

CONCEPTUAL

Beyond Reconstruction: A Five-Dimensional Recovery Model (Five-DRM) for Sustainable Post-Conflict Urban Development in Sudan

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ABSTRACT

PURPOSE: This paper introduces the Five-Dimensional Recovery Model (Five-DRM) that offers an innovative system to understand the dimensions of sustainable urban recovery and reconstruction within the context of post-conflict Sudan. The Five-DRM combines recovery dimensions of digital recovery and transformation, socio-economic recovery, environmental recovery, recovery of institutions, and urban recovery.

APPROACH/METHOD: The research involved a qualitative analysis of literature related to recovery from conflict. This analysis was supplemented by a comparative analysis of international recovery frameworks, case studies of select post-conflict situations, and a context analysis of the recovery challenges of Sudan. The framework was formed by the bundled lessons of recovery from conflicts around the world and studied to what extent these lessons could be applied to Sudan.

RESULTS: The current development of recovery frameworks deals with the separate dimensions of reconstruction. There is little to no guidance for post-conflict urban recovery in Sudan. The Five-DRM framework brings together the digital transformation and recovery, socio-economic, environmental, institutional, and urban recovery dimensions in a single framework and, in doing so, provides an opportunity to promote long-term sustainable and inclusive resilience.

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ORIGINALITY/VALUE: The model is one of the first frameworks for integrated recovery concepts for post-conflict Sudan and incorporates an innovative digital transformation and recovery dimension. The Five-DRM model focuses on recovery dimensions and will encourage the achievement of SDGs 9, 11, and 16.

RESEARCH CONSTRAINTS: The inability to collect primary field data due to conflict in Sudan was compensated for by using validated secondary data and comparative case studies. Consequently, the proposed framework should be considered an initial conceptual model that requires future empirical testing and validation.

PRACTICAL USE: The model provides a framework for policy-makers, planners, and development professionals engaged in rural reconstruction and recovery from conflict.

KEYWORDS: *Post-Conflict Reconstruction; Sudan; Sustainable Urban Recovery; Urban Resilience; Digital Transformation and Recovery; Governance; Sustainable Development; Five-Dimensional Recovery Model (Five-DRM).*

INTRODUCTION

Sudan's urban centres affected by the 2023 conflict face severe challenges, including damaged infrastructure, social fragmentation, population displacement, and economic decline. Recent Sudan-focused scholarship has similarly emphasised the importance of national reconciliation, governance reform, decentralisation, and institutional rebuilding as prerequisites for sustainable post-conflict recovery (Ahmad, 2025).

Traditional reconstruction approaches have emphasised physical rebuilding while overlooking the social, economic, environmental, and institutional dimensions required for sustainable recovery and long-term resilience (Barakat and Zyck, 2009; Vale and Campanella, 2005). Despite the availability of international recovery frameworks, limited attention has been given to developing an integrated model specifically for Sudan's post-conflict urban context.

This paper introduces the Five-Dimensional Recovery Model (Five-DRM), comprising five interconnected dimensions: digital transformation and recovery, socio-economic revitalisation, environmental recovery, institutional recovery, and urban recovery. The framework aims to address resilient, inclusive, and sustainable urban recovery in Sudan (Mohammedani and Abdelgader, 2025; Yousif and Ali, 2025).

METHODOLOGY

This study adopts a qualitative analytical methodology combining literature review, comparative analysis, and contextual evaluation. It examines global post-conflict recovery frameworks, assesses their applicability to the Sudanese context, and draws on selected international reconstruction experiences. A future-oriented perspective is also employed to identify practical pathways for sustainable recovery.

The comparative analysis interrogated existing recovery frameworks across five dimensions: digital transformation and recovery, socio-economic, environmental, institutional, and urban dimensions. Case studies were selected based on their relevance to post-conflict or post-disaster reconstruction and their applicability to Sudan. The Five-DRM was developed through the synthesis of findings from the literature review, comparative framework analysis, international case studies, and an assessment of Sudan's contemporary recovery challenges.

LITERATURE REVIEW

Urban and Historical Context of Conflicts in Sudan

Urban planning in Sudan: historical legacies, interrupted progress, and the impact of conflict

Sudan's urban development has been significantly shaped by recurring conflicts, environmental crises, and political instability. The 2023 conflict further disrupted urban planning through infrastructure destruction, displacement, and the diversion of resources from development to emergency response (Kirui *et al.*, 2024; Yousif and Ali, 2025). Despite several planning initiatives for major Sudanese cities, implementation remained limited due to financial constraints and weak public participation (UN-Habitat, 2015).

Successive conflicts and environmental shocks accelerated rural-to-urban migration, contributing to rapid urbanisation, infrastructure deficits, and growing governance challenges. As argued by Mohammedani and Abdelgader (2025), sustainable urban development in Sudan requires an integrated long-term vision linking reconstruction, environmental sustainability, economic development, and participatory governance. Figure 1 summarises the major political and conflict-related events that have influenced Sudan's urban development and continue to shape post-conflict recovery priorities.

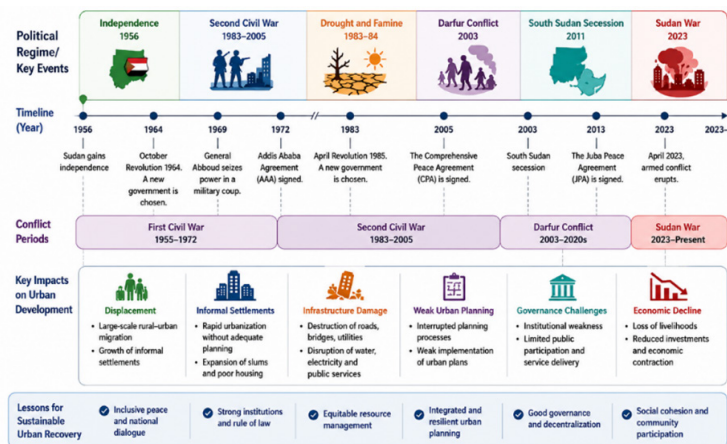


Figure 1: Major Political and Conflict Events Influencing Urban Development in Sudan (1956-2023)

Source: Constructed by author based on UN-Habitat, 2015

These conditions underscore the need for integrated recovery approaches that combine physical reconstruction with institutional, socio-economic, environmental, and digital transformation and recovery dimensions. Barakat and Chard (2002) argued that post-conflict recovery should focus on rebuilding institutional and societal capacities rather than merely replacing damaged infrastructure, providing an important theoretical foundation for the integrated approach adopted in the Five-DRM.

Demographic and social transformations after wars

Conflicts in Sudan, particularly the Second Sudanese Civil War, the Darfur conflict, and the 2023 war, have caused large-scale displacement and significant demographic changes, creating one of Africa's largest populations of internally displaced persons and refugees (Kirui *et al.*, 2024). These conflicts have accelerated unplanned urbanisation, expanded informal settlements, weakened social cohesion, and increased pressure on housing, infrastructure, and basic services (UN-Habitat, 2015). Long-term impacts include reduced access to education, healthcare, employment opportunities, and social protection, particularly for women and youth (Kirui *et al.*, 2024).

These challenges underscore the need for recovery strategies that promote social inclusion, community resilience, and equitable access to services. Figure 2 illustrates the scale of displacement and settlement expansion resulting from prolonged conflict in Sudan.



Figure 2: Displacement and Informal Settlement Expansion in Sudan Following Conflict

Source: UNHCR, 2024

Impact of conflicts on infrastructure and the local economy

The 2023 conflict severely disrupted economic activity, administrative systems, and access to information, particularly in Greater Khartoum. Displacement, market disruption, damaged commercial infrastructure, and interruptions to communication and financial services reduced access to markets and remittances, deepening the economic crisis and hindering recovery efforts (Kirui *et al.*, 2024). Major cities, including Khartoum, El Geneina, and Nyala, experienced extensive damage to critical infrastructure such as hospitals, water networks, electricity grids, and transport systems, disrupting essential services and humanitarian operations. Productive sectors, including agriculture and manufacturing, were also severely affected, with significant implications for food security and economic recovery.

Figure 3 illustrates the scale of urban destruction and infrastructure damage caused by the conflict, highlighting the challenges facing reconstruction and economic recovery efforts in Sudan.

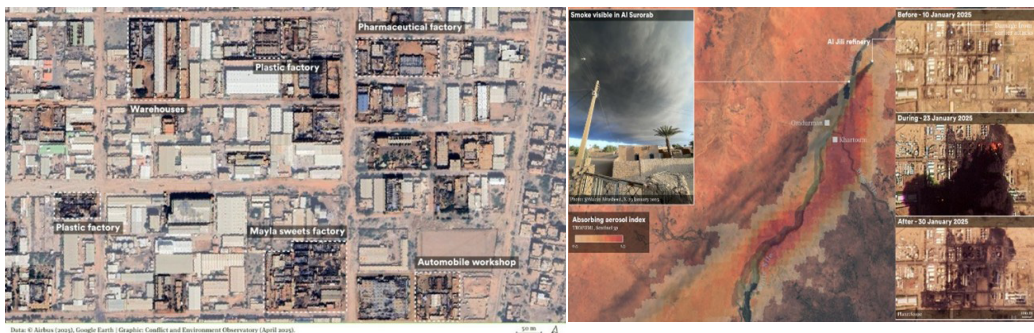


Figure 3: Urban Infrastructure Damage in Khartoum Following the 2023 Conflict

Source: Adapted from Conflict and Environment Observatory (CEOBS), 2024

These impacts highlight the need for integrated recovery strategies that combine infrastructure rehabilitation with economic revitalisation.

Urban challenges

Cities suffer from chronic planning deficiencies and resource constraints, resulting in weak governance, inadequate infrastructure, and limited access to essential services such as water, electricity, sanitation, and waste management. Since the outbreak of war in April 2023, damage to water stations, treatment facilities, pipelines, and related infrastructure has severely disrupted water and sanitation services across Sudan (Yousif and Ali, 2025). More than 300,000 people in Khartoum experienced water shortages between April and October 2023, while the number of people requiring water, sanitation, and hygiene (WASH) assistance increased significantly following the conflict (Kirui *et al.*, 2024).

These conditions have intensified urban vulnerabilities and increased pressure on already fragile service delivery systems.

Economic challenges

Since the outbreak of conflict in April 2023, Sudan's economy has deteriorated sharply. Infrastructure destruction and disrupted trade routes have undermined local markets, reduced economic activity, and weakened livelihoods across urban and rural areas (Kirui *et al.*, 2024). Millions have lost their sources of income, increasing unemployment and dependence on informal economic activities that often lack long-term security and regulatory protection (Kirui *et al.*, 2024). Revitalising the economy, restoring markets, and supporting entrepreneurship remain critical priorities for sustainable recovery.

Without targeted economic interventions, prolonged instability may further constrain reconstruction and development efforts.

Social challenges

Forced displacement has created a major humanitarian crisis, placing significant pressure on host communities and increasing demand for housing, healthcare, education, and other essential services (Kirui *et al.*, 2024). Limited livelihood opportunities have increased dependence on informal employment and heightened socio-economic vulnerability (Kirui *et al.*, 2024). Population movements from conflict-affected areas have accelerated urban growth, expanded informal settlements, and intensified pressure on infrastructure and public services, underscoring the need for integrated recovery and social stabilisation measures.

These challenges highlight the importance of strengthening social cohesion, community resilience, and equitable access to services during the recovery process.

Environmental challenges

Since the 2023 conflict, Sudan has experienced growing environmental degradation, particularly in Darfur and Gezira, including deforestation, soil erosion, water pollution, and unsustainable land-use practices associated with conflict and displacement (UNEP, 2009). In addition, conflict-related contamination, waste accumulation, and damage to environmental infrastructure pose significant risks to long-term recovery (CEOBS, 2024). These conditions highlight the importance of integrating climate adaptation, environmental restoration, and sustainable natural resource management into reconstruction planning (IPCC, 2022; Ali and Yasin, 2026).

Institutional and political challenges

Sudan’s political landscape has long been characterised by instability, corruption, and weak accountability, all of which undermine recovery efforts. Since the 2023 conflict, governance challenges have further constrained institutional capacity and recovery planning. Strengthening governance structures and promoting inclusive, participatory decision-making are therefore essential for sustainable recovery and long-term stability (Ahmad, 2025; Yousif and Ali, 2025).

In post-conflict settings, constitutional and legal reforms play a critical role in strengthening accountability, inclusivity, and effective governance (Brinkerhoff, 2005; Andrews, 2013). Sustainable institutional recovery also requires co-ordination among government institutions, local actors, and international partners to support long-term stability (Paris and Sisk, 2009).

These measures are essential for rebuilding public trust and strengthening the institutional foundations of recovery.

REVIEWING AND ANALYSING GLOBAL MODELS FOR RECONSTRUCTION

International recovery frameworks emphasise different dimensions of post-conflict reconstruction, including physical rebuilding, governance, economic revitalisation, environmental sustainability, and community participation. Table 1 compares the principal frameworks and their relevance to the Sudanese context.

Table 1: Comparative Analysis of Global Recovery and Reconstruction Frameworks

Framework	Main Focus	Strengths	Limitations	Relevance to Sudan
Traditional Reconstruction Models (Eken and Helbling (1999)	Physical reconstruction and infrastructure recovery	Rapid rebuilding of damaged assets	Often top-down, limited community participation, weak integration of social and institutional dimensions	Limited suitability unless combined with participatory approaches

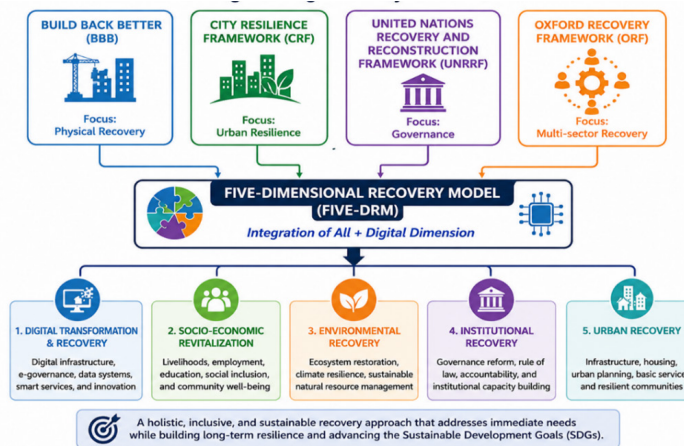
Framework	Main Focus	Strengths	Limitations	Relevance to Sudan
City Resilience Framework (Rockefeller Foundation and Arup, 2014)	Urban resilience, governance, infrastructure, environment	Holistic and resilience-oriented approach	Less emphasis on post-conflict governance reforms	Highly relevant for strengthening urban resilience
Build Back Better (BBB) Framework (Mannakkara and Wilkinson, 2014; GFDRR, 2020)	Risk reduction and resilient reconstruction	Integrates recovery with long-term resilience	Implementation can be challenging in fragile institutional contexts	Highly relevant for post-war reconstruction in Sudan
Disaster Recovery Framework (DRF) Guidance (GFDRR, 2020)	Strategic recovery management	Clear implementation and monitoring mechanisms	Primarily designed for disaster recovery rather than conflict recovery	Useful for recovery planning and implementation
Urban Recovery Framework (URF) (UN-Habitat, 2022)	Urban recovery and reconstruction	Focuses on urban systems, governance, and stakeholder engagement	Limited emphasis on digital transformation	Highly relevant for Sudanese cities
CURE Framework (UNESCO and World Bank, 2018)	Culture-based urban recovery	Protects cultural heritage and social cohesion	Less focus on economic recovery and governance	Valuable for historic urban centres and social recovery

Source: Constructed by author

The CURE Framework further builds on UNESCO's recognition of culture and cultural heritage as key drivers of sustainable urban development and post-conflict recovery (UNESCO, 2017; UNESCO and World Bank, 2018).

Existing recovery frameworks address important aspects of reconstruction but lack a comprehensive approach tailored to Sudan's post-conflict realities. Most frameworks prioritise specific recovery dimensions, such as resilience, governance, infrastructure, or cultural heritage, rather than integrating them within a single context-sensitive model. Existing frameworks also provide limited guidance on incorporating digital transformation and recovery into post-conflict urban recovery. Recent policy research similarly highlights the limitations of fragmented recovery approaches and advocates multidimensional frameworks that integrate resilience, governance, environmental sustainability, and digital innovation.

Figure 4 positions the Five-DRM in relation to existing recovery frameworks. Unlike most existing approaches, the Five-DRM integrates digital, socio-economic, environmental, institutional, and urban recovery within a unified framework tailored to Sudan's post-conflict context.



Recovery Framework	Digital	Socio-Economic	Environmental	Institutional	Urban
CURE Framework	Limited	Moderate	Moderate	Moderate	Strong
Five-DRM	Strong	Strong	Strong	Strong	Strong

Source: Constructed by author

Drawing on international recovery frameworks and case-study lessons, the model addresses Sudan's recovery challenges through five interconnected dimensions: digital transformation and recovery, socio-economic revitalisation, environmental recovery, institutional recovery, and urban recovery. By linking these dimensions, the model promotes integrated interventions that support resilience and long-term urban development (see Figure 5).



Figure 5: The Five-Dimensional Recovery Model (Five-DRM)

Source: Constructed by author

Existing recovery frameworks often address recovery dimensions separately. While BBB emphasises resilience and CRF focuses on urban systems, most frameworks concentrate on specific aspects of recovery, such as governance, infrastructure, or institutional development.

The Five-DRM extends these approaches by integrating digital and transformation, socio-economic, environmental, institutional, and urban recovery within a single framework tailored to Sudan's post-conflict context. Figure 6 illustrates the theoretical contribution of the Five-DRM.

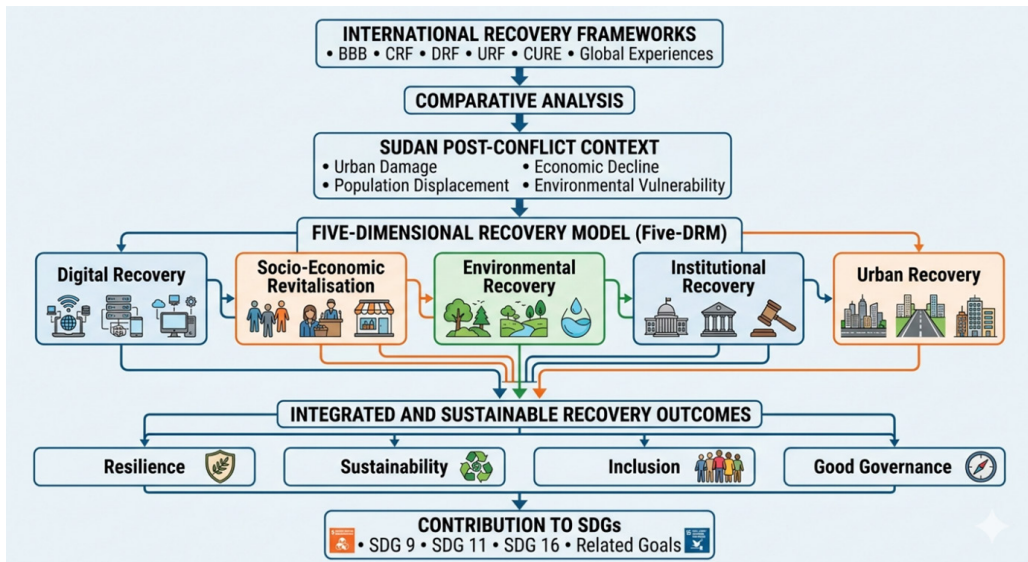


Figure 6: Theoretical Contribution of the Five-Dimensional Recovery Model (Five-DRM)

Source: Constructed by author

The Five-DRM synthesises lessons from international recovery frameworks, comparative case studies, and Sudan's post-conflict recovery challenges. By integrating digital, socio-economic, environmental, institutional, and urban recovery dimensions, the model links recovery interventions with resilience, sustainability, inclusion, and good governance, providing a context-sensitive framework for long-term urban development.

Five-DRM Principles

Integration: Sustainable recovery requires co-ordinated consideration of digital transformation, socio-economic, institutional, environmental, and urban dimensions.

1. **Context-Specificity:** The framework is tailored to Sudan's post-conflict context while drawing on international experience.
2. **Sustainability:** Recovery interventions support long-term resilience and align with the Sustainable Development Goals (SDGs).
3. **Inclusivity:** The model promotes stakeholder participation and addresses the needs of vulnerable and conflict-affected groups.
4. **Adaptability:** The framework can be applied across diverse urban contexts within Sudan.

Five-DRM Dimensions

The Five-DRM comprises five interconnected dimensions that collectively support sustainable post-conflict reconstruction.

Digital transformation and recovery

Digital technologies enhance planning, transparency, and service delivery in post-conflict environments. Digital transformation is increasingly recognised as a strategic process that reshapes organisational capabilities, governance systems, and public service delivery (Mergel *et al.*, 2019; Vial, 2019).

Recent recovery research highlights the role of AI-supported monitoring, geospatial technologies, and digital governance in strengthening urban resilience and evidence-based decision-making. Tools such as Geographic Information Systems (GIS) and Building Information Modelling (BIM) support data-driven decision-making, while digital infrastructure and e-governance improve accountability, public participation, and crisis management (Gil-Garcia *et al.*, 2014; Vial, 2019; UN, 2022).

In Sudan, digital transformation recovery is a critical enabler of post-conflict reconstruction. The 2023 conflict disrupted telecommunications, information systems, and public service delivery, highlighting the need to restore digital infrastructure alongside physical reconstruction. Technologies such as AI, GIS, remote sensing, BIM, and digital twins can support damage assessment, infrastructure planning, displacement mapping, environmental monitoring, and evidence-based decision-making.

Their integration into recovery programmes may contribute to greater efficiency, accountability, and resilience throughout the reconstruction process. Figure 7 represents the digital transformation and recovery ecosystem within the Five-DRM: digital transformation and recovery as a cross-sectoral enabler supporting urban, institutional, environmental, and socio-economic revitalisation.



Figure 7: Digital Transformation and Recovery Ecosystem within the Five-Dimensional Recovery Model (Five-DRM)

Source: Constructed by author

Socio-Economic revitalisation

This dimension focuses on restoring livelihoods, creating employment opportunities, supporting entrepreneurship, and strengthening social cohesion. Economic recovery and social inclusion are essential for rebuilding trust, reducing vulnerability, and promoting long-term stability (Del Castillo, 2008; Barakat and Zyck, 2009; Mac Ginty, 2013). This dimension combines economic revitalisation with community-based approaches that strengthen social resilience and local ownership of recovery processes.

Recent Sudan-focused studies similarly emphasise that employment generation, local economic development, and community-based recovery initiatives are critical for restoring livelihoods and strengthening social resilience in post-conflict environments (Yousif and Ali, 2025).

Environmental recovery

Environmental recovery promotes ecological restoration, climate resilience, and sustainable resource management; these are increasingly recognised as critical components of Sudan's reconstruction agenda (Jensen and Lonergan, 2012; UNEP, 2009; Elhoussein, 2025).

This dimension supports ecosystem rehabilitation, climate adaptation and the sustainable management of natural resources.

Institutional recovery

Institutional recovery focuses on strengthening governance systems, public administration, accountability, and citizen participation. Effective institutions are essential for restoring public trust, delivering services, and supporting long-term stability (Brinkerhoff, 2005; Paris and Sisk, 2009; World Bank, 2011).

This perspective is consistent with recent Sudan-focused research that identifies institutional reform, inclusive governance, and administrative capacity-building as fundamental prerequisites for successful post-conflict reconstruction and sustainable development (Yousif and Ali, 2025).

Urban recovery

Urban recovery focuses on rebuilding infrastructure, restoring basic services, and promoting inclusive planning processes that support resilient and sustainable urban development (Vale and Campanella, 2005; Fainstein and Campbell, 2011). In post-conflict contexts, urban recovery extends beyond physical reconstruction to include the restoration of housing, transportation networks, public spaces, and essential urban services. Effective urban recovery also contributes to social integration, economic revitalisation, and improved quality of life by creating safer, more accessible, and more inclusive urban environments. Within the Five-DRM, urban recovery serves as the spatial dimension that translates recovery interventions into tangible improvements in cities and communities (Table 3).

Table 3: Components, Objectives, and Expected Outcomes of the Five-Dimensional Recovery Model (Five-DRM)

Dimension	Main Objective	Key Interventions	Expected Outcomes
Digital Transformation and Recovery	Strengthen digital governance and planning	GIS, BIM, e-governance, data systems	Efficient services and transparency
Socio-Economic Revitalisation	Restore livelihoods and social cohesion	Employment, entrepreneurship, inclusion	Economic recovery and resilience
Environmental Recovery	Restore ecosystems and reduce climate risks	Land restoration, flood management, green infrastructure	Sustainable environmental systems
Institutional Recovery	Rebuild governance and accountability	Administrative reform, decentralisation, participation	Trust and effective governance
Urban Recovery	Reconstruct cities and services	Infrastructure, housing, participatory planning	Resilient and inclusive urban development

Source: Constructed by author

Table 4 demonstrates the strong alignment between the Five-DRM and the United Nations Sustainable Development Goals (SDGs) (UN, 2015). Each recovery dimension contributes to specific SDGs while simultaneously supporting broader sustainable development objectives.



Digital recovery promotes innovation, resilient infrastructure, and transparent governance (SDGs 9, 11, and 16), whereas socio-economic revitalisation contributes to poverty reduction, employment generation, and social inclusion (SDGs 1, 8, and 10).

Table 4: Alignment between the Five-Dimensional Recovery Model (Five-DRM) and the Sustainable Development Goals (SDGs)

<i>Five-DRM Dimension</i>	<i>Key Recovery Focus</i>	<i>Relevant SDGs</i>
Digital Transformation and Recovery	E-governance, digital infrastructure, smart services	SDG 9, SDG 11, SDG 16
Socio-Economic Revitalisation	Employment, entrepreneurship, social inclusion	SDG 1, SDG 8, SDG 10
Environmental Recovery	Climate resilience, ecosystem restoration	SDG 2, SDG 13, SDG 15
Institutional Recovery	Governance, participation, accountability	SDG 5, SDG 16, SDG 17
Urban Recovery	Housing, infrastructure, urban services	SDG 6, SDG 9, SDG 11

Source: Constructed by author

Operationalising the Five-Dimensional Recovery Model (Five-DRM)

The Five-DRM may be operationalised through measurable indicators that support monitoring, evaluation, and evidence-based recovery planning. Table 5 presents illustrative indicators for each recovery dimension.

Table 5: Illustrative Indicators for Operationalising the Five-DRM

<i>Dimension</i>	<i>Example Indicators</i>
Digital Transformation and Recovery	Internet connectivity rate; availability of digital government services; GIS-based planning capacity; digital data accessibility
Socio-Economic Revitalisation	Employment rate; business recovery rate; household income recovery; social inclusion programmes
Environmental Recovery	Restored green areas; flood resilience measures; environmental rehabilitation projects; sustainable resource management initiatives
Institutional Recovery	Public service delivery performance; citizen participation mechanisms; governance transparency measures; institutional capacity-building programmes
Urban Recovery	Housing reconstruction rate; infrastructure restoration progress; access to basic services; implementation of participatory planning initiatives

Source: Constructed by author

The five dimensions are mutually reinforcing and should be implemented through an integrated and phased recovery process. Figure 8 illustrates the interconnections among the recovery dimensions.

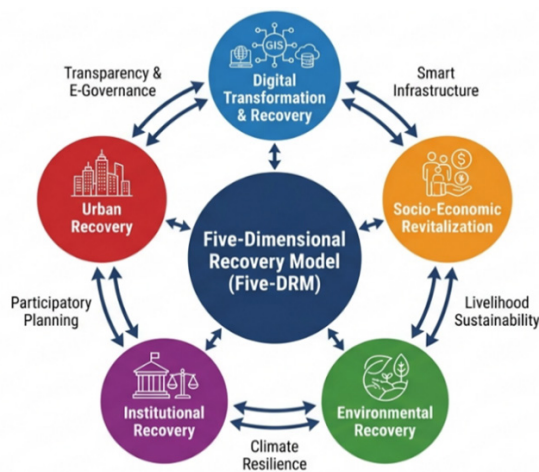


Figure 8: Interconnections among the Five Dimensions of the Five-Dimensional Recovery Model (Five-DRM)

Source: Constructed by author

Integrating the Cultural Dimension into the Five-DRM Model

Within the Five-DRM, culture is treated as a cross-cutting element that influences governance, socio-economic revitalisation, environmental management, urban reconstruction, and digital transformation and recovery. By strengthening social cohesion, local ownership, resilience, and heritage preservation, culturally informed recovery approaches can enhance participation, identity, and long-term reconciliation in post-conflict settings. Table 6 illustrates how cultural considerations can be integrated across the five dimensions of the framework.

Table 6: Integration of Cultural Considerations across the Five-Dimensional Recovery Model (Five-DRM)

Five-DRM Dimension	Cultural Reflection	Example or Application
Digital Transformation and Recovery	Design e-government tools in local languages; digitally preserve cultural heritage	Rwanda: Genocide memorial platforms fostered reconciliation and digital memory
Socio-Economic Revitalisation	Promote traditional crafts and heritage industries; culturally sensitive entrepreneurship	Afghanistan: Gender- and tribe-sensitive microfinance had better results
Environmental Recovery	Incorporate indigenous environmental knowledge and local conservation practices	South Sudan: Reviving traditional agricultural techniques for sustainable recovery
Urban Recovery	Reconstruct with respect to local identity, architectural traditions, and community norms	Lebanon: Post-war Beirut was criticised for erasing traditional urban character



Five-DRM Dimension	Cultural Reflection	Example or Application
Institutional Recovery	Incorporate traditional governance systems, local justice, and community elders	Iraq: Missed opportunity in involving tribal structures in governance early on

Source: Constructed by author

COMPARATIVE ANALYSIS AND EVALUATION OF THE FIVE-DRM

The Five-DRM differs from existing recovery frameworks by integrating digital transformation with socio-economic, environmental, institutional, and urban recovery dimensions. While frameworks such as Build Back Better (BBB), the City Resilience Framework (CRF), and the Disaster Recovery Framework (DRF) provide valuable guidance for resilience, governance, and recovery planning, they generally focus on specific aspects of reconstruction rather than integrating all dimensions within a single framework tailored to post-conflict Sudan.

The principal strength of the Five-DRM lies in its comprehensive and context-sensitive structure that recognises the interdependence of recovery processes and links short-term recovery actions with long-term sustainable urban development. However, effective implementation requires strong institutional capacity, stakeholder co-ordination, adequate financial resources, and investment in digital infrastructure. By combining lessons from international recovery experiences with Sudan-specific priorities, the Five-DRM provides an integrated approach to sustainable post-conflict reconstruction.

Operationalisation and Future Validation of the Five-DRM

To enhance practical applicability, the Five-DRM may be operationalised through measurable indicators across its five dimensions, enabling monitoring, evaluation, and evidence-based recovery planning. Future research should focus on empirical validation through expert consultation and pilot applications in Sudanese cities, as well as the development of a Five-Dimensional Recovery Index (Five-DRI) to assess recovery performance and support decision-making in post-conflict environments.

Why Five-DRM Differs from Existing Recovery Frameworks

Table 7 compares the Five-DRM with selected recovery frameworks and highlights its unique integration of digital transformation and Sudan-specific recovery priorities.

Table 7: Comparison of the Five-Dimensional Recovery Model (Five-DRM) with Selected Recovery Frameworks

<i>Framework</i>	<i>Digital transformation and recovery</i>	<i>Socio-Economic</i>	<i>Environmental</i>	<i>Institutional</i>	<i>Urban</i>	<i>Sudan-specific</i>
Build Back Better (BBB)	0	1	3	1	3	0
City Resilience Framework (CRF)	0	1	3	1	3	0
Disaster Recovery Framework (DRF)	1	3	3	3	3	1
Five-DRM Framework	3	3	3	3	3	3

Source: Constructed by author

Five-DRM Recovery Process

The recovery process operationalises the Five-DRM through a phased and adaptive approach that enables recovery interventions to evolve from immediate stabilisation towards long-term sustainable development (Figure 7).

Stage 1: Assessment and Analysis

Assess damage, identify priority needs, and establish an evidence base for recovery planning.

Stage 2: Planning and Resource Management

Develop recovery strategies, co-ordinate stakeholders, and allocate resources efficiently.

Stage 3: Implementation and Rehabilitation

Reconstruct infrastructure, housing, and services while promoting social and economic recovery.

Stage 4: Sustainability and Resilience Building

Strengthen resilience through climate adaptation, risk reduction, and sustainable urban systems.

Stage 5: Integration and Long-Term Development

Support the transition towards inclusive, innovative, and sustainable urban development.

The stages are iterative rather than strictly linear, allowing monitoring, evaluation, and stakeholder feedback to inform continuous adaptation throughout the recovery process (see Figure 9).

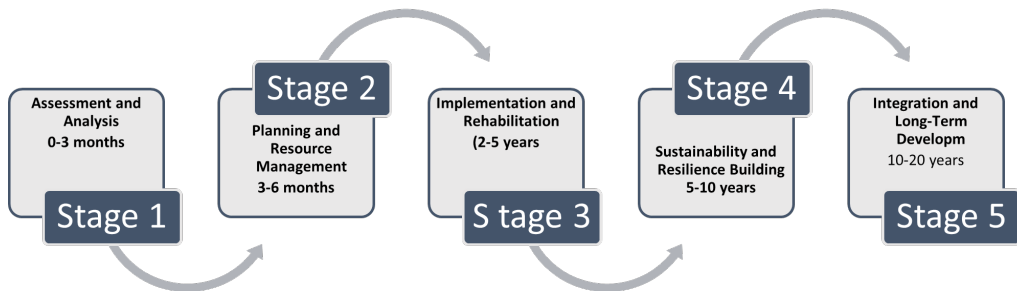


Figure 9: Stages of the Five-Dimensional Recovery Model (Five-DRM)

Source: Constructed by author

Although presented as sequential stages, the recovery process is iterative and adaptive. Monitoring, evaluation, stakeholder feedback and changing recovery conditions may require revisiting earlier stages to ensure that recovery interventions remain responsive to emerging challenges and local priorities.

Case Studies of Recovery Models and Their Relevance to Five-DRM

International experiences demonstrate that recovery outcomes depend not only on the recovery model adopted but also on governance quality, institutional capacity, resource availability, and community participation (Barakat and Zyck, 2009; Paris and Sisk, 2009). Table 8 summarises selected post-conflict and post-disaster recovery experiences and highlights their relevance to the Five-DRM.

Table 8: Selected Case Studies and their Relevance to the Five-Dimensional Recovery Model (Five-DRM)

Country/Case	Applied Model	Main Focus	Relevant Five-DRM Dimensions	Key Lessons/Challenges	Urban
Japan (Tohoku, 2011)	Build Back Better (BBB)	Infrastructure resilience and disaster risk reduction	Environmental, Urban, Institutional	Strong central planning, advanced technology, and long-term resilience planning contributed to successful recovery; implementation required substantial financial resources	Strong
Rwanda (Post-1994 Genocide)	Participatory Recovery Approach	Social healing and institutional rebuilding	Socio-economic, Institutional	Community-based governance and reconciliation mechanisms strengthened social cohesion and public participation	Strong

Country/Case	Applied Model	Main Focus	Relevant Five-DRM Dimensions	Key Lessons/Challenges	Urban
Iraq (Mosul Reconstruction)	UNRRF-based Recovery	Emergency services, governance, and reconstruction	Institutional, Urban, Digital	Institutional fragility and security challenges slowed recovery despite significant international support	Strong
Beirut (Port Explosion, 2020)	CRF and BBB Principles	Urban resilience and governance	Environmental, Urban, Institutional	Civil society played a critical role in recovery due to weak state capacity and governance challenges	Strong
Bosnia and Herzegovina (Post-1995)	Participatory Reconstruction and Economic Recovery	Reconstruction, economic transition, and decentralisation	Socio-economic, Institutional	International co-ordination supported reconstruction, but ethnic divisions continued to challenge long-term recovery and social cohesion	Strong
Afghanistan (Post-2001 Recovery)	Internationally Supported Recovery Programmes	Governance, infrastructure, and service delivery	Institutional, Socio-economic	Heavy reliance on external actors limited local ownership and reduced the long-term sustainability of recovery efforts	Strong

Source: Constructed by the author based on Barakat and Zyck (2009), Paris and Sisk (2009), Mannakkara and Wilkinson (2014), Rockefeller Foundation and Arup (2014), and UN-Habitat (2022).

The reviewed cases highlight the importance of governance, local ownership, stakeholder participation, institutional capacity, and long-term planning for successful recovery. Figure 10 illustrates the timeline of selected reconstruction experiences.

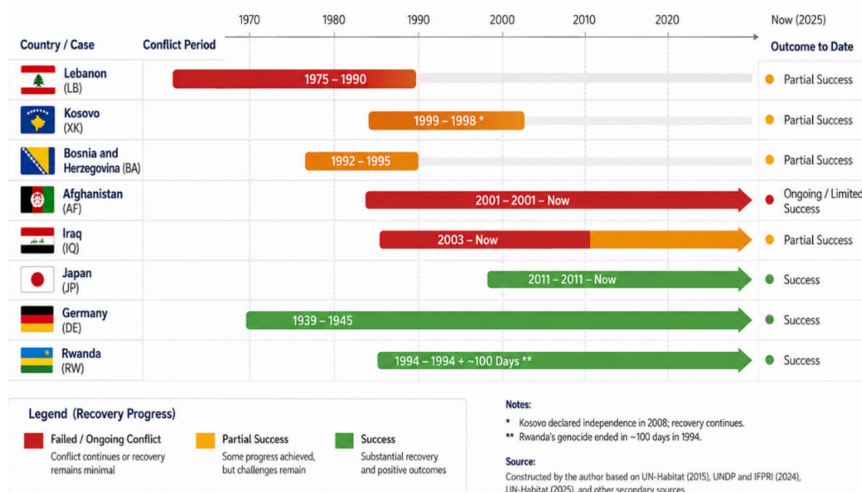


Figure 10: Timeline of Selected Post-Conflict and Post-Disaster Reconstruction Experiences

Source: Constructed by author

Figure 11 summarises the principal success and failure factors identified across the reviewed case studies and highlights their influence on long-term recovery outcomes.

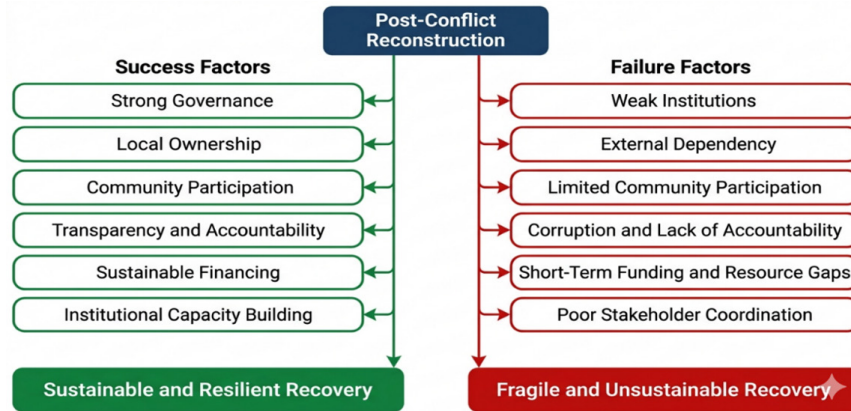


Figure 11: Critical Success and Failure Factors in Post-Conflict Reconstruction

Source: Constructed by author

DISCUSSION

Sustainable post-conflict recovery requires integrated approaches that combine governance, socio-economic revitalisation, environmental sustainability, urban reconstruction, and digital transformation (Ahmad, 2025; Yousif and Ali, 2025). Consistent with emerging Sudan-focused scholarship, the Five-DRM responds to the need for recovery frameworks that link resilience, sustainability, and long-term urban transformation (Mohammedani and Abdelgader, 2025; Yousif and Ali, 2025).

The analysis of international recovery frameworks and case studies demonstrates that successful recovery depends on the integration of multiple dimensions rather than isolated interventions. The principal contribution of the Five-DRM is its integration of digital transformation and recovery, socio-economic, environmental, institutional, and urban recovery within a single framework tailored to Sudan's post-conflict context. By recognising the interdependence of these dimensions, the model links short-term recovery actions with long-term resilience, sustainability, inclusion, and effective governance.

Although conceptual in nature, the Five-DRM provides a practical foundation for policy-makers, planners, and development practitioners engaged in post-conflict recovery. Future empirical testing in Sudanese cities will further strengthen its applicability and operational value.

The Five-DRM is a conceptual framework developed primarily from secondary data, comparative analysis, and literature synthesis. Consequently, its practical effectiveness requires future empirical validation in different Sudanese urban contexts.

CONCLUSIONS

This paper develops the Five-DRM as an integrated framework for sustainable reconstruction and urban recovery in post-conflict Sudan. Drawing on international recovery frameworks, comparative case studies, and an assessment of Sudan's recovery challenges, the model integrates five interconnected dimensions: digital transformation and recovery, socio-economic revitalisation, environmental recovery, institutional recovery, and urban recovery.

The findings demonstrate that sustainable recovery requires more than physical reconstruction. Long-term recovery depends on effective governance, economic revitalisation, social inclusion, environmental sustainability, and digital innovation. Among these dimensions, digital recovery acts as a cross-sectoral enabler that strengthens planning, governance, monitoring, and stakeholder engagement across the broader recovery process. By integrating these dimensions within a single framework, the Five-DRM provides a context-sensitive approach that links recovery efforts with resilience, sustainability, and inclusive urban development.

Although developed for Sudan, the framework may also inform recovery planning in other conflict-affected contexts. Future research should focus on empirical testing of the framework in Sudanese cities, the development of a Digital Recovery Readiness Index (DRRI), and the integration of digital recovery indicators into broader post-conflict recovery and urban resilience assessment frameworks.

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BIOGRAPHY



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