Sustainable Infrastructure Planning for Regional Tourism Development in Saudi Arabia: A Framework for Resilient and Safe Giga-Project Delivery

Abstract:

The growth of tourism in Saudi Arabia is taking place via a number of destinations spread across the region, and the success of these destinations relies on infrastructure systems that are reliable, ecologically compatible, safe when in operation, and capable of adapting afterwards. However, research in the field of tourism, studies in regional planning, and the literature on risk in large-scale projects are frequently regarded as separate areas of discussion. This review brings those different areas together and presents a lifecycle framework for the safe and resilient delivery of giga-projects. A structured integrative review was carried out using 30 peer-reviewed studies published between 2020 and 2025, all of which had resolvable digital object identifiers. The evidence was analysed according to six areas: regional accessibility, energy and water security, blue-green and heritage systems, construction safety and risk, governance and community value, and adaptive destination operations. The synthesis demonstrates that infrastructure should be planned as part of a interconnected regional service ecosystem rather than as a collection of separate project assets. In dry and coastal areas, ecological thresholds, heat exposure, the availability of water, the reliability of renewable energy, evacuation capacity, and the continuity of the supply chain must all be considered as design constraints before any capital is committed. Megaproject safety is improved when the interdependencies of risk are taken into account, resilience responsibilities are shared among different institutions and contractors, and commissioning tests the overall continuity of services at the destination level rather than just that of individual facilities. The proposed Regional Tourism Infrastructure Resilience and Safe Delivery framework connects regional need, environmental capacity, integrated masterplanning, resilience assurance, phased construction, operational commissioning, and adaptive monitoring by means of clear decision checkpoints. It provides a planning approach based on a review of the evidence for transforming major tourism investments into lasting regional benefits while reducing lock-in, ecological damage, and safety risks.

1. Introduction

The geography of tourism in Saudi Arabia is changing as a result of large-scale destination initiatives, the development of new mobility corridors, efforts to regenerate heritage sites, coastal development, and increased investment in supporting utilities. In this situation, infrastructure goes beyond simply giving access to individual attractions; roads, airports, transit systems, power networks, water supplies, digital connectivity, waste management, public space, ecological buffers, and emergency facilities all play a role in determining whether a destination can handle tourist demand without damaging the resources that tourism relies on. Recent studies concerning tourism infrastructure stress that tourism is both made possible by physical networks and at the same time has the ability to reorganise the areas through which those networks pass [26]. The significance for regional planning is that infrastructure is not a neutral backdrop to tourism growth but rather a spatial system which spreads access, risk, environmental pressure, and economic opportunity over different territories.

The application of this systems approach is pertinent to Saudi Arabia since a number of developing destinations are situated in environments that are ecologically sensitive, subject to harsh climatic conditions, or spread out over a large area. Research concerning the Red Sea has proven that conservation results can be included in development plans by means of marine spatial planning, the establishment of protected areas, and the conscious avoidance of high-value habitats [1]. Investigations into tourism development in Saudi Arabia also show that environmental performance, destination competitiveness, and economic diversification are closely linked to the infrastructure decisions made [7]. On an urban level, studies of Riyadh reveal that access by public transport, dense development, connectivity on foot, thermal comfort, and the coordination of land use affect whether transport investments lead to liveable and accessible districts [21,29]. These results highlight a wider regional issue: tourism infrastructure has to support visitor movement and service quality without exceeding ecological, climatic, social, and operational constraints.

The difficulty involved in planning becomes even greater when tourism is carried out via giga-projects. Such large-scale projects involve long delivery times, a number of contractors, constantly changing technologies, complex interfaces, uncertain demand, and a high level of public attention. Traditional project risk registers tend to underestimate the level of systemic exposure since they usually separate out hazards that are causally linked. Research into megaprojects has demonstrated that risk moves through a network of dependencies relating to design, finance, schedule, supply, governance, safety, and the environment [13-15,17]. Construction safety studies also indicate that prevention alone is not enough when complexity and delays lead to changing conditions; organisations must have the ability to anticipate, respond, recover, and adapt [25]. In the case of tourism destinations, this kind of resilience must go beyond the construction sites to include the infrastructure systems which will support the residents, workers, visitors, ecosystems, and emergency response during the entire operating life of the destination.

Another problem concerns scale. Even if a resort, cultural area, or attraction is designed to high environmental standards it may still have unsustainable effects on the region since it could increase traffic congestion, since the demand for desalination or energy goes beyond the system's capacity, since the need for labour housing and logistics has to be met elsewhere, or since the benefits fail to reach the adjacent communities. Regenerative tourism research has consequently turned its focus from reducing the harm at the project level to restoring ecological and social capacity [9,10,16,19]. This approach is in line with regional infrastructure planning since it examines how a destination affects the wider system in which it is situated. It also redefines resilience in that a destination is considered resilient not only when its assets are able to withstand hazards, but also when the infrastructure keeps on providing essential services, ecological functions remain feasible, the communities are able to share in the benefits, and the operators can adjust to shocks or changes in demand.

Even though these areas are relevant, the existing literature is still fragmented. Research into tourism resilience usually centres on crisis response and on the recovery of destinations [3,11], infrastructure studies often focus on specific modes or assets, and research concerning the safety of megaprojects is generally carried out without regard to destination planning. While Saudi-specific studies have provided useful evidence regarding marine conservation, sustainable tourism, walkability, giga-project destination development, and public-private collaboration [1,7,20,21,29,30], there is still a need for an integrated planning model which links regional tourism demand with infrastructure capacity, environmental thresholds, safe construction, and long-term operational adaptation. In order to fill this gap, the present review brings together recent evidence into a lifecycle framework appropriate for regional tourism development in Saudi Arabia.

2. Aim, objectives and review questions

This review is intended as a means of creating an integrated regional planning framework which connects tourism demand, infrastructure capacity, ecological limits, safety governance, phased delivery, and adaptive operation in relation to large-scale tourism development in Saudi Arabia. The review is guided by five objectives: to identify the infrastructure areas that have the most consistent impact on regional tourism performance; to detect the vulnerabilities resulting from the arid and coastal environmental conditions; to synthesise the risk and safety measures that are relevant to the delivery of complex giga-projects; to look at the ways in which infrastructure can extend the benefits of tourism beyond the boundaries of the project; and to turn the evidence obtained into lifecycle decision gates and specific, measurable planning actions. The synthesis is organised around three questions: which infrastructure relationships are most important for achieving sustainable regional tourism; how climate, ecological and safety risks should be incorporated before and during the delivery phase; and what governance approach can transform investment at the project level into resilient regional results?

3. Methodology

A structured integrative review was chosen since the research question spans the fields of tourism studies, regional planning, environmental management, transport, construction management, and safety science. Instead of aiming to calculate a single effect size, the aim was to link the evidence that had been generated by different research designs and to develop an explanatory planning framework. The review was limited to peer-reviewed publications that were issued between January 2020 and December 2025. The initial seed studies were found by looking at recent Saudi and Gulf research concerning tourism giga-projects, transit-oriented development, regenerative tourism, and sustainable destination planning. Citation chaining and specific cross-publisher searches were then carried out in order to find studies on tourism infrastructure, destination resilience, coastal adaptation, nature-based planning, mega-infrastructure risk, construction safety, and public-private governance. Bibliographic details were verified using DOI records and the publishers' official pages.

To be eligible, a study had to have a direct bearing on at least one of the six analytical areas: regional accessibility and mobility; energy and water security; blue-green, coastal, or heritage systems; megaproject risk and construction safety; governance, skills, and community value; or adaptive destination operations. The sources also needed to include a clear method, a conceptual contribution, or an empirical basis that could be of use to regional planning. Those studies were excluded which were outside the date range, which were duplicates of another record, which lacked a verifiable DOI, or which dealt with a technical issue without having any transferable relevance to tourism, regional infrastructure, resilience, or megaproject delivery. Thirty studies were kept for in-depth analysis. The fact that this corpus has been deliberately limited serves to promote conceptual depth and traceability rather than implying that it provides a complete account of all publications in the fields of tourism or infrastructure.

The studies were entered into an evidence matrix which included details on the geographic setting, the infrastructure domain, the unit of analysis, the main risk or constraint, the planning intervention, the governance implications, and the reported outcome. During a second coding stage, the relationships between different domains were identified, for example, how changes in transport accessibility affect visitor pressure, how water and energy constraints modify carrying capacity, and how schedule pressure influences construction safety. The evidence was then compared in terms of convergence, contextual differences, and its transferability to the Saudi situation. Special emphasis was placed on evidence from Saudi Arabia and on studies coming from arid, coastal, infrastructure-intensive, or crisis-affected areas. Instead of ranking the studies in a league table, attention was paid to methodological transparency and to the extent to which the evidence supported the claim being made when interpreting each source.

The process took place in three stages. In the first stage, the recurring infrastructure functions and failure modes were grouped thematically. In the second stage, the findings at the project level were scaled up to a regional level by considering where the impacts, dependencies or benefits crossed the official boundary of a destination. In the third stage, the themes were ordered according to the lifecycle, from strategic need onwards to operation, thus leading to a stage-gated framework. This method is in accordance with the logic of an integrative review: by making use of diverse evidence the mechanisms and relationships are identified, while the final framework stays as a conceptual proposal that will need to be tested by future empirical research. Since the review was designed as a targeted conceptual synthesis and not as a bibliometric census, no screening counts are given apart from those in the final evidence corpus.

4. Thematic synthesis of the evidence

In the available evidence, sustainable tourism infrastructure is best seen as a connected regional system rather than as a set of efficient individual assets. There are four mechanisms that link infrastructure to destination performance. The first of these is access: it is the infrastructure that decides who can get to a destination, the cost involved, and the means by which they can do so. The second is capacity: the utilities and environmental systems set the level and pattern over time of the activity that can be accommodated. The third is protection: ecological buffers, resilient design, emergency access and safe construction all help to reduce losses and service disruptions. The fourth is distribution: infrastructure influences where jobs, investment, public services and environmental burdens are situated. These mechanisms are interdependent. For example, an improvement in transport can lead to an increase in demand that outstrips the capacity of water, waste or ecological systems; and a highly efficient resort can still be regionally vulnerable if the access road, power supply or emergency route has a single point of failure.

4.1 Regional accessibility and spatial structure

Mobility is the most obvious link between tourism projects and the areas in which they are located. A review of the evidence on transit-oriented development indicates that accessibility is not just a matter of having transport infrastructure but also depends on land-use diversity, density, network connectivity, and the quality of the pedestrian environment [2]. The studies carried out in Riyadh include a dimension that is specific to the climate: in hot conditions walkability calls for shade, thermal comfort, short blocks, connected public transport, and context-sensitive design rather than simply providing footpaths [21]. Recent research into Riyadh's transit-oriented renewal also combines spatial analysis, transport accessibility, and planning regulations in order to find out where investments in mobility can help to promote compact urban development [29]. In the case of tourism areas, the equivalent task is to regard airports, regional roads, rail systems, shuttle services, walking networks, cycling routes, and last-mile services as part of a single access hierarchy.

Planning must therefore start with the desired regional patterns of movement rather than with the internal circulation plan for a single destination. The levels of visitor traffic during peak times have to be compared with those of residents, together with staff transport, freight, maintenance, and emergency movements. Junctions should be situated in such a way that they can meet both tourism requirements and the everyday travel needs of the region. Redundancy is also necessary: alternative access routes and connections involving more than one mode of transport can lessen the effects of a road closing, severe weather, a technical failure, or a sudden rise in demand. Accessibility should be assessed in terms of reliable travel time from door to destination and in relation to the mode of transport available, not just by the number of kilometres of new road. This method can help avoid a typical lock-in situation in which the initial capacity of a highway leads to development spread out over a wide area, making it later more difficult to improve collective transport, walkability, and the consolidation of services.

4.2 Climate, ecological limits and resource security

Environmental capacity plays a fundamental role as an element of infrastructure in the planning of tourism in Saudi Arabia. Places along the coast rely on coral reefs, mangroves, beaches, water quality and the visual scenery; in contrast, those located inland and which are of heritage value depend on scarce water supplies, thermal comfort, the integrity of the landscape and on sites that have cultural significance [5]. The example of marine spatial planning in the Red Sea shows how conservation objectives can be included prior to the development areas being decided upon, so that different scenarios can be compared and areas that are sensitive can be avoided [1]. Research into regional restoration in the Gulf also indicates that the performance of mangroves varies according to biophysical and anthropogenic conditions, which means that choosing sites and carrying out long-term monitoring become more important than setting simple planting targets [24]. This kind of evidence lends support to a planning process in which ecological thresholds are set up before any commitment is made to infrastructure capacity.

Climate adaptation also needs to be incorporated at a regional level. The risks to coastal areas do not end with the design height of individual buildings. Sea-level rise, erosion, storm surges, heavy rainfall, movement of sediment, and heat have the potential to disrupt access routes, utilities, beaches, public spaces, and ecological services. When coastal adaptation is reviewed, there is an emphasis on combining an understanding of hazards with flexible options rather than depending on a single fixed defence [4]. Research into coastal cities also shows that it is necessary to take into account compound climate-related hazards and the way in which exposure is distributed across space [22]. For tourism destinations, this involves identifying key service corridors, having the capacity for safe evacuation, ensuring backup power and communication systems, arranging for water-security in case of emergencies, and determining the areas where natural systems can absorb or reduce hazards.

Blue-green infrastructure has the potential to reduce risk and improve the quality of destinations. Research into nature-based planning indicates that such interventions work better when they are distributed in accordance with the spatial demand for ecosystem services rather than being used merely as ornamental landscaping [18,23]. In the context of tourism, the relevant services are shade, cooling, storm-water retention, habitat connectivity, coastal protection, recreation, visual quality, and cultural interpretation. Resource planning should also integrate water and energy management. Since desalination, wastewater treatment, cooling and landscape irrigation are energy-intensive, while renewable energy generation and storage require land and network infrastructure, the Gulf studies on energy transition point out the interaction between energy systems, economic diversification and environmental commitments [27,28]. The practical result is an integrated resource budget which, before occupancy targets are approved, assesses daily and seasonal demand, the need for an emergency reserve, source diversity, reuse, and recovery.

Table 1. Evidence themes, recurring vulnerabilities and regional planning responses

Domain	Recurring vulnerability	Regional planning response	Illustrative indicators
Access and mobility	Peak congestion, single-route dependence, heat-exposed last mile	Multimodal hierarchy; redundant access; heat-safe pedestrian network; demand management	Peak travel time; public/collective mode share; route redundancy
Energy and water	High cooling/desalination load; source concentration; seasonal peaks	Integrated resource budgets; storage; reuse; diverse supply; phased capacity	Peak reserve margin; water intensity; reuse rate; outage duration
Blue-green and heritage systems	Habitat fragmentation, coastal exposure, loss of landscape or cultural value	Threshold-led spatial planning; buffers; restoration; nature-based risk reduction	Habitat condition; ecological connectivity; heat/shade coverage; shoreline exposure
Safety and continuity	Interface failure, schedule pressure, fragmented responsibilities	Portfolio risk network; resilient safety governance; cross-system commissioning	Safety leading indicators; unresolved interfaces; recovery time; exercise performance

Domain	Recurring vulnerability	Regional planning response	Illustrative indicators
Regional value and capability	Benefits concentrated inside project boundary; skills and supplier gaps	Shared infrastructure; local access; supplier development; operating competence	Local procurement; training completion; resident accessibility; service co-benefits

4.3 Safe and resilient giga-project delivery

The implementation of a giga-project brings with it a new kind of safety and resilience risk since a tourism area may involve multiple construction packages, temporary logistics networks, the movement of workers, commissioning operations, and early operational areas. Research into megaproject risks always dismisses the idea that risks are independent; network analysis proves that one event can spread via contractual, scheduling, technical, environmental, and organisational links [14,15]. Moreover, analytic network modelling shows the importance of including feedback and interdependence when measuring a project's exposure [13]. In a sustainability-focused risk assessment, this approach is extended by combining environmental, social, and economic goals with the traditional kinds of project risks [17]. All of these studies therefore advocate for a risk structure at the portfolio level rather than having separate risk registers for each package.

Safety governance should also be regarded as a resilience capability. Evidence relating to the construction of megaprojects shows that resilient safety systems combine preventative measures with the capacity to absorb disturbances, to respond effectively, to recover and to learn [25]. In the case of tourism giga-projects, this means that there must be clear ownership of the interfaces between the developer, the programme manager, the contractors, the utility providers, the transport operators, the emergency services, and the eventual asset operators. Leading indicators should comprise unresolved design interfaces, high-risk simultaneous operations, competence gaps, temporary-route changes, fatigue exposure, permit deviations, and the delay in closing safety-critical actions. Although lagging injury statistics are still necessary, they are not capable of identifying deteriorating conditions early enough. Schedule recovery plans should be safety-tested since speeding up the work can lead to increased congestion, more overtime, greater workface conflicts, and greater pressure on supervision.

Resilience assurance also has an impact on the commissioning process. In the traditional approach, commissioning ensures that a building or a utility meets the requirements set out in its specification. A regional tourism system, however, needs an extra stage of integrated commissioning in order to examine cross-system scenarios. Examples of such scenarios are a feeder failing during periods of high occupancy, the closure of a main access corridor, a communication failure occurring during an evacuation, extreme heat at the same time as high cooling demand, or wastewater treatment having to operate under a surge. The exercises should include operational staff and outside responders, not just the construction teams. In the case of a destination opening in stages, each stage must show that the temporary infrastructure, emergency response arrangements, accommodation for the workforce, logistics, and environmental controls are adequate without depending on assets that will be put in place in later phases. This in turn reduces the risk that the commercial opening dates result in hidden dependencies on incomplete regional systems.

4.4 Regional value, communities and destination resilience

Infrastructure that is resilient should generate value that goes beyond that of the visitor economy. Research into tourism crises indicates that a community's capacity, the quality of its communication, its local economic networks, and the level of collective action all affect whether a destination is able to recover from a disruption [3,11]. By building on this idea, regenerative tourism defines value in terms of ecological renewal, community capability, and long-term responsibility for the place [9,10,16]. For regional development in Saudi Arabia, this means that when assessing infrastructure it should take into account local accessibility, the development of suppliers, pathways for acquiring skills, improvements to public services, and the durability of cultural and environmental assets. A road which serves a resort and the adjacent settlements, a digital network which supports both visitor services and local businesses, or the reuse of wastewater to aid landscape restoration can all contribute to greater regional legitimacy and to various kinds of resilience.

Skills are a vital yet at times overlooked aspect of infrastructure. Studies in the field of tourism sustainability point out that deficiencies in technical, managerial, and interdisciplinary skills act as obstacles to the implementation of ambitious environmental strategies [8]. Even if a large-scale project manages to acquire advanced technology, it can still be operationally weak because the local teams are unable to maintain the sensors, optimise the utilities, manage biodiversity data, co-ordinate emergency procedures, or interpret performance trends. Regional workforce planning must therefore be linked to the project's timetable, and training as well as the capabilities of suppliers should be established before commissioning. Although public-private partnerships might assist in coordinating finance, expertise, service delivery, and place management, comparative research also indicates that responsibilities and the arrangements for sharing value need to be clearly defined [30]. Governance quality is thus an asset that operates in practice, and not simply an administrative requirement.

Figure 1. Regional tourism infrastructure as a connected resilience system. Source: authors' synthesis of the reviewed evidence.

5. Proposed Regional Tourism Infrastructure Resilience and Safe Delivery framework

The synthesis presents a seven-stage framework for the resilience of regional tourism infrastructure and for the safe delivery of tourism projects. Its main idea is that a major tourism project should not move forward merely because its own business case is appealing; instead, progress must be based on evidence showing that the wider regional system is able to support, protect, and learn from the development. The framework is stage-gated in order that uncertainty may be addressed before irreversible commitments build up. The gates are not meant to function as bureaucratic checkpoints; rather, they represent decision points at which alternatives can still be modified, delayed, resized or resequenced in light of the evidence. This approach applies equally to coastal resorts, heritage sites, metropolitan tourism areas and connected multi-destination routes, even though the indicators and thresholds will vary.

In the first stage the regional requirement and the spatial structure are established. Planners identify the target markets, the needs of residents and workers, the seasonal variations, the accessibility goals, and the relationship between destinations. In the second stage environmental and resource limits are set, these including habitat restrictions, water budgets, exposure to heat, coastal hazards, energy demand, waste handling capacity, and sensitivities regarding cultural and heritage sites. The aim here is to determine a safe operating boundary before choosing a preferred footprint. In the third stage an integrated master plan for the infrastructure is prepared, covering transport, utilities, digital networks, the public realm, the blue and green systems, logistics and access for emergencies. The alternatives are evaluated on the basis of their lifecycle cost, redundancy, scalability, carbon and ecological impact, and not just on their initial cost.

The resilience and safety assurance check occurs at stage four. Across the various projects and institutions, the interdependent risks are mapped, key nodes are identified and responsibilities are assigned. At this stage, evidence relating to the safety aspects of construction, emergency procedures, the continuity of the supply chain, cyber-physical dependencies, the design conditions associated with climate change, and recovery strategies must be required. Stage five involves turning the masterplan into a phased delivery programme. Each phase has to have enough independent service capacity, safe logistics, temporary works, support for the workforce, and environmental controls. The phasing should safeguard future optionality; for instance, routes for transit or for district utilities should not be obstructed by early development which assumes a permanent reliance on cars or the use of a fixed technology.

In stage six, integrated commissioning and operational readiness is achieved by carrying out tests of the infrastructure using realistic cross-system scenarios, passing on asset information to the operators, verifying the availability of maintenance resources, and connecting environmental baselines to operational monitoring. In stage seven, adaptive regional management is carried out by examining the data collected after the site has opened—this includes information on visitor movement, utility intensity, safety incidents, habitat condition, resident access, local procurement, the maintenance backlog, and service interruptions—against predetermined thresholds; if any of the indicators decline, the framework calls for predefined actions such as demand management, altering transport services, adding storage, carrying out restoration, modifying the operating procedures, or delaying expansion. The feedback loop is important since tourism demand, climate conditions, technology costs, and regional development patterns will all change during the lifetime of a giga-project.

Two principles apply to all seven stages. The first of these is that the extent of the analysis should correspond to the seriousness of the possible failure. For example, a remote low-intensity attraction does not need the same level of modelling as a coastal destination which supports tens of thousands of users, although in both cases it is necessary to show that the key dependencies are understood. The second principle is regional transparency, which means that assumptions regarding demand, ecological limits, service capacity, safety tolerances, and phasing should be made available to all agencies and project organisations. This helps to avoid the risk of different packages being optimised against inconsistent standards, and it also enhances the ability to compare projects and to spot instances where shared infrastructure can provide greater resilience than having a number of separate private systems.

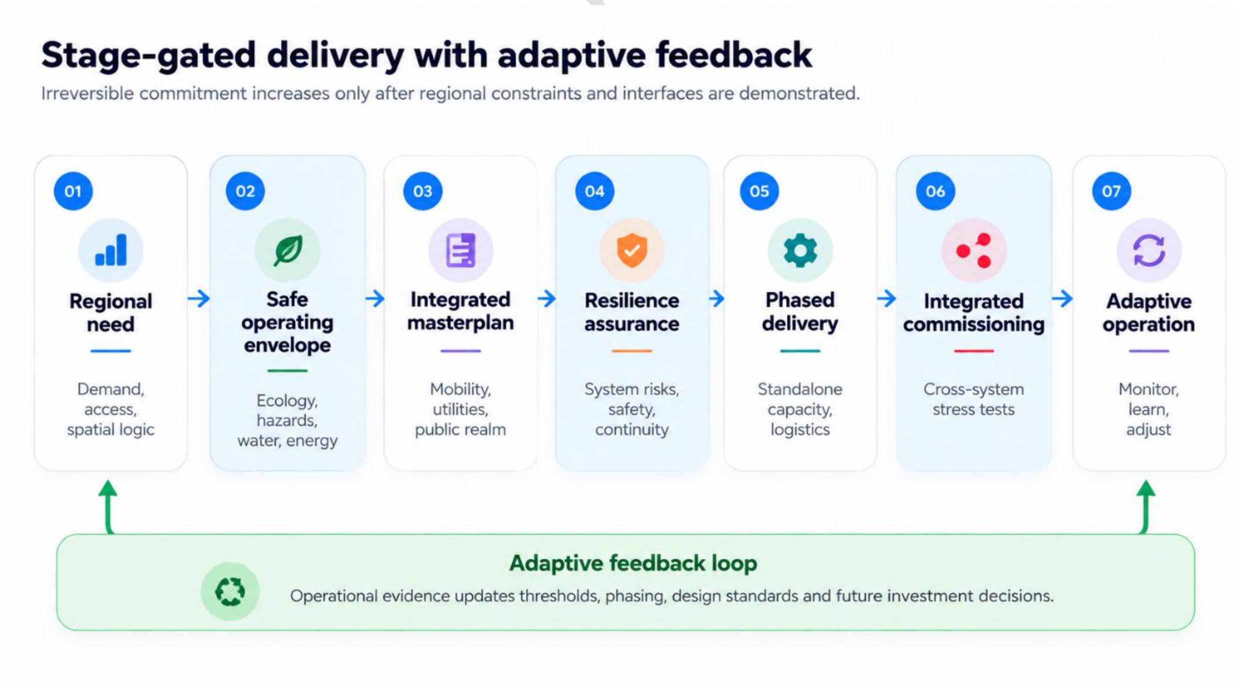

Figure 2. Seven-stage delivery logic with adaptive feedback from operations to future planning and investment.

Table 2. Lifecycle implementation matrix for resilient and safe tourism giga-project delivery

Stage	**Primary decision**	**Required evidence**	**Gate test**
1. Regional need	Where and why to invest	Demand ranges; resident/worker needs; accessibility; destination relationships	Regional need cannot be met more effectively through an alternative spatial or service strategy
2. Safe operating envelope	How much activity can be supported	Ecological thresholds; hazards; water/energy budgets; heritage sensitivity	Proposed demand remains within defined environmental, resource and emergency limits

Stage	Primary decision	Required evidence	Gate test
3. Integrated masterplan	Which infrastructure configuration performs best	Multimodal access; utilities; digital; logistics; public realm; blue-green network	Preferred option is scalable, maintainable and avoids critical single points of failure
4. Resilience assurance	Are systemic risks controlled	Risk interdependencies; safety interfaces; continuity plans; climate design; emergency roles	Critical interfaces have owners, controls and credible recovery arrangements
5. Phased delivery	Can each opening phase operate safely	Standalone capacity; temporary works; workforce/logistics; environmental controls	No phase depends on incomplete future assets for essential safety or service continuity
6. Integrated commissioning	Will connected systems work under stress	Scenario tests; operator readiness; asset data; maintenance resources	Cross-system stress tests meet service, safety and recovery criteria
7. Adaptive operation	When should the system be adjusted or expanded	Performance trends; ecological condition; safety events; maintenance; regional value indicators	Expansion or intervention is triggered by observed thresholds and verified learning

6. Discussion

The study contributes to the existing body of literature in three respects. On the one hand, it positions infrastructure at the heart of sustainable tourism without merely equating sustainability with technical efficiency. Research into Saudi Arabia's giga-projects demonstrates the value of conservation-based spatial planning [1] and comparative studies of destinations show the extent to which large-scale projects can alter the course of tourism development [20]. Yet the environmental performance at a specific site may be compromised by spillover effects at the regional level. To address this, the model in question views infrastructure as a factor that mediates between the destination's ambitions and the wider territorial impacts. This is in line with the general perspective that tourism infrastructure is responsible for organising mobilities and relationships rather than just accommodating them [26]. It also accounts for why regional indicators—such as multimodal accessibility, water stress, emergency reach, ecological connectivity, and local supplier participation—are just as important as the efficiency figures obtained at the hotel level.

Second, the review links destination resilience with megaproject safety. In the case of tourism resilience, the literature usually starts after a crisis has occurred and looks at how destinations manage their recovery or transformation [3,11]. On the other hand, the literature on megaproject safety begins at an earlier stage and examines how complex systems can prevent, absorb and adapt to adverse events [25]. By combining these two approaches a more robust lifecycle logic is obtained. A resilient tourism destination is in part developed during the planning and construction phases through the inclusion of redundancy, interfaces, information structures, operating competence, and ecological buffers before the destination opens. Likewise, safety decisions made during construction can have an impact on long-term resilience if temporary solutions become permanent, if the accelerated schedules reduce maintainability, or if the fragmented contracting weakens ownership of cross-system hazards.

Thirdly, the framework interprets carrying capacity in an infrastructural sense. Traditional discussions of tourism carrying capacity can tend to be abstract since a single visitor figure cannot take into account different seasons, different locations, different technologies, different behaviours, or different ecological conditions. Research into coastal carrying capacity and ecosystem-based planning indicates that management should use a number of indicators and have spatially varied thresholds [12]. The framework thus substitutes a fixed ceiling for the destination with a safe operating envelope. Capacity is then defined as the range in which mobility, water, energy, waste, emergency response, public space, ecosystems and communities can function without suffering unacceptable deterioration. This envelope can be expanded through proven efficiency, restoration, the introduction of new infrastructure or demand management, and it can shrink when drought, habitat decline, a backlog of maintenance or increased exposure to hazards occurs.

The framework also makes clear the part that technology plays. Although digital twins, sensors, predictive maintenance, visitor-flow analytics, and smart utility controls can enhance situational awareness, they do not eliminate the need for physical redundancy or for coordination between institutions. When designing technology it should be based on decisions—such as which threshold is to be monitored, who is to receive the alert, what action is to be taken, and how the action is to be verified—otherwise monitoring will generate a large amount of data without leading to operational learning. The same warning holds true in the case of sustainability certification: certification may help to ensure accountability, but regional resilience relies on the interactions between assets which may be owned by different parties and which may be subject to different contracts, standards, and reporting systems. It is therefore more important to have shared operating procedures and interoperable data than to have a number of separate high-performing assets.

Saudi Arabia provides a useful setting in which to test this integrated approach since its tourism transformation involves coastal, desert, heritage and metropolitan areas. Evidence from the Red Sea shows how conservation planning can be carried out in a delicate marine environment [1], and research on AlUla and the Red Sea demonstrates the various destination-development routes that exist within the same national tourism transition [20]. The evidence from Riyadh illustrates the way in which land use, transit and pedestrian design affect the success of major urban mobility investments [21,29]. The different contexts should not be treated as if they were the same. The framework is intentionally modular so that coastal projects place greater importance on habitat condition and shoreline hazards, heritage areas stress landscape integrity and visitor dispersal, and metropolitan destinations give priority to transit integration, heat-safe walking and network capacity.

7. Practical implications for planning and delivery

For regional planners the main point is to have a single shared infrastructure baseline drawn up before each individual project finalises its own assumptions. This baseline should include definitions of demand scenarios, critical environmental thresholds, strategic corridors, utility capacity, hazard conditions, emergency standards, and regional performance indicators. Developers and programme managers should direct their portfolio risk reviews towards the interfaces and shared dependencies, rather than just focusing on the greatest risks in each individual contract. Operators should get involved right from the stage of design so that aspects such as maintainability, staffing, spare parts, digital handover, and emergency procedures can be checked before the project is completed. As for financiers and partnership organisations, the release of capital should be tied to evidence obtained at each of the successive decision gates, thus encouraging ecological, safety, and capacity issues to be resolved before they turn into sunk-cost problems.

Measurements should be brief enough to aid in making decisions. A well-balanced dashboard should include indicators for service reliability, peak mobility performance, contribution from renewable energy, water intensity and reuse, ecological condition, construction leading indicators, emergency response time, local procurement, workforce competence, the level of maintenance backlog, and resident access [6]. Each indicator should have an owner, defined thresholds, a set reporting frequency, and predetermined responses. The aim is not to maximise all the metrics at the same time, but rather to identify trade-offs early on. For instance, higher visitor numbers might still be acceptable if the share of public transport goes up and the ecological indicators stay stable, whereas the same level of visitors would be unacceptable during a heatwave, a water shortage, or in a sensitive ecological season.

8. Limitations and future research

The review deliberately focuses on 30 studies carried out between 2020 and 2025 and so can be seen as constructing a framework rather than providing a comprehensive overview of all the research on infrastructure and tourism. Since the evidence base includes a variety of geographic scales and research methods, it will be necessary to carry out local testing if the framework is to be applied to specific regions of Saudi Arabia. Future research should put the framework into practice by means of comparative case studies in coastal, heritage, mountainous and metropolitan destinations. The main areas that should be prioritised are quantifying cross-system resilience, defining dynamic carrying-capacity thresholds, testing stage-gate governance in ongoing programmes, assessing the regional distribution of the benefits of infrastructure, and linking digital monitoring to actual operational decisions. Longitudinal evidence will be especially important since many of the resilience benefits only become apparent after the destinations have gone through periods of high demand, maintenance cycles, environmental stress or disruption.

9. Conclusion

Sustainable regional tourism cannot be achieved by designing efficient attractions on their own. As the evidence examined indicates, the performance of a destination is the result of a network of interconnected systems covering mobility, energy, water, ecology, digital services, safety governance, institutions, communities, and operations. In the case of Saudi Arabia's extensive and varied tourism initiatives, these systems have to be planned beyond the boundaries of individual projects and over time. The suggested framework addresses this by connecting regional needs, environmental capacity, integrated infrastructure, resilience assurance, phased delivery, commissioning, and adaptive management via clear decision gates. Its key contribution is a shift in the way planning is approached: rather than viewing infrastructure as a subsequent reaction to expected numbers of visitors, it is considered instead as a constraint, a facilitator, and a safeguard that determines what kind of tourism can realistically take place. Using this approach can help to avoid lock-in, reveal hidden interdependencies, improve both the safety during construction and operation, and maintain flexibility as environmental conditions and demand change. The framework does not offer a single model for each destination. Instead, it offers a structured process for deciding what should be built, where, in what order, under what safeguards, and for what regional benefits.

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