CHAPTER THREE:
RESEARCH METHODOLOGY

This study adopts a qualitative and design-based research methodology that integrates architectural theory, contextual analysis, and practical design application. This approach is particularly suited to the dual nature of the research, which seeks to address both the academic and physical dimensions (Hoadley, 2004)of redesigning the Faculty of Economics and Administrative Sciences at Sharq El-Nile University. The qualitative component enables an in-depth understanding of the existing conditions, spatial functions (Chand, 2025), and user needs within the faculty, while the design-based component translates these findings into tangible architectural solutions (Barrett & Proper, 2021).

Through this integrated methodological framework, the study systematically links theoretical inquiry with the practical process of architectural design (Bashier, 2014). It begins with an assessment of the current campus environment, examining spatial organization, environmental performance, accessibility, and functionality, supported by field observations, interviews, and document analysis. These qualitative insights are then synthesized to inform the development of design concepts that respond to the identified issues and align with the principles of sustainability, smart campus development, and contemporary educational design.

By combining research and design processes (Castro et al., 2025), the study ensures that the final architectural proposal is not only aesthetically and functionally effective but also grounded in evidence-based strategies (Marques et al., 2025) that enhance energy efficiency, spatial comfort, and user experience. This methodological approach ultimately bridges the gap between theoretical exploration and applied architectural innovation, contributing to both academic discourse and the practical advancement of sustainable campus design in Sudan.

3.1 Qualitative and Design Research Method

The research employs a qualitative and design-based methodology that bridges theoretical inquiry and practical architectural application. This methodological integration allows the study to explore the complex relationship between educational space, user experience, and sustainability (Hoadley, 2004), while simultaneously producing a feasible architectural proposal. The choice of this approach reflects the multidimensional nature of architectural research, where understanding human, environmental, and contextual factors is as important as developing technical design solutions.

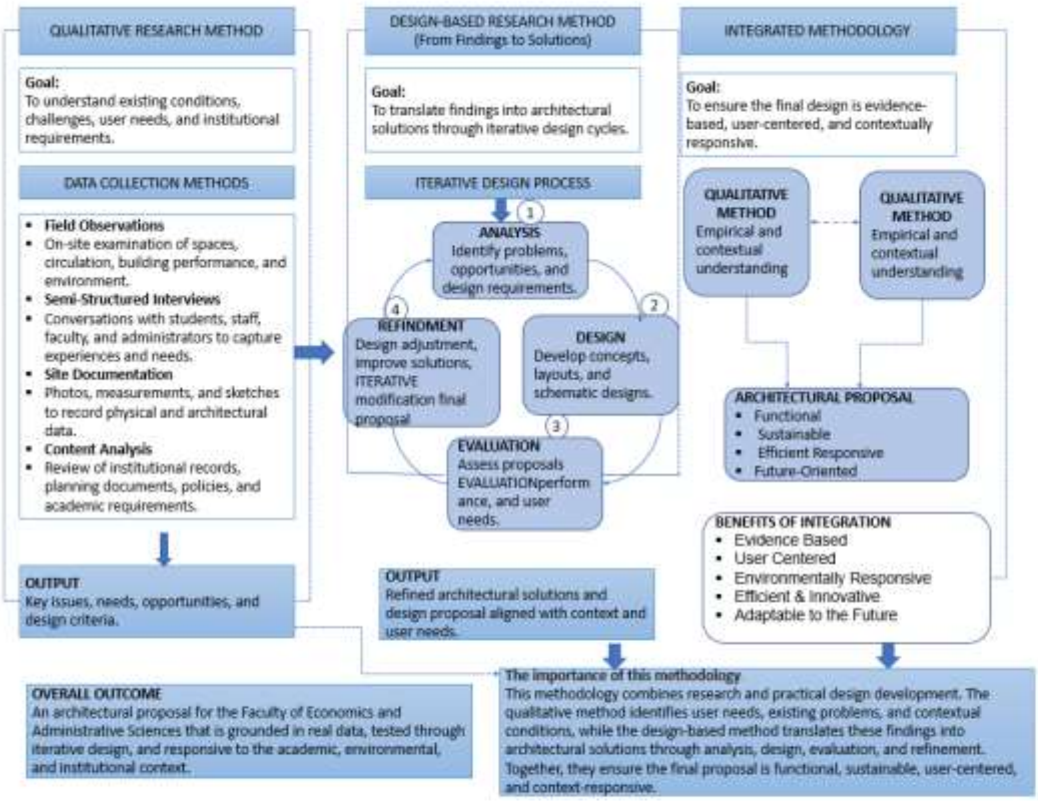

Diagram 8. Integrated Qualitative and Design-Based Research Methodology for Faculty Redesign

Diagram 8 visually communicates an integrated research methodology that combines qualitative inquiry with a design-based approach. At the top, it presents three foundational pillars—Architectural Theory, Contextual Analysis, and Practical Design Application—indicating that these elements collectively support the methodological framework. These components are connected through arrows to a central Venn diagram, symbolizing their convergence in shaping the research process. The Venn diagram is divided into two overlapping circles representing the

Qualitative Component and the Design-Based Component, with their shared space labeled "Dual Academic & Physical Dimensions," emphasizing how both strands work together to address the comprehensive needs of the project.

The left side of the Venn diagram highlights the qualitative dimension, which includes understanding existing conditions, analyzing spatial functions, and identifying user needs. The right side emphasizes the design-based dimension, focusing on developing design solutions, translating research insights into architectural form, and generating practical design outputs. Together, these components lead downward to a unified outcome— "Dual Academic & Physical Dimensions"—which flows into the final objective: the redesign of the Faculty of Economics and Administrative Sciences at Sharq El-Nile University. The layout clearly illustrates how theoretical knowledge, contextual understanding, and practical design actions integrate to inform a holistic architectural redesign process.

3.2 Qualitative Research Method

The qualitative component of the study focuses on understanding the existing conditions, challenges, and needs (Chasokela & Chasokela, 1 C.E.)of the Faculty of Economics and Administrative Sciences at Sharq El-Nile University. Rather than relying on numerical data alone, qualitative inquiry emphasizes depth, meaning, and context. It involves collecting rich descriptive data through methods such as field observations, semi-structured interviews, site documentation, and content analysis of institutional records.

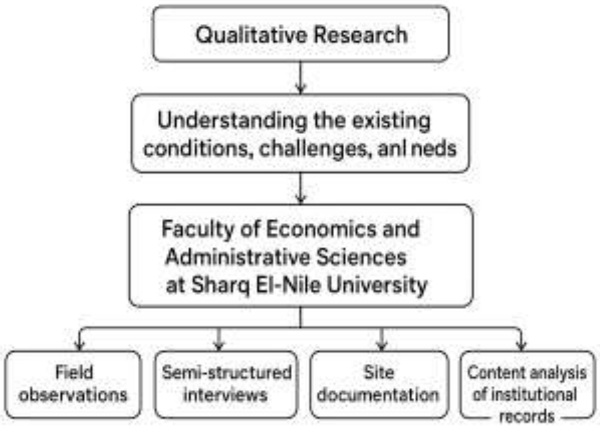

Diagram 9. Methodological Structure of the Qualitative Inquiry at the Faculty of Economics and Administrative Sciences

Diagram 9 represents the methodological structure of the qualitative inquiry guiding the redesign of the Faculty of Economics and Administrative Sciences (FEAS) at Sharq El-Nile University. It shows a sequential yet interconnected process in which qualitative research forms the foundation for understanding the real conditions within the faculty. The next layer—identifying existing conditions, challenges, and needs—highlights that the redesign must be grounded in an accurate grasp of how the building currently functions and what limitations users experience. This understanding is then applied specifically to the FEAS context, ensuring that the inquiry focuses on the faculty's academic, administrative, and spatial realities. The four data-collection methods—field observations, semi-structured interviews, site documentation, and content analysis of institutional records—represent complementary tools that together provide a holistic picture of the faculty environment. Field observations reveal everyday functional issues; interviews capture users' lived experiences; site documentation provides architectural and spatial evidence; and institutional records offer formal insights into policies, usage patterns, and historical needs. Collectively, the diagram shows that the redesign process is rooted in a systematic, multi-source qualitative methodology that ensures the proposed solutions are context-responsive, user-centered, and evidence-based.

Through these methods, the research captures the lived experiences of users—students, faculty members, and administrative staff—and analyzes how spatial organization, lighting, ventilation, and accessibility affect teaching, learning, and overall comfort. This understanding is essential to ensure that the redesign responds to real human and institutional needs. The qualitative approach also allows the researcher to interpret the cultural and environmental context of Sudanese higher education, providing a grounded foundation for design decisions that are contextually appropriate and socially responsive.

3.3 Design-Based Research Dimension

Complementing the qualitative inquiry, the design-based research (DBR) component translates the findings into a structured architectural development process. In architectural research, design-based methods are iterative and practice-oriented, involving cycles of analysis, design, evaluation, and refinement. This approach allows the researcher to test conceptual ideas against practical constraints and continuously improve the design in response to feedback and contextual realities.

The design process begins with the formulation of design criteria derived from the qualitative analysis, followed by the creation of conceptual layouts and schematic designs. These are then evaluated based on sustainability principles, space efficiency, environmental performance, and alignment with smart campus concepts. The iterative nature of design-based research ensures that each stage of development—conceptual, schematic, and final design—is informed by evidence and reflective analysis rather than intuition alone.

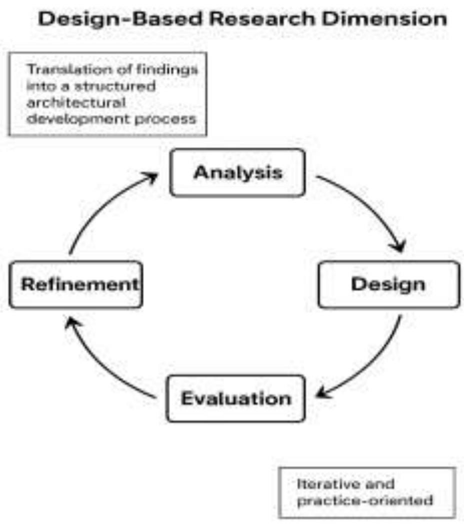

Diagram 10. Framework for Design-Based Research in Architecture

Diagram 10 presents a Design-Based Research Framework in Architecture that guides the redesign of the FEAS building through an iterative cycle of Analysis, Design, Evaluation, and Refinement. The process begins with analyzing existing challenges and user needs, which inform the creation of design proposals addressing spatial, functional, and environmental priorities. These proposals are then evaluated through performance assessments and stakeholder feedback, generating insights that shape the refinement of the design. The cycle repeats until an optimized architectural solution is achieved, allowing findings to be translated into a structured and evidence-based development process tailored to the needs of the FEAS Faculty.

3.4 Integration of the Two Approaches

By combining qualitative research with design-based methodology, the study creates a dynamic framework that unites theoretical insight and practical creation. The qualitative phase provides the empirical and contextual data necessary to define problems accurately, while the design-based phase offers a platform to propose, visualize, and refine solutions. This integration ensures that the final architectural proposal is:

- Evidence-based, grounded in user needs and contextual realities;
- Innovative, incorporating contemporary educational and environmental design standards;
- Sustainable, addressing energy efficiency, natural ventilation, and material optimization; and
- Functional and aesthetic, reflecting both practical requirements and cultural identity.

Diagram 14 below illustrates how qualitative research and design-based methodology interact to form a comprehensive, evidence-driven framework for developing an effective architectural proposal.

3.5 Research Design and Process

The research follows a problem-solving framework that proceeds through interconnected phases: identifying existing challenges in the Faculty of Economics and Administrative Sciences, analyzing the site and environmental context, reviewing relevant theories and precedents, developing architectural concepts, and evaluating the proposed design through sustainability and functionality criteria. The methodology ensures a continuous feedback loop between analysis and design, allowing theory and practice to inform one another throughout the process.

The overall research process can be divided into three major phases: (1) Planning and Analysis, which focuses on data collection and situational understanding; (2) Design Development, which involves concept generation and spatial synthesis; and (3) Evaluation and Refinement, which assesses the proposal in relation to global standards and local needs. Each phase contributes to a coherent and systematic progression from problem identification to solution implementation.

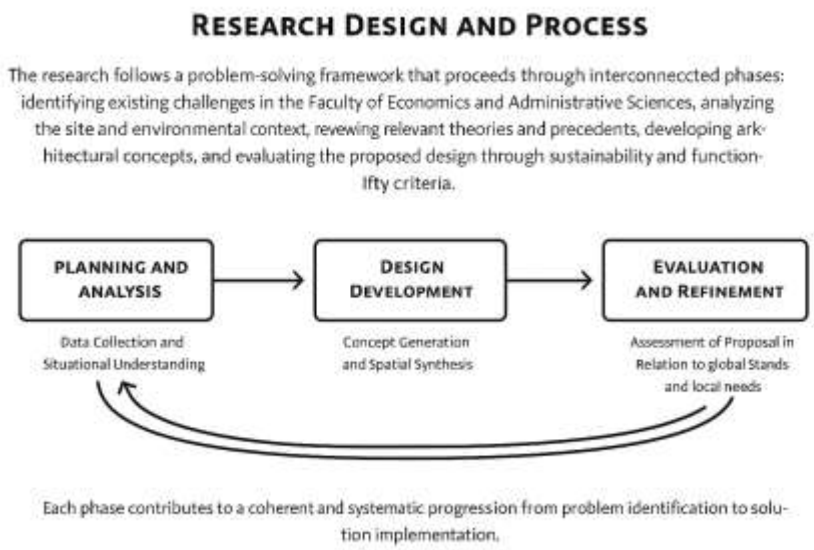

Diagram 11. Research Design and Process Framework

Diagram 12 of the Research Design and Process Framework illustrates an iterative, interconnected progression that guides the redesign of the FEAS building from problem identification to tested design solutions. It begins with Planning and Analysis, where existing spatial, functional, and environmental challenges within FEAS are examined through data collection and situational understanding. These insights lead to Design Development, where conceptual ideas, spatial strategies, and architectural responses are generated to address the identified needs while considering educational functions, circulation efficiency, and climatic conditions. The process culminates in Evaluation and Refinement, during which the proposed redesign is assessed against sustainability principles, global academic building standards, and local contextual requirements, ensuring cultural relevance and feasibility. The feedback loop in the diagram emphasizes that the design is continuously revisited and improved, resulting in a responsive, evidence-based, and contextually grounded redesign of the Faculty of Economics and Administrative Sciences.

In addition to the straightforward linear progression, the diagram includes a curved feedback arrow looping from the final phase back to the first. This visual element highlights the cyclical nature of research, indicating that conclusions drawn during evaluation can lead to revisiting and refining earlier stages. Overall, the diagram illustrates a coherent, iterative methodology where analysis and design continuously inform one another to guide the development of effective, context-responsive architectural solutions.

3.5.1 Planning and Analysis Stage

The first stage of the research is dedicated to a comprehensive assessment of the current conditions and needs of the Faculty of Economics and Administrative Sciences. This stage involved three main activities: needs assessment, site analysis, and environmental scanning.

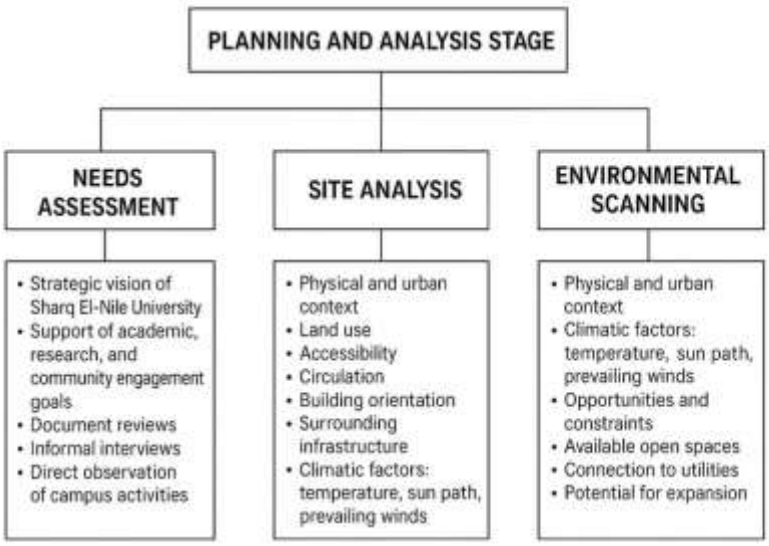

Diagram 12. Framework of the Planning and Analysis Phase

Diagram 12 of the Research Design and Process Framework illustrates an iterative, interconnected progression that guides the redesign of the FEAS building from problem identification to tested design solutions. It begins with Planning and Analysis, where existing spatial, functional, and environmental challenges within FEAS are examined through data collection and situational understanding. These insights lead to Design Development, where conceptual ideas, spatial strategies, and architectural responses are generated to address the identified needs while considering educational functions, circulation efficiency, and climatic conditions. The process culminates in Evaluation and Refinement, during which the proposed redesign is assessed against sustainability principles, global academic building standards, and local contextual requirements, ensuring cultural relevance and feasibility. The feedback loop in the diagram emphasizes that the design is continuously revisited and improved, resulting in a responsive, evidence-based, and contextually grounded redesign of the Faculty of Economics and Administrative Sciences.

The needs assessment identified the strategic vision of Sharq El-Nile University and evaluated how the current physical environment supports—or limits—its academic, research, and community engagement goals. Data was collected through document reviews, informal interviews with faculty members and students, and direct observation of campus activities. This process helped determine the spatial and functional requirements of the faculty, including the number and size of classrooms, administrative offices, research laboratories, and common facilities.

The site analysis focuses on the physical and urban context of the university's Bahri/Shambat location in Khartoum. This includes studying land use, accessibility, circulation, building orientation, and surrounding infrastructure. Climatic factors such as temperature, sun path, and prevailing winds are analyzed to inform environmentally responsive design strategies. The analysis also identifies opportunities and constraints within the site—such as available open spaces, connection to utilities, and potential for expansion—that influence design decisions.

The environmental scan evaluates the ecological and sustainability implications of the design process. It involves identifying opportunities for passive design strategies such as natural ventilation, daylight optimization, and shading. This step also considers the use of local materials and renewable energy systems to minimize the proposed design's environmental footprint. Together, these analyses provide a holistic understanding of the existing context and lay the foundation for a responsive architectural solution.

3.5.2 Design Development Stage

The second phase focuses on the design process, where theoretical knowledge and analytical findings are translated into architectural form. This phase integrates spatial planning, functional organization, and environmental performance considerations to produce a cohesive design solution. The process follows an iterative concept generation, evaluation, and refinement sequence.

The architectural design begins with the development of conceptual frameworks that emphasize flexibility, adaptability, and user-centered spatial arrangements. These concepts are shaped by the results of the needs and site analyses, ensuring that the proposed building configuration responds directly to identified problems. The design incorporates passive and active environmental strategies, including natural ventilation systems, green roofing, solar shading devices, and photovoltaic energy generation. Aesthetic decisions are guided by both modern architectural principles and Sudanese cultural identity, resulting in a design that is innovative yet contextually grounded.

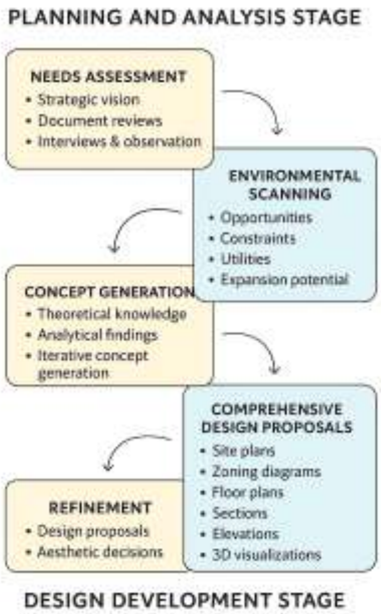

Diagram 13. Comprehensive Architectural Planning and Design Workflow

The diagram above presents an integrated visual framework that combines the Planning and Analysis Stage with the Design Development Stage to illustrate the full progression of an architectural project. The upper section outlines the foundational analytical processes, beginning with Needs Assessment, where strategic vision, document reviews, and observations inform the core requirements of the project. This leads into Environmental Scanning, which evaluates opportunities, constraints, available utilities, and potential for expansion within the site context. These analytical inputs then flow into Concept Generation, where theoretical knowledge and findings are used to develop initial spatial and functional ideas. Arrows between elements highlight the logical, sequential relationship among these tasks, demonstrating how each stage builds upon the previous one.

The lower section transitions into the Design Development Stage, capturing how early concepts are refined into detailed architectural outputs. The process continues with *Evaluation*, which assesses spatial planning, functional organization, and environmental performance based on the initial concepts. The insights gained from evaluation feed into *Refinement*, where design proposals and aesthetic decisions are iteratively improved. This culminates in the production of

Comprehensive Design Proposals, including site plans, zoning diagrams, floor plans, sections, elevations, and 3D visualizations. Together, the two stages represent a complete workflow—from identifying needs and conditions to generating and finalizing high-quality architectural design solutions.

The infrastructure design addresses the integration of energy-efficient systems and digital technologies that enable a smart campus environment. This includes the implementation of renewable energy sources, smart lighting, and digital communication infrastructure that supports interactive learning spaces. Water management systems—such as rainwater harvesting, greywater recycling, and low-flow fixtures—are proposed to enhance environmental sustainability.

In addition, the outdoor and landscape design focuses on creating shaded social spaces, pedestrian-friendly pathways, and biodiversity-supportive green areas that improve the microclimate and encourage community interaction. Safety and accessibility considerations are embedded throughout the design, including fire safety measures, emergency exits, and inclusive access for persons with disabilities. The outcome of this stage is a comprehensive set of design proposals, including site plans, zoning diagrams, floor plans, sections, elevations, and three-dimensional visualizations.

3.5.3 Implementation and Visualization Stage

The implementation and visualization stage represents a pivotal phase in the architectural design process, where conceptual ideas are translated into detailed technical outputs (Horvath & Pouliou, 2024). This stage involves the creation of comprehensive architectural drawings, including floor plans, elevations, and construction details, which articulate the spatial organization and structural systems of the proposed faculty building. These drawings are complemented by 3D digital renderings and visual simulations that allow stakeholders to experience the design in a realistic and immersive manner. Such visual tools serve not only as communication instruments but also as evaluative mechanisms for assessing spatial efficiency, material selection, and aesthetic quality.

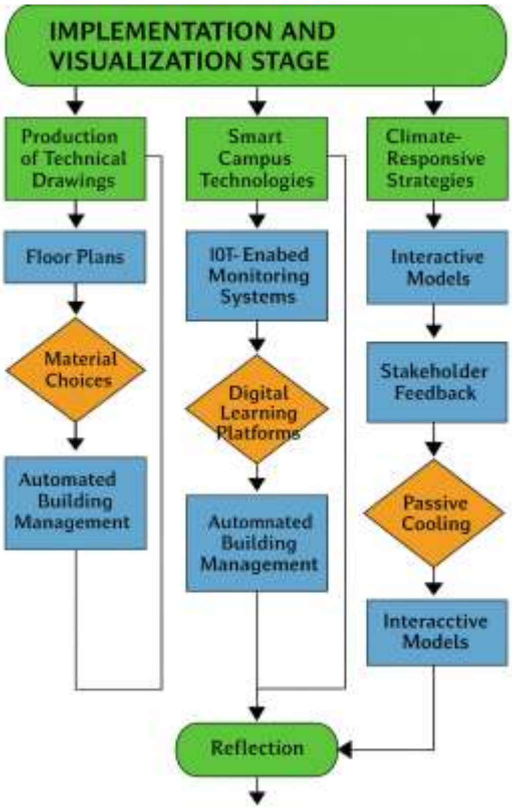

Diagram 14. Implementation and Visualization Workflow in Architectural Design

The diagram illustrates the *Implementation and Visualization Stage* of an architectural design process through a structured flowchart composed of three parallel columns representing technical drawing production, smart campus technology integration, and climate-responsive strategies. Each column begins with a green header indicating a major component of the stage, followed by blue rectangular process steps and orange diamond-shaped decision points that show key choices within the workflow. The left column focuses on producing technical drawings, progressing from floor plans to material selection and system integration; the middle column highlights the incorporation of IoT monitoring, digital learning platforms, and automated building management; and the right column emphasizes climate-responsive and culturally grounded strategies, including stakeholder feedback, passive cooling, and iterative interactive modeling. All three paths converge at a final green “Reflection” box, signifying the synthesis and evaluation of outcomes before finalizing the architectural design.

Building on the processes illustrated in the diagram, a central component of the implementation and visualization stage is the integration of smart campus technologies that modernize the faculty building and align it with current educational innovations. These technologies include IoT-enabled environmental monitoring systems that track temperature, humidity, and air quality in real time, generating data that supports adaptive building operations such as automated ventilation and lighting control. Digital learning platforms are also embedded within the building’s infrastructure to facilitate hybrid and remote education through high-speed connectivity, interactive teaching tools, and cloud-based content delivery. Complementing these systems, automated building management tools centralize HVAC, lighting, and security functions, enabling predictive maintenance and responsive adjustments based on daily user patterns.

In parallel, the implementation process emphasizes climate responsiveness and cultural relevance (Paloma & Cathy, 2025), consistent with the contextual strategies represented in the diagram. Material selection prioritizes locally available and environmentally appropriate resources, including compressed stabilized earth blocks and passive cooling components suited to Sudan’s climate. The architectural language incorporates vernacular elements—such as shaded courtyards, mashrabiya screens, and arcaded walkways—to reflect Sudanese cultural identity while enhancing environmental performance. These features work in tandem with passive design strategies like orientation optimization, cross-ventilation, and solar shading, ensuring that the building achieves thermal comfort with reduced dependence on mechanical systems.

Visualization also plays a crucial role in linking technical development with user engagement, as depicted in the interactive modeling pathway of the diagram. Through digital simulations and participatory design sessions, stakeholders—including faculty, students, administrators, and community members—are able to explore spatial configurations, assess accessibility, and provide feedback on functional and aesthetic choices. This collaborative process fosters a shared sense of ownership and ensures that the final design responds directly to the needs and expectations of its users. Ultimately, the implementation and visualization stage synthesizes technological innovation, climatic adaptation, and participatory input, transforming conceptual ideas into an environmentally grounded and community-aligned architectural solution.

3.5.4 Monitoring and Evaluation Stage

The evaluation phase assesses the design's effectiveness against key performance criteria related to sustainability, functionality, and user experience (H. Lin et al., 2023). The proposed redesign is evaluated qualitatively using sustainability indicators such as energy performance, environmental comfort, spatial flexibility, and adaptability (Sacchetti & Di Giulio, 2025).

Furthermore, the design outcomes are compared with international case studies, including Columbia Business School and the London School of Economics' Marshall Building, to benchmark the project against global best practices in academic architecture.

Feedback from experts and potential users (when available) is also considered to refine the proposal. This ensures that the final design not only meets technical and aesthetic standards but also aligns with the lived experiences and expectations of its future occupants.

3.5.5 Research Instruments and Techniques

A combination of research instruments and analytical techniques supports the data collection and design process. These include:

- **Document and Literature Review:** Examination of academic literature on smart and sustainable campus design, architectural typologies of educational buildings, and relevant international precedents.
- **Site Observation and Analysis:** Collection of environmental, climatic, and spatial data from the Bahri/Shambat campus to inform context-sensitive design strategies.

- **Comparative Case Studies:** Evaluation of international examples of sustainable university design to identify applicable lessons and design benchmarks.
- **Architectural Visualization:** Use of diagrams, floor plans, 3D renderings, and physical or digital models to communicate design intentions and validate spatial organization.

3.5.6 Design Criteria

The design criteria collectively guide the architectural process to ensure that the final environment is functional, aesthetically pleasing, sustainable, safe, and environmentally responsible (Nocera et al., 2024). Functional standards shape how spaces are organized and connected, prioritizing user comfort, smooth circulation, and accessibility for all users, including those with disabilities. Aesthetic criteria influence the visual character of the building through thoughtful use of form, materials, color, texture, and lighting to create harmony with the surrounding context while enhancing the user experience.

Sustainability and adaptation standards ensure that buildings are designed for long-term efficiency and resilience, incorporating strategies such as green façades, natural ventilation, solar energy systems, and the use of local, eco-friendly materials (Ali El Ashmawy et al., 2024b). Safety and security standards guide the integration of protective systems, clear evacuation routes, and appropriate access control to maintain a secure environment for all occupants. Environmental standards reinforce responsible resource use by reducing pollution, conserving natural systems, and encouraging the adoption of renewable energy and low-impact materials. Together, these criteria form a holistic framework that supports high-performance, human-centered, and future-ready architectural design.

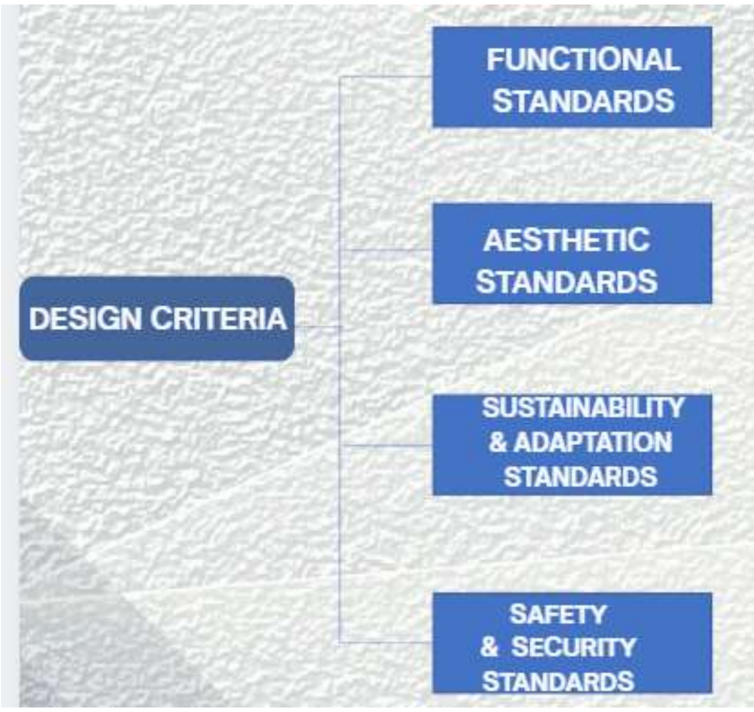

Diagram 15. Determinants of Architectural and Planning Design Criteria

Diagram 16, Determinants of Architectural and Planning Design Criteria, highlights how multiple contextual forces shape the foundations of any architectural decision, and this becomes essential when redesigning the FEAS building. The diagram shows that regulations and codes form a mandatory framework that the redesign must follow, ensuring compliance with safety standards, structural requirements, and institutional policies. Culture and social factors emphasize the need for a design that reflects the identity, values, and academic culture of Sharq El-Nile University, supporting collaboration, comfort, and community. The geographical and climatic context underscores Sudan's hot, arid environment, requiring passive cooling strategies, optimized orientation, and materials suitable for thermal comfort and energy efficiency. Additionally, the urban and natural environment shapes how the redesigned FEAS integrates with surrounding buildings, circulation patterns, landscape, and ecological features on campus. Together, these determinants create the legal and planning constraints that guide and limit architectural choices, ensuring that the redesign is environmentally responsive, culturally grounded, and fully compliant with planning regulations.

3.5.7 Design Setting

Design projects are shaped by a range of contextual factors that guide both their form and function (Sein et al., 2011). Legal and planning constraints ensure responsible development, requiring compliance with zoning laws, land-use regulations, height limitations, and environmental protection policies, all of which influence how designers organize space and scale within a site (Bansal & Pandey, 2024).

Diagram 16. Key Determinants in the Design Setting Process

The diagram illustrates how a design setting is shaped by multiple influencing factors, including functional, aesthetic, and structural standards, as well as economic criteria, technical constraints, and safety and security standards. Each of these elements branches out from the central concept of design setting, showing that the overall design process must balance performance requirements, visual considerations, structural integrity, cost limitations, technological capabilities, and safety regulations.

Cultural and social factors also play a vital role, as understanding local traditions, religious practices, and community values helps architects create designs that are meaningful, respectful, and aligned with user expectations (Krstić et al., 2024). Alongside these, building regulations and safety codes establish essential standards for fire protection, structural stability—especially in seismic zones—accessibility for individuals with disabilities, and energy efficiency, ensuring that buildings are safe, healthy, and sustainable.

The geographical and climatic context further shapes design decisions; for instance, hot and dry climates demand strategies such as shading, natural ventilation, and effective insulation to enhance comfort while reducing energy consumption, while topography influences drainage, orientation, and wind exposure (Koch-Nielsen, 2013). Additionally, both urban and natural environments impose their own requirements: in dense urban areas, designers must balance efficiency with livability through mixed-use development, green roofs, and public spaces, whereas natural settings call for sensitive integration with ecological features. Together, these factors form a comprehensive framework that guides responsible, functional, and context-responsive architectural design.

3.5.8 Relationship Between Design Criteria & Design Setting

The relationship between Design Criteria and Design Setting represents a dynamic and deeply interconnected aspect of the architectural process. Design Criteria define what a building must achieve—its functional performance, aesthetic identity, safety provisions, sustainability strategies, and cultural alignment (Elnagar et al., 2024)—while the Design Setting establishes the contextual conditions within which these criteria must operate (Cash et al., 2023). The setting shapes the criteria by introducing legal, cultural, environmental, social, and climatic factors that influence design priorities (Brandsma et al., 2024). For instance, a hot climate necessitates sustainability measures such as shading and natural ventilation, zoning regulations determine functional aspects like building height and density, and cultural values inform aesthetic and social design decisions that reinforce identity and community acceptance.

Conversely, the design criteria interpret and respond to these contextual conditions, guiding spatial organization, material choices, safety measures, and environmental strategies (Jens & Gregg, 2021). Functional criteria address site-specific needs such as circulation and user demographics; aesthetic criteria harmonize the building with local traditions or natural surroundings; and safety criteria translate environmental risks and regulatory requirements into practical solutions. Together, the setting and criteria form a holistic, cyclical framework in which context informs design requirements, and those requirements shape responsive, responsible, and contextually meaningful architectural solutions (Saylan et al., 2024). This synergy ensures that the resulting architecture is functional, sustainable, culturally grounded, safe, and aligned with both human and environmental needs.

Diagram 17. Interrelationship Between Design Setting, Design Criteria, and the Architectural Project

The diagram illustrates the dynamic relationship between design setting, design criteria, and the architectural project. On the left side, the design setting is shaped by contextual and environmental factors such as the urban and natural environment, geographical and climatic conditions, cultural and social factors, legal and planning constraints, and regulations and codes. These elements provide the foundational context in which an architectural project is conceived. Arrows from these factors toward the design setting show how each component contributes to shaping the conditions and boundaries within which architects must operate. The design setting, in turn, influences the architectural project, establishing the broad constraints and opportunities that guide initial design decisions.

On the right side, the diagram presents design criteria, which include functional standards, aesthetic standards, sustainability and adaptation standards, and safety and security standards. These criteria represent the performance expectations, user needs, and formal qualities that the architectural project must satisfy. The architectural project *responds* to both the design setting and the design criteria, creating a feedback loop shown through circular arrows. This conveys that architectural design is not linear but an iterative process, continuously shaped by contextual realities and evaluative standards (Salama & Holgate, 2025). Collectively, the diagram highlights how an architectural project emerges through a balanced interaction between environmental contexts and required design principles.

3.6 Case Project Description (Location, Condition, Functions & Regulations)

The case project is situated within the main campus of Sharq El-Nile University**,** located in Khartoum Bahri (North Khartoum)**,** Sudan. The university occupies a strategically significant and easily accessible location within the expanding urban fabric of Bahri, one of the three main cities forming the Khartoum metropolitan area. This location places the campus in proximity to major road networks, public transportation routes, and essential services, ensuring seamless connectivity with surrounding neighborhoods and the wider city. The surrounding context is characterized by a diverse mix of land uses, including educational institutions, residential zones, and governmental facilities, all of which contribute to the vibrancy and socio-economic importance of the area.

Figure 24. **Satellite Map of Sharga Nile University – Faculty of Economics and Administrative Sciences**

[Source: Retrieved June 1, 2026, from Google Earth]

The satellite diagram shows the Faculty of Economics and Administrative Sciences at Sharq El-Nile University positioned within a dense residential grid, with its buildings arranged in long, rectangular blocks. These structures are separated by open, largely undeveloped spaces that form informal courtyards. The main vehicular access is provided by Al Baraha Street to the south, while smaller surrounding streets create multiple secondary entry points. This configuration gives the campus a fragmented layout, with movement across the site depending on unstructured pathways rather than a defined circulation system.

In the context of redesigning the faculty, the diagram highlights significant opportunities for spatial reorganization. The open internal areas suggest potential for creating a central pedestrian spine, landscaped courtyards, and shaded student zones that could promote social and academic interaction. Because the existing buildings appear to be low-rise, vertical expansion is a viable strategy to consolidate academic functions, freeing ground space for communal and green areas. The redesign could also introduce improved zoning—separating academic blocks, administrative areas, and student services to establish a more coherent campus environment.

Finally, the diagram's wider neighborhood context indicates the importance of integrating the faculty with its surrounding community. Proximity to local services, housing, and small businesses positions the campus as a community node, and redesign efforts could enhance this relationship through better-defined entrances, improved walkability, and sustainable landscaping to reduce heat and dust. Overall, the image reveals a campus with strong foundational space but substantial potential for modernization, environmental comfort, and functional cohesion.

As one of the university's central academic precincts, the Faculty of Economics and Administrative Sciences occupies a prominent position near the administrative core of the campus. Its placement adjacent to other educational buildings, student facilities, and landscaped open spaces fosters an integrated learning environment that promotes academic interaction and social engagement. The spatial organization of the campus reflects principles of functional zoning and accessibility, where pedestrian pathways and green corridors link various faculties and communal areas, encouraging movement and visual continuity across the site (Akkurt & Akbulut, 2025).

Climatically, the site experiences the hot semi-desert conditions typical of central Sudan, defined by long, intensely hot summers and short, mild winters, with very limited annual rainfall and occasional dust storms driven by seasonal winds (Elagib & Elhag, 2011). These environmental conditions exert a profound influence on architectural design decisions, demanding strategies that mitigate heat gain and enhance thermal comfort (Mba et al., 2024b). Design responses such **as** optimal building orientation**,** deep shading devices**,** natural cross-ventilation, and the incorporation of vegetation and shaded courtyards become essential in achieving environmental sustainability (Ergün & Bekleyen, 2025). The use of locally appropriate materials and passive cooling techniques further reflects a contextual approach that aligns with the climatic realities of the region while ensuring user comfort and energy efficiency (Manshour & Lehmann, 2025).

The Sharq El-Nile University campus, and particularly the Faculty of Economics and Administrative Sciences, represents a microcosm of educational development within the rapidly urbanizing fabric of Khartoum Bahri**.** Its strategic location, contextual integration, and climate-responsive design potential highlight the opportunities and challenges inherent in developing sustainable academic environments within arid and semi-arid regions (Davies, 1994).

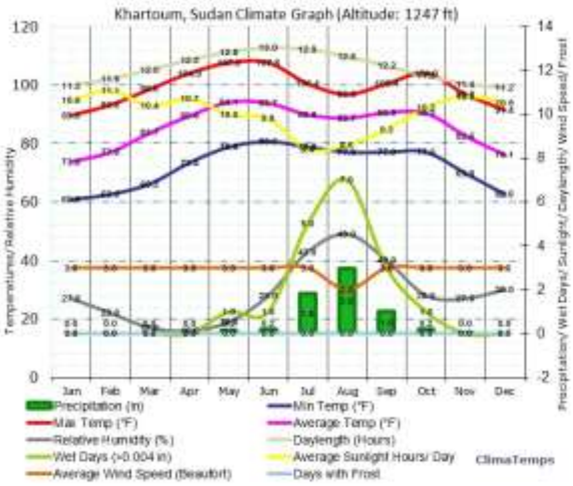

Diagram 18. Khartoum, Sudan: Comprehensive Monthly Climate Graph (Temperature, Rainfall, Humidity & Daylength 2023)

Sudan’s climate is largely characterized by high temperatures and significant seasonal variation (A. Ahmed et al., 2025). During the summer months, which extend from March to October, temperatures often become extremely hot, especially in the northern and central regions of the country (Mohamed et al., 2016). In these areas, daytime temperatures commonly reach between 40°C and 45°C. Locations close to the Nile River may also experience increased humidity, adding to the intensity of the heat (Sudan's Red Crescent Society, 2024). In contrast, the winter season in Sudan, spanning from November to February, brings noticeably milder weather. Daytime temperatures generally range between 15°C and 25°C, offering a more comfortable climate for residents and visitors alike (Sudan's Red Crescent Society, 2024). However, the desert regions can become quite cold at night, with temperatures sometimes dropping below 10°C. Overall, Sudan’s climate is shaped by its geography, with vast desert areas in the north and more tropical influences in the south (A. Ahmed et al., 2025). The long, hot summers and short, mild winters reflect the country's position within the arid and semi-arid zones of Africa (Mohamed et al., 2016). These climatic conditions influence everything from agriculture and water availability to daily life and seasonal activities.

3.6.1 Existing Condition

The existing Faculty building is a two-story reinforced concrete structure constructed in the early 1990s as part of the university’s first phase of physical expansion. At the time, the building served the institution’s needs adequately; however, more than three decades of continuous use without substantial renovation have led to severe physical and functional deterioration. The effects of material aging, combined with minimal preventive maintenance and lack of modernization, have resulted in a structure that no longer supports contemporary academic practices or sustainability standards.

Structurally, the building remains stable, but signs of wear are evident throughout its fabric. Cracks in plaster surfaces, water seepage through the roof and walls during the rainy season, and corrosion in exposed reinforcement elements indicate the gradual decline of the structure. The finishes—such as wall paint, flooring, and ceiling panels—are outdated and damaged in several areas, diminishing the building’s aesthetic and spatial quality. The absence of soundproofing and acoustic treatment further affects learning comfort, particularly in classrooms adjacent to high-traffic corridors or outdoor activity zones (C. Liu et al., 2023).

Spatially, the existing layout follows a traditional corridor-based organization, with rows of classrooms arranged along double-loaded hallways. While this layout maximized space efficiency during the time of construction, it now imposes significant limitations on flexibility and functionality. Classrooms are typically overcrowded, with fixed seating arrangements that restrict interactive or collaborative learning activities. The narrow corridors create congestion during class transitions, while the lack of designated student lounges or informal learning spaces discourages social interaction and self-directed study outside formal class hours.

Figure 25. **Student Designated Area for Refreshment**

[Source: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcShG5B81aTTPSEx9taryZEhljKNY8guGWjsDQ&s. Retrieved June 1, 2026]

Figure 26 shows a student refreshment area that is functional but visibly outdated and insufficient in meeting the spatial, environmental, and comfort needs of a modern academic complex. The open seating area is furnished with simple blue metal benches arranged under a corrugated roof supported by thin poles. While the structure provides basic shade, it lacks adequate thermal insulation, ventilation control, and spatial organization. The concrete floor is plain and exposed, offering little in terms of comfort, durability enhancement, or accessibility considerations. The surrounding environment—characterized by unfinished edges, exposed sandy ground, and minimal landscaping—reinforces a sense of underdevelopment and limited aesthetic appeal.

In the context of redesigning the FEAS complex, the current condition highlights several critical deficiencies: the absence of dedicated cooling strategies for a hot climate, inadequate seating quality for long-term student use, and a lack of integrated amenities such as lighting, charging points, or refreshment facilities. Additionally, the space does not promote social interaction, academic engagement, or well-being—key pillars of contemporary campus design. The simplicity of the structure and its limited environmental performance underscore the urgent need for a comprehensive redesign that aligns with modern student expectations, fosters comfort and community, and transforms the refreshment area into an active, inviting, and climate-responsive part of the FEAS complex.

Figure 26. **Entrance Gate to the Faculty of Economics and Administrative Science**
[Source: Google-hosted image reference, Accessed 1 June 2026]

Figure 27 shows the current entrance gate to the Faculty of Economics and Administrative Science at Sharq El-Nile University, illustrating an environment that is functional but visibly outdated and lacking coherent spatial organization. The gate itself consists of multiple-colored signboards mounted on a simple metal frame, creating a visually cluttered appearance with no unified identity or architectural language. The surrounding structures—including shaded waiting areas, exposed service stalls, and brick corridor walls—appear to have developed organically rather than through coordinated planning. This has resulted in a fragmented aesthetic that does not reflect the academic stature or branding aspirations of the faculty.

The condition of the entrance also highlights several functional limitations that reinforce the need for redesign. Circulation pathways are narrow and unstructured, offering minimal guidance for students and visitors entering the faculty. The shading structures lack architectural integration, while the signage, though informative, does not form a cohesive gateway element that communicates a strong institutional character. Additionally, the lack of clear landscape elements, pedestrian orientation, and modern wayfinding reduces the entrance's capacity to serve as a welcoming and navigable threshold. Redesigning this entrance would therefore offer an opportunity to establish a unified visual identity, improve circulation and comfort, and create a more professional, student-centered environment aligned with the future vision of the faculty and the wider campus.

Figure 27. **Existing Classroom Space Appearance**

[Source: [Photograph of an existing classroom space appearance] *(n.d.),* Google Images. Retrieved June 1, 2026]

Figure 28 presents an existing classroom characterized by outdated, bulky wooden–metal furniture arranged in compact rows along a narrow central aisle. The overall appearance of the space reflects limited flexibility, with fixed desk layouts that dominate the room and restrict alternative use. The worn flooring, aging finishes, and visible deterioration on desks and structural elements highlight a learning environment designed for traditional, high-density classroom occupancy rather than multipurpose academic functions. The room's current configuration, therefore, occupies a significant footprint without offering versatility or efficiency.

In relation to the growing demand for more office space within the faculty, the existing classroom's condition reveals an opportunity for strategic redesign and spatial reallocation. Given its outdated infrastructure and inefficient layout, the room could be reimagined to accommodate administrative offices, staff workrooms, or shared academic facilities that better support institutional operations. Transforming such underutilized or inflexible classrooms into offices would not only optimize spatial distribution but also enhance functional performance across the complex. The existing condition thus underscores the necessity of redesigning spaces to align with evolving academic needs, particularly the pressing requirement for additional, well-organized office environments.

3.6.2 Functions and Programs Offered in the FEAS

The Faculty of Economics and Administrative Sciences plays a central role in the academic and administrative operations of the university. It serves as a space for learning, research, and professional development, accommodating a range of academic departments, staff offices, and student activity areas. The existing building currently provides the basic facilities necessary for the daily functioning of the faculty. These include lecture halls and classrooms used for both undergraduate and postgraduate courses, offices for academic staff and administrative departments, as well as a modest computer laboratory and a small library section that offers limited access to learning resources. Additionally, the building contains meeting rooms, examination halls, restrooms, and storage spaces, which support essential academic and logistical operations.

While these existing facilities meet the most fundamental requirements of teaching and administration, they fall short of addressing the evolving needs of contemporary higher education. The current spatial configuration is largely traditional, characterized by compartmentalized classrooms, static furniture layouts, and insufficient technological integration. There are no designated areas for collaborative learning, interdisciplinary research, or student innovation. Similarly, the limited number of multipurpose spaces restricts the flexibility of the building to host academic events, workshops, or community engagement activities. The absence of digital learning infrastructure, modern study environments, and social interaction zones further limits opportunities for creativity, collaboration, and personal development among students and staff. As a result, the existing building is unable to fully support the faculty's academic ambitions or respond effectively to emerging educational trends such as blended learning, research-based teaching, and entrepreneurial education.

The departments of Economics, Administrative Sciences, Accounting, Finance, and Political Science collectively form an integrated academic structure that underpins the study of economic behavior, institutional management, financial systems, and governance processes within the faculty. Together, these disciplines provide a cohesive and multidimensional foundation that supports the investigation of how organizations, markets, and public institutions operate and interact within broader socio-economic contexts. By combining theoretical inquiry with practical analytical skills, this academic framework enables students and researchers to engage critically with contemporary challenges related to economic development, administrative performance, fiscal accountability, and political decision-making. As a result, the faculty is well-positioned to produce graduates and research outputs that contribute meaningfully to policy formulation, institutional improvement, and the advancement of knowledge across public, private, and academic sectors.

3.6.3 Regulations and Planning Framework

The proposed development of the Faculty of Economics and Administrative Sciences strictly adheres to the regulatory, technical, and planning frameworks established by the Government of Sudan through the Ministry of Higher Education and Scientific Research and the Sudanese Engineering Council. These frameworks provide comprehensive guidelines that govern the design, construction, and operation of institutional buildings, ensuring that such facilities meet the national standards for safety, quality, and sustainability (Bansal & Pandey, 2024). By aligning the project with these regulations, the design aims to ensure both compliance and excellence, reflecting the broader national agenda for modernizing higher education infrastructure in Sudan while remaining environmentally and culturally grounded (Davies, 1994).

A primary consideration in the project's development is structural integrity and safety (Spong & Gallagher, 2013). The design follows the principles outlined in the Sudanese Building Code, which sets forth technical specifications for the design and construction of reinforced concrete buildings (World Green Building Council, 2018). Given the climatic and geotechnical conditions of Khartoum Bahri, structural calculations have been based on parameters that ensure the building's resilience to wind pressure, soil settlement, and moderate seismic activity. The use of durable local materials, combined with adherence to modern structural engineering standards, ensures long-term stability and minimizes maintenance requirements. The structural design framework emphasizes safety not only during the building's operational life but also throughout its construction phases, in line with national occupational safety guidelines (Housing Finance Africa, 2025).

In terms of environmental performance and sustainability, the project is guided by the Sudan Green Building Council (SGBC) standards, which encourage environmentally responsible and resource-efficient construction practices (Davies, 1994). The design incorporates passive cooling strategies to mitigate Khartoum's hot, dry climate—such as maximizing cross-ventilation, using shaded courtyards, and optimizing building orientation to reduce direct solar exposure (United Nations Framework Convention on Climate Change, 2021). The integration of natural lighting in classrooms and offices reduces dependence on artificial illumination, thereby conserving energy. Rainwater harvesting systems and low-flow plumbing fixtures are proposed to promote water efficiency, while waste reduction measures and the use of locally sourced, low-impact materials contribute to the sustainability agenda. These efforts collectively aim to lower the building's environmental footprint and operational costs while promoting a healthy and comfortable learning environment.

Accessibility and inclusivity form another essential component of the planning framework. The design complies with both the Sudan Disability Act of 2009 and the United Nations Convention on the Rights of Persons with Disabilities (UN CRPD), ensuring that the facility provides equitable access for all users (United Nations, 2009). This commitment is reflected in the provision of ramps, wide corridors, accessible toilets, and designated seating and circulation spaces for persons with mobility challenges (Bridging the Gap, 2021). Way finding signage, handrails, and visual markers are incorporated to support users with sensory impairments. By embedding accessibility considerations into the core of the architectural design rather than treating them as add-ons, the project promotes a sense of inclusion and social equity within the academic community (Republic of Sudan, 2009).

From an urban planning perspective, the project observes all municipal zoning and land use regulations applicable to educational institutions in Khartoum Bahri (Ali, 2011). The site layout aligns with local planning policies regarding land coverage, building setbacks, and permissible height limits. Adequate vehicular access and parking provisions are ensured to facilitate smooth traffic flow within and around the campus, while pedestrian pathways are designed to promote safety, comfort, and connectivity across functional zones. Landscaping is used not only to provide aesthetic and environmental benefits but also to create shaded gathering spaces and natural buffers that enhance the campus experience. The planning strategy emphasizes harmony between the new faculty building and its surrounding institutional and residential context, promoting an integrated urban environment conducive to learning and community interaction (Ojo & Ojo, 2024).

Equally important are the fire safety and emergency response measures embedded within the project's technical design (National Fire Protection Association, 2025). In line with international standards such as those set by the National Fire Protection Association (NFPA), the building includes well-defined evacuation routes, multiple emergency exits, and clearly marked assembly points (National Fire Protection Association, 2025). Fire detection and suppression systems—such as smoke detectors, fire extinguishers, and alarm systems—are strategically distributed throughout the facility. The selection of fire-resistant materials, the provision of fire-rated doors, and the installation of adequate ventilation in escape corridors further reinforce user safety. Regular maintenance and preparedness training will be integral to ensuring that the facility remains compliant and fully operational in the event of emergencies.

Lastly, the project is deeply rooted in cultural and heritage considerations, recognizing the importance of reflecting Sudan's architectural identity and climatic adaptability in contemporary educational infrastructure. The design language draws inspiration from Sudanese vernacular architecture, characterized by the use of locally available materials, earthy tones, and shaded arcades that respond effectively to the regional climate. Courtyards and semi-open spaces reinterpret traditional social and academic gathering areas, fostering interaction and collaboration among students and staff. Through these culturally sensitive design decisions, the building becomes not only a place for academic activity but also a representation of Sudanese values, aesthetics, and environmental wisdom.

The regulatory and planning framework guiding the design of the Faculty of Economics and Administrative Sciences integrates technical precision, environmental stewardship, social inclusivity, and cultural expression. By aligning with national and international standards, the project aspires to set a benchmark for sustainable, functional, and contextually meaningful educational architecture in Sudan. It serves as a model for how modern academic institutions can evolve within the country's regulatory landscape while preserving a strong sense of identity and purpose.

3.6.4 Framework and Methods for Identifying Problems

Identifying the architectural, functional, and environmental problems of the existing Faculty of Economics and Administrative Sciences building is a critical foundation for developing an effective redesign proposal. This section outlines the conceptual framework and methodological approaches used to diagnose existing conditions, determine user needs, and identify design deficiencies. The framework integrates both qualitative and analytical techniques to ensure a comprehensive understanding of the project context.

In summary, the methodology of this research combines qualitative inquiry and design-based experimentation to develop a comprehensive and contextually grounded architectural proposal (Zboinska, 2021). By integrating theoretical understanding, environmental analysis, and creative design processes, the study delivers a solution that is evidence-based, environmentally responsive, and culturally appropriate (Ba´c & Shi, 2024). The resulting proposal not only addresses the current deficiencies of the Faculty of Economics and Administrative Sciences but also establishes a framework for future sustainable and smart campus development in Sudan.

The second part of the diagram shows how identified user needs become the foundation for two parallel analytical streams: environmental analysis and the identification of design deficiencies. Environmental analysis examines factors such as climate responsiveness, daylighting, ventilation, and energy performance, while design deficiency analysis highlights issues related to circulation, spatial organization, accessibility, and functionality. The integration of findings from both streams ultimately converges into the development of an evidence-based, culturally responsive, and sustainable redesign proposal. This comprehensive process ensures that the final design addresses existing problems holistically while supporting future campus development goals.