

## **CHAPTER: INTRODUCTION**

### **1.1 Background**

Universities are vital in advancing education, research, and community development (Bonilla-Jurado et al., 2024; Chankseliani & McCowan, 2021). They are not merely centers of teaching and learning but also integrated environments that shape innovation, foster creativity, and nurture cultural identity (Robertson et al., 2025). The physical infrastructure of higher education institutions significantly influences their ability to achieve these goals (Anuar et al., 2024; Nurpaidah et al., 2025). In particular, architectural design affects how efficiently academic, administrative, and social activities are conducted and how institutions respond to sustainability challenges in the 21st century (Ibiyeye et al., 2024).

Sharq El-Nile University, located in Khartoum Bahri, Sudan, was established in 1990 and has grown into one of the country's respected institutions, offering programs in economics, administrative sciences, and other fields. The Faculty of Economics and Administrative Sciences faces significant challenges to its critical infrastructure, despite its long-standing presence. The existing building no longer meets the functional requirements of modern education, with inadequate classroom space, outdated facilities, and insufficient support services. These limitations negatively affect the quality of the learning environment and hinder the university's capacity to respond to increasing student numbers and evolving academic needs (Ahmed Salih Hmdan et al., 2025).

Globally, universities are rethinking their architectural frameworks by embracing smart and sustainable campus designs (Butt et al., 2025). These approaches integrate advanced digital technologies with eco-friendly materials and practices, creating flexible, efficient, and environmentally responsible spaces (Elshapasy & Mohamed, 2024). Smart technologies—such as automated lighting, digital learning platforms, and intelligent building management systems—enhance academic efficiency and operational effectiveness (Alhassan et al., 2024). Similarly, sustainable architecture emphasizes passive design strategies, renewable

energy, green roofs, water conservation, and biodiversity, contributing to environmental resilience while reducing long-term operational costs (Alhamd & Yasser, 2025).

In recent years, the concept of the smart and sustainable campus has gained prominence as a response to climate change, rapid digital transformation, and shifting pedagogical practices (Polin et al., 2025a). Universities in developed and developing countries alike have adopted innovative architectural strategies that emphasize modular learning spaces, energy efficiency, and the integration of digital learning technologies (Carrasco-Beltrán et al., 2024; Samudro et al., 2025). These trends have been particularly significant in the aftermath of global challenges such as the COVID-19 pandemic, which highlighted the need for resilient, adaptable, and technology-enabled academic environments (Turgel & Chernova, 2024).

In the context of Sudan, higher education institutions play a crucial role in national development, serving as centers for knowledge creation, innovation, and human resource development (ALAMIN et al., 2024a). However, many of these institutions continue to struggle with substantial infrastructural and organizational shortcomings (Kantabutra & Ketprapakorn, 2021). Chronic underfunding from both government and private sectors, coupled with the ongoing war and its associated socio-economic challenges, has resulted in aging and poorly maintained buildings, inadequate learning environments, and limited access to modern educational technology (BTI, 2024). The rapid increase in student enrollment across Sudanese universities has further exacerbated these issues, as existing facilities are often unable to accommodate the growing academic population (Ahmed & Mohamed, 2020). Consequently, overcrowded classrooms, deteriorating utilities, and a shortage of functional learning spaces have become recurring problems that hinder effective teaching, learning, and research (Ahmed & Mohamed, 2020).

The Faculty of Economics and Administrative Sciences at *Sharq El-Nile University* provides a representative example of these broader challenges. Established to produce competent graduates in the fields of economics, management, and administration, the faculty currently faces serious infrastructural constraints that limit its capacity to fulfill its mission. The existing building suffers

from an insufficient number of classrooms, inadequate ventilation and lighting, outdated electrical and plumbing systems, and a general lack of accessibility and comfort. Moreover, the absence of essential shared facilities—such as a central library, multipurpose hall, research rooms, and student interaction spaces—further diminishes the quality of academic and social life on campus. These limitations not only affect the efficiency of academic operations but also reduce the institution's attractiveness and competitiveness in Sudan's higher education landscape.

Given these pressing conditions, there is an urgent need to re-examine and redesign the physical environment of the faculty to align with modern standards of educational architecture. A well-planned and sustainable redesign can address space shortages, improve functionality and aesthetics, and promote a more conducive learning atmosphere (Papaioannou et al., 2023). Furthermore, the improvement of campus infrastructure is directly linked to achieving broader educational goals, such as enhancing academic performance, supporting innovative teaching methods, and fostering collaboration between students and faculty members (Schnarre et al., 2022). Therefore, this study seeks to investigate and propose architectural solutions that respond to these challenges, ensuring that the Faculty of Economics and Administrative Sciences at Sharq El-Nile University evolves into a modern, efficient, and inspiring academic environment that supports both current and future educational needs.

A sustainable architectural redesign offers a promising solution to address these multifaceted challenges (Alhamd & Yasser, 2025; Savitri, 2021; Taneja & Kumar, 2024; Villegas-Ch et al., 2019a). Modern educational architecture emphasizes flexibility, energy efficiency, accessibility, and environmental responsiveness (Bac et al., 2025a). By integrating sustainable design principles, the faculty can optimize space utilization, reduce operational costs, and create healthier environments for users (Fournier, 2004). Moreover, the incorporation of natural lighting, ventilation, and green spaces aligns with both ecological responsibility and user well-being (Zhong et al., 2023). This approach aligns with global best practices in university design and supports Sudan's commitment to sustainable development.

Redesigning the faculty also provides an opportunity to align the physical environment with pedagogical transformation (van Merriënboer et al., 2017). Education today increasingly demands spaces that accommodate active learning, interdisciplinary collaboration, and digital innovation (Zamiri & Esmaeili, 2024a). An upgraded facility can thus support modern teaching methodologies such as blended learning, group-based projects, and research-driven instruction (Tang et al., 2025). This alignment between architecture and pedagogy ensures that the physical design becomes an enabler of academic excellence rather than a constraint.

This thesis, therefore, focuses on assessing the current conditions of the Faculty of Economics and Administrative Sciences at Sharq El-Nile University and developing a comprehensive architectural redesign proposal. The study examines spatial organization, environmental performance, and functional requirements to create a more effective and sustainable educational facility. The proposed redesign aims to address existing inadequacies while introducing innovative features that reflect contemporary educational and environmental standards. Through this process, the research contributes both practically and theoretically to the discourse on sustainable campus development in Sudan.

This study seeks to demonstrate how thoughtful architectural design can enhance the quality of higher education infrastructure in developing contexts such as Sudan. By reimagining the Faculty of Economics and Administrative Sciences as a model of functional efficiency, aesthetic quality, and sustainability, the project aspires to influence future campus planning initiatives nationwide. The redesigned facility will not only improve the learning and teaching environment but also symbolize the university's commitment to progress, innovation, and community service (Audretsch et al., 2005; de Moraes et al., 2024; Evans et al., 2023; Hailu, 2024; Mouwen, 2000). In doing so, it reinforces the idea that architecture and education are deeply interconnected forces shaping the future of society (Taneja & Kumar, 2024).

## **1.2 Rationale of the Study**

The rationale for selecting the topic **“Redesigning the Building of Sharq El-Nile University's Economics and Administrative Sciences Faculty in Sudan: A Smart and Sustainable Campus Design”** stems from the growing recognition that the quality of the physical learning environment directly influences academic performance, institutional reputation, and student engagement (Kassab et al., 2024). In many developing countries, including Sudan, higher education institutions face persistent infrastructural limitations that hinder their ability to meet the evolving demands of modern education (Zickafoose et al., 2024). As global trends move toward smart, sustainable, and student-centered campuses, Sudanese universities remain constrained by aging buildings, inadequate facilities, and a lack of strategic investment in architectural modernization. This research, therefore, arises from a pressing need to reimagine and redesign academic spaces to foster innovation, inclusivity, and sustainability within the Sudanese higher education system.

At Sharq El-Nile University, one of Sudan’s established centers for learning, the Faculty of Economics and Administrative Sciences exemplifies these challenges. The existing infrastructure, characterized by outdated design and insufficient functional spaces, no longer accommodates the increasing student population or the growing complexity of academic and administrative activities. Classrooms are overcrowded, technological integration is minimal, and essential facilities such as libraries, study zones, seminar halls, and communal areas are lacking. This spatial inadequacy not only limits teaching effectiveness but also constrains research collaboration and the overall student experience (ALAMIN et al., 2024b; Zickafoose et al., 2024). Hence, a comprehensive architectural redesign is vital to transform the faculty into a modern, efficient, and adaptive academic environment capable of meeting present and future educational needs.

In addition to addressing physical limitations, the redesign offers an opportunity to embed sustainability and smart design principles into the core of university development (De Wilde et al., 2025). Integrating renewable energy solutions, natural ventilation, water management systems, and digital technologies can significantly reduce the environmental footprint of the building while improving operational efficiency (Manzoor et al., 2025). These interventions are

particularly critical in Sudan, where climate change, energy scarcity, and economic constraints pose serious challenges to infrastructure sustainability. By incorporating eco-friendly materials and passive design strategies suited to Sudan's climatic conditions, the proposed redesign would exemplify responsible architectural practice that aligns with both environmental and socio-economic realities.

Furthermore, this study acknowledges that architectural design is not merely a technical process but a cultural expression (Koirala, 2016). The redesign of Sharq El-Nile University's Faculty of Economics and Administrative Sciences must therefore reflect the cultural and social identity of Sudan, preserve its architectural heritage, and embrace modern design innovations. In this sense, the research advocates for a context-sensitive design approach—one that harmonizes global sustainability trends with local architectural traditions, ensuring that modernization does not erase cultural continuity but rather enhances it (Salingaros et al., 2023).

Globally, universities are investing heavily in sustainable and intelligent campus models that promote flexibility, collaboration, and technological innovation (J. Liu et al., 2025). Institutions such as Columbia Business School in New York (Diller Scofidio and Renfro, 2023) serve as leading examples of how design excellence can enhance institutional identity and academic functionality. By studying these international precedents and adapting their principles to the Sudanese context, this research bridges the gap between global architectural innovation and local contextual adaptation—demonstrating how universities in resource-limited settings can still achieve high-performing, sustainable infrastructure.

The rationale for this study is grounded in the belief that architecture plays a transformative role in education. A well-designed campus supports creativity, social interaction, and emotional well-being, factors that are essential for holistic learning and personal development (Peters & D'Penna, 2020). The proposed redesign aims to create a dynamic environment that encourages active learning, interdisciplinary collaboration, and digital integration, thereby strengthening the pedagogical mission of Sharq El-Nile University.

From a developmental perspective, this study aligns with the United Nations Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education), Goal 11 (Sustainable Cities and Communities), and Goal 13 (Climate Action) (UNESCO, 2021). Through sustainable architectural practices and intelligent spatial planning, the project contributes to global commitments to equitable education, environmental resilience, and responsible urban development (Emekci & Emekci, 2022). The redesign of the faculty building thus extends beyond an institutional initiative; it becomes part of a broader national and international agenda for sustainability and educational reform.

Additionally, the study holds professional and academic significance for the field of architecture. It challenges designers, planners, and policymakers to rethink how architectural interventions can respond to emerging socio-environmental needs in developing nations. By proposing a framework for sustainable campus design within the constraints of Sudan's economic and environmental realities, the research contributes to both theoretical discourse and practical innovation in architectural education and practice.

Upon this, the rationale for this study lies in its integrated vision: to modernize an outdated academic structure, to embody sustainability and cultural relevance, and to position architecture as a catalyst for educational transformation. The redesign of the Faculty of Economics and Administrative Sciences at Sharq El-Nile University is not merely an exercise in spatial improvement—it represents a strategic model for revitalizing higher education infrastructure in Sudan and other similar contexts. By bridging global best practices with local authenticity, the study seeks to demonstrate how thoughtful architectural design can advance learning, foster sustainability, and strengthen institutional identity in a rapidly changing world (Nursanty et al., 2024).

### **1.3 Project Problem Identification**

Despite its advantageous location and long-standing reputation, the College of Economics and Administrative Sciences at Sharq El Nile University faces significant physical and functional challenges. The most critical issue is the

inadequacy of existing academic spaces. The current buildings, originally established in the early 1990s, were not designed to accommodate the increasing number of students enrolled over the years. Classrooms are often overcrowded, with insufficient seating, ventilation, and lighting. The spatial organization does not support flexible learning methods, group discussions, or the use of modern teaching technologies. As a result, the quality of the learning environment has a direct impact on student concentration, participation, and academic performance (Kinshuk et al., 2016; Samudro et al., 2025).

Another major problem is the lack of a comfortable and stimulating study environment. The existing facilities are characterized by outdated infrastructure, poor thermal comfort, and limited natural ventilation. Many rooms rely on artificial lighting and mechanical cooling, which are both expensive and unreliable due to frequent power interruptions. Outdoor areas are largely unshaded, offering few spaces for relaxation or informal study. This absence of comfort and supportive amenities discourages students from spending time on campus beyond formal class hours, weakening the sense of academic community and campus life that is essential for holistic education (Barnard & Henn, 2023).

Also, the university lacks essential public service buildings that form the backbone of a modern academic environment (Foroughi et al., 2023). There is no central library equipped with digital resources or collaborative study areas. Students have limited access to research materials, computer laboratories, or quiet study zones. The campus also lacks student service facilities, such as cafeterias, health centers, counseling spaces, and recreation areas. These omissions contribute to a fragmented academic experience where students and staff struggle to balance academic and social needs. The absence of such facilities also prevents the university from engaging with the broader community through exhibitions, seminars, and public programs.

Compounding these issues is the lack of long-term planning and rehabilitation. Although Sharq El Nile University is one of the oldest and most respected institutions in Sudan, its infrastructure has not been updated to meet contemporary educational standards or sustainability principles. The buildings show signs of physical deterioration, with aging materials, inefficient layouts, and

minimal accessibility features for persons with disabilities. Maintenance has been reactive rather than strategic, resulting in patchwork repairs instead of comprehensive upgrades. This neglect not only diminishes the university's image but also limits its capacity to compete with newer, better-equipped institutions.

There is an evident mismatch between the university's academic identity and its built environment. As a college of economics, administrative sciences, and architecture, it should embody innovation, order, and creativity through its spatial and architectural character. Instead, the current facilities communicate a sense of constraint and obsolescence. The absence of well-planned circulation, communal gathering spaces, and symbolic architectural elements prevents the campus from reflecting the values of academic excellence and institutional pride. Therefore, a new design proposal is urgently needed — one that redefines the Sharq El Nile complex as a modern, sustainable, and inclusive educational environment, equipped to serve current and future generations of students.

At the same time, global developments in higher education highlight the growing importance of smart and sustainable campus design (de Moraes et al., 2024). Universities worldwide are adopting energy-efficient systems, integrating smart technologies, and using environmentally friendly materials to reduce operational costs, improve educational efficiency, and promote sustainability (Shishakly et al., 2024). In Sudan, however, many higher education institutions—including Sharq El-Nile University—have yet to adopt these practices. As a result, their facilities remain outdated, environmentally inefficient, and misaligned with international standards.

The absence of a coherent architectural strategy at the Faculty of Economics and Administrative Sciences has led to three critical problems:

1. Educational inefficiency: Overcrowded classrooms, rigid spatial layouts, and outdated infrastructure hinder effective teaching and learning.
2. Environmental unsustainability: Buildings are not designed to optimize energy use, natural lighting, or ventilation, resulting in higher operating costs and negative environmental impacts. Unless these challenges are addressed, Sharq El-Nile University risks falling further behind regional and global benchmarks in higher education infrastructure.

3. There is an urgent need for a comprehensive redesign framework that integrates sustainability and smart technology to create a modern, functional, and future-ready faculty building.

The research aims to synthesize these findings into a holistic and adaptable redesign framework that can guide the future transformation of Sharq El-Nile University and similar academic institutions in Sudan. This framework will serve as a strategic tool for architects, planners, and decision-makers, offering clear principles for balancing sustainability, technology, and identity in campus development.

#### **1.4 Research Questions**

This study aspires to answer the following research questions, which are aligned and academically derived directly from the Research Problem Identification. They are grouped into *Primary* and *Secondary* categories to match this architectural research design.

##### **1.4.1 Primary Research Question**

How can a sustainable, smart, and culturally informed architectural redesign framework be developed to improve the spatial, functional, and environmental performance of the Faculty of Economics and Administrative Sciences at Sharq El-Nile University?

##### **1.4.2 Secondary Research Questions**

1. What are the current spatial, functional, and environmental limitations of the existing faculty buildings, and how do these shortcomings affect teaching, learning, and daily campus activities?
2. Which international best practices in sustainable and smart campus design can be adapted to the climatic, cultural, and infrastructural conditions of Sudan?
3. What passive design strategies, renewable energy systems, and environmentally friendly materials are most appropriate for enhancing environmental efficiency in the redesign of the faculty?

4. How can smart technologies—such as digital learning infrastructure, automated building systems, and environmental monitoring—be integrated into the redesign to support academic excellence and operational efficiency?
5. In what ways can Sudanese cultural identity and local architectural traditions be incorporated into the redesign while maintaining contemporary functionality?
6. What spatial planning and zoning principles should guide the development of a comprehensive campus master plan that balances academic, administrative, recreational, and service spaces?
7. How can the proposed redesign framework be evaluated to ensure its sustainability, cost-effectiveness, adaptability, and alignment with the Sustainable Development Goals (SDGs)?

### **1.5 Research Objectives**

The primary objective of this research is to formulate a comprehensive architectural redesign framework for the Faculty of Economics and Administrative Sciences at Sharq El-Nile University. This framework aims to reimagine the existing campus infrastructure through an integrated approach that combines sustainability and smart technology. The intention is not merely to upgrade physical spaces, but to create a modern academic environment that supports dynamic learning, innovation, and social interaction, while maintaining a strong sense of place and institutional identity (A. Davis & Wagner, 2025; De Caro-Barek et al., 2023; Vezhbovska et al., 2024).

A key focus of the study is to assess the current spatial and functional performance of the faculty's facilities. This involves evaluating the existing building layout, circulation systems, lighting, ventilation, and accessibility to determine their effectiveness in supporting educational activities. Understanding these baseline conditions will help identify major deficiencies and design gaps, particularly in relation to comfort, environmental efficiency, and adaptability (Emekci & Emekci, 2022). The assessment will also examine how the existing architecture aligns with Sharq El-Nile University's mission and the broader vision for higher education development in Sudan.

Another central objective is to explore sustainable architectural strategies and smart technologies that can be effectively incorporated into the redesign. The research will examine how energy-efficient systems, renewable materials, passive design principles, and digital innovations—such as smart classrooms and environmental monitoring systems—can be harmonized within the campus context (Calotă et al., 2024). The goal is to propose a design that minimizes environmental impact, reduces operational costs, and enhances the overall user experience through intelligent spatial management and responsive design solutions.

Equally important is the goal of preserving and reflecting Sudanese cultural identity in the architectural expression of the faculty. The research recognizes that successful academic environments in the region should resonate with local traditions, climatic conditions, and social values (Yencken et al., 2003). Therefore, the redesign will seek to draw inspiration from vernacular architectural elements, such as shading devices, courtyards, and locally sourced materials, to achieve a design language that is both contemporary and contextually grounded (He et al., 2024). By doing so, the new framework will ensure that modernization does not come at the expense of cultural continuity.

### **1.5.1 Specific Objectives**

1. To analyze the current conditions, limitations, and spatial inefficiencies of the existing faculty building in relation to academic and administrative needs.
2. To examine global best practices and case studies of smart and sustainable campus design that can be adapted to the Sudanese context.
3. To identify sustainable architectural strategies—including passive design, renewable energy systems, and eco-friendly materials—that enhance environmental efficiency.
4. To propose the integration of smart technologies such as automated systems, digital learning infrastructure, and intelligent building management to support academic excellence.
5. To preserve and reflect Sudanese cultural and institutional identity within the architectural design while modernizing functionality.

6. To develop a design framework and master plan that balances academic, administrative, recreational, and service spaces for optimal campus functionality.
7. To evaluate the proposed design in terms of sustainability, cost-efficiency, adaptability, and its alignment with the Sustainable Development Goals (SDGs).
8. To apply the proposed design at Sharq El-Nile University in Sudan.

### **1.6 Significance of the Research**

This study holds significance at multiple levels—academic, institutional, societal, and global—by addressing the urgent need to redesign the Faculty of Economics and Administrative Sciences at Sharq El-Nile University in Sudan.

**Academic Significance:** The research contributes to the field of architecture and campus planning by developing a redesign framework that integrates sustainability, smart technology, and cultural identity. By examining international best practices and contextualizing them within Sudan, the study enriches scholarly discourse on sustainable campus development in regions with limited resources. The findings will serve as a reference for future research on architectural modernization in higher education institutions, especially within developing countries facing similar infrastructural challenges.

**Institutional Significance:** For Sharq El-Nile University, the study provides practical solutions to existing infrastructural deficiencies. The redesign framework directly addresses overcrowded classrooms, inadequate facilities, and outdated utilities, thereby improving the overall quality of the learning environment. By adopting the recommendations of this research, the university can enhance its reputation, attract more students, and strengthen its competitiveness within Sudan's higher education sector.

**Societal Significance:** At the societal level, improving university infrastructure contributes to the broader goal of human capital development. A well-designed campus fosters creativity, innovation, and collaboration among students, preparing them to contribute effectively to Sudan's socio-economic development.

Additionally, the integration of cultural and social identity within the architectural redesign ensures that the project resonates with local traditions and strengthens the community's sense of ownership and pride.

**Environmental Significance:** The study promotes environmentally responsible architecture by incorporating sustainable design strategies such as passive cooling, natural ventilation, renewable energy systems, and green materials. These approaches not only reduce the environmental footprint of the faculty building but also set a precedent for eco-friendly development in Sudan. In the long term, such initiatives can reduce operational costs and promote resilience to climate-related challenges, which are particularly pressing in Sudan's hot and dry climate.

**Global Relevance:** This research aligns with international movements toward sustainable development. It directly contributes to the United Nations Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education), Goal 11 (Sustainable Cities and Communities), and Goal 13 (Climate Action). By bridging global best practices with local realities, the study demonstrates how developing countries can pursue sustainability and modernization while preserving cultural identity.

This study is significant because it goes beyond proposing a new building design; it offers a replicable model for integrating sustainability, technology, and smart technological values into higher education infrastructure. Its outcomes will benefit students, faculty, and administrators at Sharq El-Nile University while also informing policymakers, architects, and planners engaged in similar projects across Sudan and the wider region.

## **1.7 Expected Output (Design Deliverables)**

The research is expected to produce a comprehensive set of design deliverables that demonstrate the transformation of Sharq El-Nile University's Faculty of Economics and Administrative Sciences into a smart and sustainable academic facility. The key outputs include:

### **1. Site Analysis Report**

- Detailed analysis of the site in Bahri, Khartoum, covering climatic conditions, sun path, wind direction, and environmental context.

- Assessment of geographical, cultural, and social factors influencing the design.
- Recommendations for optimal building orientation and environmental integration.

## 2. Conceptual Design Proposal

- A master plan outlining spatial zoning for academic, administrative, recreational, and service facilities.
- Design concept integrating sustainability (green roofs, passive design, renewable energy) and smart campus principles (IoT, digital classrooms, flexible learning spaces).
- Visual exploration of sustainable strategies such as natural ventilation, shading systems, vertical gardens, and solar panel integration.

## 3. Architectural Drawings

- **Site Plan:** Showing building orientation, circulation, and relationship with the wider campus.
- **Floor Plans (G.F., 1st, 2nd, 3rd):** Including classrooms, administrative offices, libraries, laboratories, student lounges, seminar halls, and recreational areas.
- **Movement and Functional Relationship Diagrams:** Mapping interactions between academic spaces, faculty, and student facilities.
- **Sections and Elevations:** Illustrating building form, façade treatment, and integration of smart/sustainable elements.

## 4. Smart and Sustainable Design Features

- Deliverables showcasing passive cooling/heating strategies, energy-efficient systems, and water management solutions.
- Proposals for modular interiors, adaptive learning spaces, and green landscaping.
- Integration of smart technologies (digital classrooms, IoT-enabled facilities, AI-driven resource management).

## 5. 3D Visualization and Renderings

- Computer-generated images (CGI) and 3D perspectives that communicate the spatial quality, aesthetics, and sustainability features.
- Visualizations of interior layouts, green outdoor areas, and interactive learning spaces.

## 6. Design Evaluation Framework

- Alignment with design criteria (functional, aesthetic, sustainability, safety, cultural identity).

- Assessment of environmental impact, user comfort, and energy efficiency.
- Compliance with Sudanese regulations and international standards for smart, sustainable campus design.

### **1.8 Research Methodology**

The research adopts a qualitative and design-based methodology that integrates architectural theory, contextual analysis, and practical design application (Fross et al., 2015). This approach is chosen to address both the academic and physical dimensions of redesigning the Faculty of Economics and Administrative Sciences at Sharq El-Nile University. By combining research and design processes, the study ensures that the final architectural proposal is not only visually and functionally effective but also grounded in evidence-based strategies aligned with sustainability and smart campus principles (Lima et al., 2025).

The methodology begins with a planning and analysis stage, where key challenges in the existing facility are identified through a needs assessment, site observation, and document review. This phase focuses on understanding the university's goals, estimating future spatial requirements, and evaluating the shortcomings of the current infrastructure. Additionally, the environmental and urban context of the Bahri/Shambat site is analyzed to determine how climatic conditions, accessibility, and surrounding land uses influence the design process (X. Chen & Chen, 2016).

Following analysis, the design phase translates data and theoretical insights into architectural concepts. Here, the focus is on developing flexible, modular spaces that accommodate future growth and promote a conducive academic environment (Kariippanon et al., 2019). The design incorporates passive and active environmental systems such as natural ventilation, solar energy use, and efficient water management, ensuring that sustainability is embedded in both structure and operation (Akbar et al., 2023; Mba et al., 2024a). Cultural identity is equally prioritized, reflecting Sudanese aesthetics and spatial traditions through materials, patterns, and form.

The implementation stage converts conceptual ideas into technical deliverables, including zoning diagrams, functional layouts, architectural plans, and 3D renderings. These outputs illustrate how the proposed redesign can function in practice. At this stage, the integration of smart campus technologies—such as Internet of Things (IoT) monitoring systems, smart classrooms, and digital learning platforms—is emphasized to create a responsive and future-oriented educational environment (Y. Zhang et al., 2022).

To ensure that the design meets its objectives, a monitoring and evaluation stage is undertaken. The proposed solutions are assessed against sustainability and smart campus criteria, focusing on energy efficiency, user comfort, and adaptability (Cheekatamarla et al., 2022; Firoozi et al., 2025). Comparative analysis with international case studies, such as Columbia Business School and the LSE Marshall Building, provides a benchmark for evaluating the effectiveness and innovation of the proposed design in a global context (*Case Study: LSE's Marshall Building - CIBSE Journal*, n.d.; *Twin Buildings with Shuffling Façades Define DS + R's New Columbia Business School*, n.d.).

The research also employs varied instruments and techniques, including literature review, site observation, case study comparison, and architectural visualization. These tools enable a comprehensive understanding of the problem and foster an iterative design process in which insights from analysis directly inform design decisions. This triangulated method enhances both the reliability and validity of the research outcomes (Moon, 2019).

The research methodology is guided by key design criteria—functionality, aesthetics, sustainability, safety, and cultural relevance. Together, these principles ensure that the proposed redesign is contextually appropriate, environmentally responsible, technologically advanced, and socially meaningful. Overall, the methodology provides a systematic pathway from problem identification to design realization, ensuring that the final architectural proposal contributes to the creation of a smart, sustainable, and culturally expressive university environment.

## 1.9 Thesis Structure

The thesis is systematically organized into six main chapters, each addressing a specific phase of the research and design process. The structure follows a logical progression — from understanding the background and theoretical foundations to developing a design methodology and finally presenting the proposed architectural solution for Sharq El-Nile University. This arrangement ensures coherence between the research, analysis, and design components of the study.

- I. CHAPTER ONE- INTRODUCTION: The first chapter establishes the foundation of the study. It introduces the background and context of Sharq El-Nile University, identifies the research problem, and states the objectives and significance of the work. This chapter also outlines the significance of the study and provides a brief overview of the research methodology. While the methodology is mentioned only in broad terms here, detailed procedures are discussed later in Chapter 3. Overall, Chapter 1 sets the stage for understanding the rationale and purpose of the research.
- II. CHAPTER TWO- LITERATURE REVIEW: This chapter forms the conceptual backbone of the thesis. It discusses key theories and frameworks relevant to university architecture, sustainability, smart buildings, and cultural identity within the Sudanese context. It also includes a study of precedent cases — exemplary university projects that integrate sustainability and cultural values successfully. The aim is to build a strong theoretical foundation that informs the subsequent design process, ensuring that the proposal is grounded in both academic theory and real-world best practices.
- III. CHAPTER THREE- RESEARCH METHODOLOGY: Chapter 3 elaborates on the research approach and methodological framework adopted for the study. It explains how qualitative and design-based methods were applied to analyze existing conditions, gather data, and generate design solutions. This includes techniques such as literature review, site observation, spatial analysis, and case study comparison. The chapter also describes how the research process transitions into the design phase,

connecting theoretical understanding with practical architectural exploration.

- IV. CHAPTER FOUR- SHARQ EL-NILE UNIVERSITY DESIGN APPROACH: This chapter translates the research findings into a specific design framework for Sharq El-Nile University. It provides an overview of the university's existing conditions, identifies its functional and spatial requirements, and establishes the design criteria based on sustainability, smart technology, and Sudanese cultural values. The chapter includes site analysis, spatial programming, and determination of key facilities and activities, serving as the analytical and strategic foundation for the actual design phase.
- V. CHAPTER FIVE- DESIGN CONCEPT: The fifth chapter represents the creative phase of the research— the development of the architectural concept. It outlines the guiding philosophy, conceptual ideas, and schematic designs that embody the project's goals. Through diagrams, concept sketches, and preliminary layouts, this section demonstrates how theoretical and methodological insights are translated into tangible design solutions. (Note: This chapter presents the full design phase).
- VI. CHAPTER SIX- DESIGN REPORT: The final chapter presents the completed architectural design proposal. It includes detailed drawings such as the site plan, floor plans, sections, elevations, and 3D perspectives. This chapter also evaluates how the proposed design fulfills the established criteria of sustainability, smart technology integration, and cultural identity. It effectively showcases the outcome of the research and design process — a comprehensive and contextually responsive redesign of the Faculty of Economics and Administrative Sciences at Sharq El-Nile University.
- VII. CONCLUSION AND RECOMMENDATIONS: This section summarises the thesis's progress from theoretical understanding (Chapters 1–2), to methodological development and contextual analysis (Chapters 3–4), and finally to design formulation and presentation (Chapters 5–6). This structure

ensures a coherent narrative that links research inquiry with architectural creation, reflecting both academic rigor and design innovation.