Group [MAG], 2024; United Nations Environment Programme [UNEP], 2025). Achieving this environmental agenda will therefore succeed or fail through localisation and the implementation of humanitarian environments agendas, and the adoption of mobile, neighbourhood-based UXO clearance technologies and techniques as well as emerging construction methods for mitigating the risk of asbestos release into the environment for future generations.

Processed structural debris is being removed from the site and re-used in local construction. Local technical innovations for the re-use of building materials are more than just cost effective solutions. They are crucial for the economy, and indeed geopolitics, allowing materials to be imported across borders that have been blocked for post conflict reconstruction due to the fear of posing a threat at borders by being declared ‘dual use’. Often a large proportion of a building can be re-invented and re-used, with up to 100% of non structural elements being re-cycled (Alfaqawi, 2018; Mashharawi, 2017). Using local innovations, the skills and labour of local people can be empowered within the reconstruction supply chain to create materials that are sovereign and independent of external aid. Idealised solutions might be to process the large volumes of debris within a centralised recycling facility, however due to restrictions on the importation of heavy industrial crushers, and on time as fuel runs out, an innovative neighbourhood approach has been adopted. Processing of the large volumes of building materials has been organised and facilitated through the principles of crisis adapted Cittaslow (Plomteux, 2024), reorganising how the residents of a neighbourhood go about reusing building materials found in the ruins. However, the so-called humanitarian crisis in the West Bank is often turned into a good business by making this time-consuming work. By investing in grassroots recycling cooperatives, IEE is catalysing the collapsed local economy and turning the crisis into a cash-for-work micro-economy.

The social dimension of urbicide refers to the social damage caused to the inhabitants of the target city. In the case of the Palestinian urbicide, the ruins of demolished Palestinian residential spaces and areas are gradually being transformed into reused and recycled spaces. However, these new created spaces and their newly found uses entail double erasure of the original Palestinian identity and their spatial memories and experiences. The social trauma and stigmatisation attached to the inhabitants of the destroyed city and their future transmuted and devalued spaces cause shame, making it difficult to discuss or display them positively and thereby impeding the healing process. Therefore, and to overcome such social problems, it is imperative that the healing processes be inclusive of the community at large, and that the ruins be re-used positively and constructively, thus turning the destroyed city into a “living monument” to Palestinian memory and the strength of their spirit and ability to be resilient in the face of adversity. It is also important that the psychological and social processes of healing are facilitated in safe spaces within the current undeveloped institutional landscape in the Gaza Strip. Technical standards should be used to build social trust. Initially, a short-term approach to address the immediate needs of those affected by the crisis can grow into a long-term urban strategy in which local engineering syndicates and Palestine Higher Green Building Council (PHGBC) mandate the use of recycled aggregate in building codes post-disaster. Currently, PHGBC works with local engineering syndicates to encourage voluntary use of 15% recycled aggregate in building construction (PHGBC, 2024).

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TABLE III. DISCUSSION SYNTHESIS: PARADIGM SHIFTS AND STRATEGIC INTERVENTIONS

Sustainability Dimension	Required Paradigm Shift	Core Paradox & Tension	Strategic Interventions & Policies
1. Environmental	From the "Tabula Rasa" (mass clearance) approach ➔ to "In-situ Circular Urbanism," conceptualizing rubble as the "Topological Baseline."	The Ethical/Ecological Tension: The impossibility of rubble disposal (due to logistical constraints) versus the lethal ecological and public health hazards (asbestos, UXO) inherent in the ruins.	Deploy international mobile units at the neighborhood level for UXO clearance and asbestos containment to support local grassroots efforts. Establish rigorous, safe frameworks to prevent secondary health catastrophes during material recovery.
2. Economic	From dependency on politically controlled crossings ("dual-use" materials) ➔ to "Material Independence" and localized supply chains.	The Geopolitical Tension: The exploitation of the blockade to paralyze urban recovery versus the success of local innovations in achieving material substitution rates of up to 100%.	•Abandon import-reliant megaprojects in favor of highly adaptive, decentralized urban frameworks. •Systematically channel financial recovery funds into "cash-for-work" cooperatives, transforming the humanitarian crisis into a local economic catalyst.
3. Social	From sterile reconstruction (architecture as erasure) and emergency coping mechanisms ➔ to building "Living Monuments" and permanent, resilient urban strategies.	The Psychosocial Tension: Rubble serves as a vital vessel for spatial memory and psychosocial recovery, yet community-led efforts are paralyzed by an "institutional vacuum."	Transition the voluntary 15% recycled baseline (PHGBC) into a legally binding, post-disaster building code to ensure structural safety. •Implement community-led sorting and participatory design, drawing on crisis-adapted Cittaslow principles to facilitate psychosocial repair.

VII. CONCLUSION

Recycling rubble is not only significant for dealing with the huge amounts of rubble caused by the war, but also affects how architects design within Gaza's confines and utilizes the available spaces within the city. The study explores the uses of recycled concrete in building design. It emphasizes the viewer's perception in using the recycled concrete in building designs at the post war reconstruction period in Gaza. The study highlights the importance of perceiving the amounts of rubble from the war as raw and available materials in the sustainable design for reconstruction and development of the city of Gaza. Environment can be protected in the process of reconstruction and a more sustainable city could be built.

The use of recycled rubble in construction has the potential to provide numerous benefits for the environment, economy and society. Firstly, by using recycled concrete aggregate, or RCA, the amount of virgin raw materials needed decreases, the emission of carbon dioxide decreases, and the environmental impacts associated with quarrying and materials transportation decrease. Secondly, the use of recycled locally sourced materials can have economic benefits such as saving money while also creating jobs and boosting the local economy. thirdly, reusing war-debris for construction has deep social meaning, by giving communities the opportunity to rebuild in the aftermath of destruction, while also trying to preserve cultural heritage and history of significant events.

Designing buildings and reusing the old rubble in the constructive process to make functional spaces for living in dignity in an environmentally friendly way, is as relevant as kiosks, squares, public spaces, housing, other structures and weather. This concept is not different from Cittaslow principles and methodologies, especially in post conflict reconstruction. Involving the community and feeling of belonging are equally important.

This short study examines low-cost alternative approaches to architecture using rubble as a primary building material. The study report outlines the lessons learned in relation to post-disaster rebuilding in Gaza, suggesting that current approaches to rebuilding need to change. The report discusses the use of locally available materials in constructive methods and the incorporation of recycled materials in architectural designs, both structurally and as part of the architectural character of a space. Rebuilding with recycled materials can be a sustainable, economically intelligent and community-sensitive method of reconstruction. This approach can be particularly relevant in conflict affected areas and can form a component of a longer term sustainable development approach.

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