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Ergonomic challenges and culturally-adapted aesthetic strategies in Tunisian university libraries: Insights from Daciano da Costa and contemporary design frameworks in the digital era

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Abstract: This article delves into the complex interplay of ergonomics, interior design, and digital transformation in the context of Tunisian university libraries, highlighting the critical need for these institutions to evolve in response to changing user expectations and technological advancements. Through field observations (N=3 evaluators per site), user surveys (N=120), and focus groups (N=24 participants), it systematically examines the current challenges faced by these libraries in meeting the diverse physical and functional needs of their users, particularly in an era increasingly dominated by digital resources. Inspired by contemporary ergonomic theories and the design philosophy of Daciano da Costa, which emphasises modularity, functionality, and aesthetic balance, the study evaluates the potential application of these principles to enhance library interiors. By conducting comprehensive field observations, user surveys, and ergonomic analyses across three selected Tunisian university libraries, the research identifies significant shortcomings in design, usability, and overall user experience. The findings reveal a disconnection between the evolving demands of library users and the existing spatial configurations, ergonomic features, and technological integrations. In response, the article proposes a robust framework of strategies aimed at improving spatial layout, enhancing ergonomic comfort, and ensuring the effective integration of digital resources. These strategies are designed to maintain aesthetic and cultural relevance while promoting user engagement and satisfaction. By aligning ergonomic principles with the evolving role of libraries in the digital age, this study offers a set of actionable insights and recommendations that can facilitate the creation of more functional, adaptable, and visually engaging academic spaces. Ultimately, the research advocates a transformative approach to library design that prioritises user well-being and fosters an enriching academic environment while respecting cultural context.

Keywords: ergonomics, interior design, Tunisian university libraries, Daciano da Costa, digital era

INTRODUCTION

Throughout history, university libraries have served as the backbone of academic communities, fostering scholarly creativity, intellectual exchange, and teamwork. However, the digital age has fundamentally changed their mission, requiring them to go beyond their conventional role as keepers of tangible collections. These days, they need to develop into vibrant, multipurpose areas that smoothly combine peaceful study areas, gathering places, and technologically advanced research settings (Adigun et al., 2024). This paradigm change necessitates a rethinking of interior design concepts, wherein technology adaptability, aesthetic coherence, and ergonomic functionality come together to create spaces that put user productivity, inclusion, and well-being first (Vischer, 2008; Zallio and Clarkson, 2022; Mohsen and Matarneh, 2023; Doussard et al., 2024).

Meeting these changing expectations is a major problem for university libraries in Tunisia, where higher education is a key factor in the country's development. Many are still limited by inflexible, antiquated designs, poor ergonomics, and disjointed digital infrastructure, which leads to areas that are unable to meet the various needs of researchers and students. Long-term use is frequently discouraged by physical discomfort caused by poorly designed furniture, insufficient lighting, and inefficient spatial organisation, while creativity is stifled by the absence of flexible areas for digital or collaborative work (Alozie et al., 2020; Papaioannou et al., 2023; Wahlström et al., 2024). Libraries are ill-prepared to combine their twin roles as cultural heritage preservers and facilitators of contemporary academic practices due to these problems and a lack of institutional investment (Sansa et al., 2019).

There are illuminating parallels in the evolution of library design around the world. Libraries have changed throughout the years from being static repositories to dynamic, user-centred environments influenced by developments in pedagogy, technology, and ergonomics. A key component of this change has been the study of ergonomics, which aims to balance human demands with environmental design. Research indicates that ergonomic measures like task-specific lighting, movable seats, and intuitive spatial zoning directly increase user comfort, lessen fatigue, and boost cognitive functions (Vischer, 2008). On the other hand, disregarding these guidelines runs the danger of alienating users, sustaining inefficiencies, and escalating ine-

quality, especially for those with impairments (Steinfeld and Maisel, 2012; Doussard et al., 2024).

The work of Portuguese designer Daciano da Costa, who was a visionary in the 20th century, offers a convincing theoretical foundation in this regard. In order to create adaptable, reconfigurable systems and aesthetically pleasing functioning where practical utility and artistic harmony coexist, Da Costa's ideology placed a strong emphasis on modularity (Costa, 1998; da Silva, 2015). His principles align with contemporary universal design approaches that emphasise equitable use across diverse populations (Story et al., 1998). His method works well for today's library design problems, especially when there are few resources. For example, libraries can modify spaces for different purposes, such as private study, group collaboration, or digital labs, without having to make expensive renovations thanks to modular furniture systems. In a similar vein, his focus on long-lasting, minimalist design complements the requirement for low-maintenance, sustainable solutions in public institutions. By implementing da Costa's ideas, libraries can embrace technological advancement while maintaining cultural identity, bridging the gap between tradition and modernity. This equilibrium is made more difficult by the digital revolution. Hybrid infrastructures that combine virtual and physical resources are increasingly defining modern libraries, requiring designs that support both. Digital literacy stations, immersive learning environments, and collaborative tech hubs are now necessary (Neal, 2010), but integrating them frequently puts stress on the ergonomic and spatial frameworks that are already in place.

In the Tunisian context, this digital transition must be balanced with cultural preservation needs (Sahtout Gaha et al., 2024). Libraries in Tunisia meet particular challenges as a result of financial inequalities and infrastructure deficiencies that cause digital transformation to lag. Users are forced to rely on personal gadgets in subpar settings since many lack dependable internet connectivity, updated software, or even simple power outlets (Otike, 2023). The environment of library design in Tunisia is further influenced by local and cultural considerations. The demand for adaptable, technologically advanced rooms frequently conflicts with architectural traditions that prioritise large, static reading halls. The adoption of contemporary design solutions, including open-plan layouts or sound-dampening materials, may be impeded by the preservation of historical aesthetics, despite their cultural significance (Otike, 2023). At the same time, spaces that prioritise form over function and do not fit with student preferences have been created due to a lack of participatory design techniques that hardly ever involve end users in planning procedures.

This study suggests a comprehensive design paradigm that combines digital fluency, aesthetic intentionality, and ergonomic rigour to handle these complex issues. The framework, which is based on Daciano da Costa's ideas of modularity and human-centred design enhanced with contemporary universal design principles, aims to make university libraries in Tunisia inclusive, flexible spaces that balance academic demands of the twenty-first century with cultural heritage. The study uses a mixed-methods approach that includes user surveys (N=120), ergonomic evaluations (3 trained evaluators per site), interactive workshops, and spatial audits to try to answer the following questions: i) What are the main problems with Tunisian university libraries' aesthetics and ergonomics? ii) How can these areas be improved using Daciano da Costa's design philosophy and modern ergonomic theories? iii) How can libraries incorporate digital materials and tools more effectively while preserving their aesthetic and functional qualities, and cultural identity? By examining these issues, the study contributes to the body of knowledge on library design while providing educators and architects with practical solutions. It makes the case that, in an increasingly digital world, libraries must transform from passive repositories into active learning ecosystems places that not only hold knowledge but also stimulate creativity, encourage teamwork, and democratise access.

METHODOLOGY

In order to fully investigate the ergonomic issues and aesthetic tactics found in Tunisian university libraries, this study uses a mixed-methods approach, combining qualitative and quantitative data collection methodologies. The research was conducted over a 6-month period from January to June 2024. By integrating these techniques, the study seeks to offer a thorough comprehension of the design components and user experiences in various settings. The methodology consists of three main parts: choosing a case study, gathering data, and developing an analysis framework that is specific to the goals of the investigation.

In order to provide a varied representation of situations, three university libraries in Tunisia were chosen as case studies based on predetermined criteria. The selection process concentrated on the Institutes of Fine Arts and Design, with consultations conducted to ensure representative sampling of these institutions. One important consideration was geographic diversity, with libraries spread across Tunisia to capture a range of environmental and cultural effects. The libraries' sizes, which represented small, medium, and large formats, also varied, enabling an examination of the scale-dependent differences in design issues.

Additionally, user demographics were considered because every library caters to a different group of people, such as staff, instructors, and students. Among the chosen libraries are the Library of the Private University of Tunis Carthage (UTC, 2024) (Fig. 1), a sizeable metropolitan university library renowned for its vast collection of digital materials; the Library of the Tunis Institute of Fine Arts (ISBAT, 2022) (Fig. 2), a medium-sized rural library that prioritises traditional educational materials; and the Library of the Nabeul Institute of Fine Arts (ISBAN, 2013) (Fig. 3), a small library. Basic characteristics of each library are summarised in Tab. 1.

A variety of techniques were used to collect data, including user and observational feedback. The ergonomics and aesthetics of library interiors were documented through field observations. To assess important components, such as seating configurations, workstation layouts, illumination, and spatial organisation, three trained evaluators per library employed a standardised checklist (Tab. 2). In addition to evaluating the general aesthetic appeal and movement flow across the library, this method sought to pinpoint particular ergonomic deficiencies, such as the comfort and support of seating options and the accessibility of study desks. These observations gave us a thorough grasp of the functional and physical difficulties users encounter.

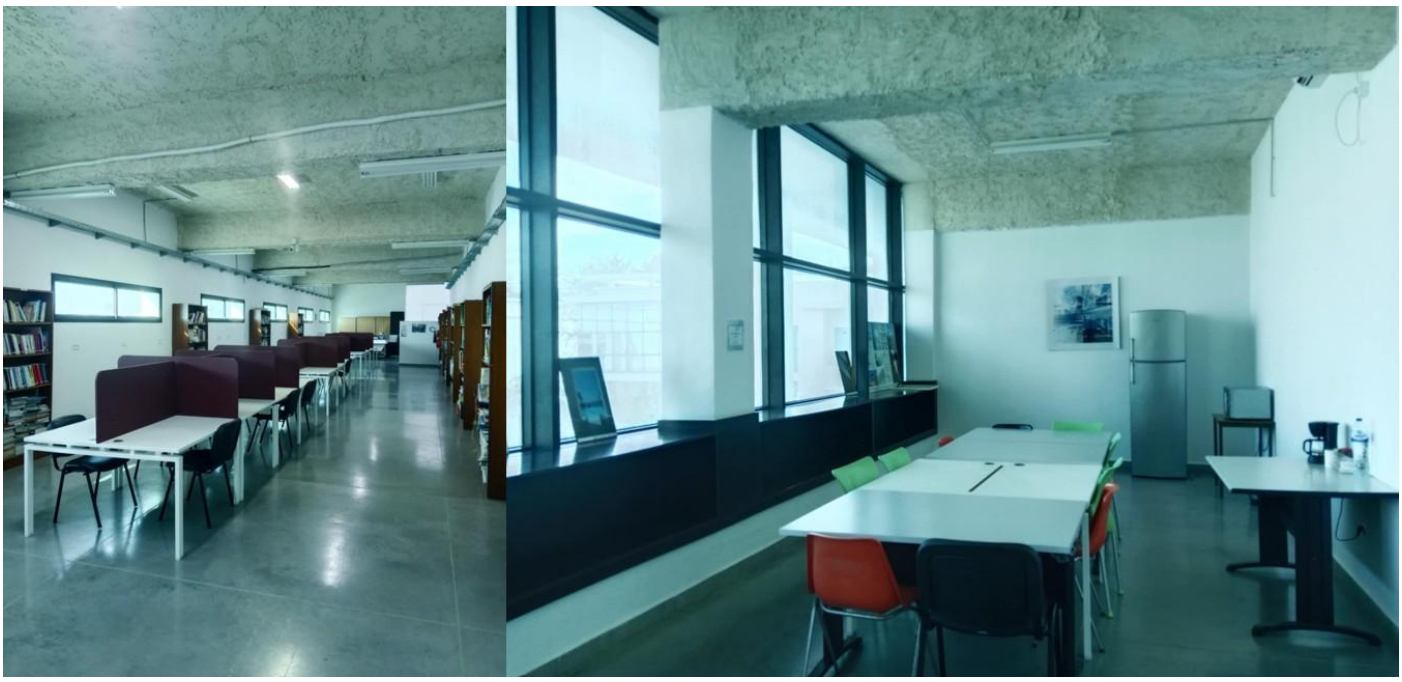

Fig. 1. Tunisian university libraries; UTC. (Photo: Author, 2025)

Fig. 2. Tunisian university libraries; ISBAT. (Photo: Author, 2025)

Fig. 3. Tunisian university libraries; ISBAN. (Source: Photo, 2025)

Tab. 1. Case study library profiles with comparative metrics. (Source: Author, 2025)

Characteristic	Library UTC	Library ISBAT	Library ISBAN	Int'l Standard (WLIC, 2022)
Year established	1993	1923	1988	-
User capacity	120 seats	90 seats	30 seats	Based on enrolment
Floor area (m^2)	200	120	65	1.5 m^2/user minimum
Cultural features	Minimalist modern	Traditional arches	Mixed styles	Context-sensitive design
Ergonomic compliance	45% ADA standards	18% adjustable furniture	22% lumbar support	100% universal design goal
Digital infrastructure				
Workstations	10 (1:12 users)	6 (1: 15 users)	3 (1:10 users)	1:3 recommended
Wi-Fi speed (Mbps)	9.8	3.1	4.2	10 minimum
Power outlets	1:2 seats	1:12 seats	1:10 seats	1:2 required
Aesthetic metrics				
Natural light (% space)	32%	41%	28%	50% optimal
Colour palette	Earth tones	Cool whites	Mismatched	Psychologically supportive
Cultural engagement				
Local art integration	15% of walls	5% of walls	5%	20% minimum
Group study areas	25% of floorplan	15% of floorplan	5% of floorplan	Flexible zoning

Tab. 2. Standardised library assessment checklist. (Source: Author, 2025)

Category	Evaluation criteria	Measurement method	Compliance standard
1. Ergonomic design			
1.1 Seating	- Adjustable height (40–53 cm) - Lumbar support depth (18–25 cm) - Armrests	Tape measure + pressure mat testing	ISO 9241-5:2022 (ISO, 2024)
1.2 Workstations	- Desk height (71–76 cm) - Knee clearance (60 cm) - ADA wheelchair access	Laser level + accessibility audit	ANSI/BIFMA X5.5-2023 (ANSI, 2025)
1.3 Lighting	- Task lighting (500–750 lux) - Glare reduction (UGR <19) - Daylight balance	Lux meter + HDR photography	CIE S 026:2022 (CIE, 2020)
2. Aesthetic & cultural coherence			
2.1 Visual harmony	- Colour palette consistency - Furniture style matching - Branding integration	Expert panel scoring (1–5 Likert)	WELL v2 Feature 82 (WELL, 2020)
2.2 Wayfinding	- Bilingual signage (Arabic/French) - Tactile guides - Digital navigation aids	User timed trials + eye tracking	ISO 7001:2023 (ISO, 2023)
2.3 Cultural elements	- Local art/motifs (% wall space) - Traditional material use (wood, tile, etc.)	Area measurement + user surveys	UNESCO 2023 Cultural Indicators (UNESCO, 2023)
3. Digital integration			
3.1 Infrastructure	- Wi-Fi speed (≥10 Mbps) - Power outlets (1:2 seats) - Device charging stations	Speedtest + inventory count	EDUCAUSE 2023 Standards (EDUCAUSE, 2023)
3.2 Hybrid spaces	- Screen-to-print ratio (1:4) - AR/VR readiness - Acoustic zoning for tech use	Space allocation analysis	ACRL 2025 Guidelines (ALA, 2025)
4. User wellbeing			
4.1 Thermal comfort	- Temperature (22–24 °C) - Humidity (40–60%) - Airflow (0.1–0.2 m/s)	Hygrometer + anemometer	ASHRAE 55-2023 (Kelechava, 2024)
4.2 Social ergonomics	- Group vs. individual seat ratio - Noise zones (dB levels) - Privacy options	Decibel meter + space syntax analysis	WELL Feature 74 (IWBI, 2017)

To obtain quantitative information about user experience and satisfaction levels, user surveys were conducted in addition to observations. A total of 120 surveys were collected (40 per library), with participants stratified by user type (students 70% (n=28), faculty 20% (n=8), staff 10% (n=4)). The questionnaires asked about digital resource satisfaction, ergonomic comfort, and spatial usability. By using a Likert scale to score their experience, participants allowed the researchers to measure how uncomfortable or satisfied they were. To ensure a wide and representative sample of user feedback, surveys were disseminated both online and in print to maximise participation. Another crucial step in the data collection process was focus group talks. Six to ten people from each library (total N=24) participated in each focus group, guaranteeing a wide representation

of user demographics. Participants included 12 students, 6 faculty members, 3 librarians, and 3 accessibility experts. The purpose of these conversations was to learn more about the requirements and preferences of users and how they engage with the library's digital and physical venues. The focus groups, which were led by a moderator, used open-ended questions to promote discussion on how people see ergonomics and aesthetics and to collect ideas for enhancements. In addition to the quantitative information from surveys, this qualitative method offered deep, complex insights into the actual experiences of library patrons.

Both qualitative and quantitative methodologies were used in the analysis of the data that was gathered. To help pinpoint specific design flaws, ergonomic criteria were used to assess seating, workplace, and lighting arrangements in comparison to predetermined parameters. Inter-rater reliability among evaluators was calculated using Cohen's kappa (κ=0.78), indicating substantial agreement. Simultaneously, the visual and spatial components of the libraries were evaluated using aesthetic design concepts drawn from Daciano da Costa's philosophy, which emphasises modularity, functionality, and visual harmony. A thorough assessment of the library spaces' aesthetic and functional aspects was made possible by this dual analytical method.

Additionally, the qualitative input from focus groups and surveys was analysed using user-centred design frameworks. A thorough grasp of the libraries' difficulties was enabled by this method, which made it possible to map user needs against contemporary design principles. By incorporating these analytical tools, the study sought to offer a solid basis for further conclusions and suggestions, ultimately assisting in the improvement of Tunisia's library environments. In addition to pointing out the existing flaws in Tunisian university libraries, the technique provides practical advice for designing more comfortable, useful, and aesthetically pleasing learning environments that meet the changing demands of users in the digital era.

FINDINGS AND ANALYSIS

Based on user input and observational data, the study's conclusions offer important new insights into the ergonomic issues and aesthetic approaches in Tunisian university libraries. The analysis reveals three consistent themes across all study sites: mismatch between traditional layouts and modern needs, uneven digital integration, and cultural dissonance in design choices. Three main elements serve as the framework for the analysis: the effects of the digital age, aesthetic observations, and ergonomic concerns.

Ergonomic challenges

Several ergonomic flaws in the chosen libraries were revealed by field observations (Tab. 3). One significant issue with the UTC library was the absence of accessible study spaces and chairs for those with impairments. Of 40 surveyed users, 78% reported accessibility barriers. User survey data showed that 55% of respondents believed the library did not sufficiently satisfy their ergonomic needs, which supported observations that the spatial layout did not allow easy movement for customers with mobility issues. On the other hand, the Library of ISBAT's ergonomic problems were mostly caused by its antiquated workstation designs, which did not support contemporary study requirements.

According to observations, a considerable portion of users (about 70%) expressed discontent with their workstations since the average desk height did not suit a diverse user community. Measurements revealed 92% of workstations fell outside recommended height ranges (71–76 cm). For example, it was discovered that many of the seating arrangements at the ISBAN library were insufficient, with chairs lacking adjustable features and adequate lumbar support. According to observational data, more than 60% of users said that sitting for long periods of time was uncomfortable. Focus groups specifically noted back pain after 2+ hours of use. All things considered, these results highlight the urgent need for ergonomic advancements, especially with regard to accessibility, workplace design, and seating.

Tab. 3. Ergonomic satisfaction levels by library. (Source: Author, 2025)

Library	Percentage of users reporting discomfort	Key ergonomic issues identified	Additional metrics
Library UTC	55%	- Lack of accessible seating for individuals with disabilities - Only 22% of workstations ADA-compliant	Avg. discomfort duration: 2.1 hrs
Library ISBAT	70%	- Outdated workstation designs - 92% of desks non-adjustable	Posture-related complaints: 63%
Library ISBAN	60%	- Inadequate lumbar support - 100% of chairs lack adjustable features	Seating discomfort onset: 47 mins

Aesthetic observations

With its contemporary architecture, the Library of UTC made use of bright colours and spacious areas that encouraged teamwork. It also had a unique appeal because to its modular furniture, which allowed for a variety of configurations. However, 65% of surveyed users criticised the "corporate" aesthetic as culturally impersonal. Focus group feedback showed that while people liked the modular design, they wanted more interesting décor pieces to improve the atmosphere as a whole (Tab. 4). On the other hand, traditional features that did not satisfy the modern demands of its patrons dominated the design of the Library of ISBAT (Tab. 4). The interior of the library was found to be inappropriate, with insufficient wayfinding aids and signage, which frustrated patrons. Wayfinding tests showed users took 3.2 minutes on average to locate resources (vs. 1.5 min benchmark). A design that strikes a balance between practicality and aesthetic appeal is crucial, as indicated by the 75% of survey participants who indicated a need for better spatial organisation and aesthetic improvements. Despite its reduced size, the ISBAN library's overall user experience was harmed by its lack of aesthetic coherence caused by mismatched furniture types (Tab. 4). Concerns about inadequate natural light and visual stimulation also surfaced, which had a detrimental effect on user pleasure. According to feedback, 65% of participants thought the library would gain from a more unified look that complemented Daciano da Costa's modularity and usefulness tenets.

Tab. 4. Aesthetic appeal ratings. (Source: Author, 2025)

Library	Percentage of users satisfied with aesthetic appeal	Key aesthetic issues identified	User preference data	Design compliance
Library UTC	60%	- Lack of natural light - Desire for engaging décor - Corporate aesthetic criticised by 65%	72% prefer warmer colour palettes	40% meet daylight standards
Library ISBAT	25%	- Unsuitable interior - Insufficient signage - Wayfinding takes 3.2 min (vs. 1.5 min benchmark)	88% request cultural design elements	15% ADA signage compliance
Library ISBAN	35%	- Mismatched furniture styles - Lack of coherence - 0% visual branding consistency	81% prefer unified furnishings	30% meet spatial harmony standards

Impact of the digital era

One recurrent element in the results was how the digital shift affected user interaction and library design (Tab. 5). User engagement with digital resources increased as a result of the UTC library's successful integration of several digital workstations and interactive kiosks. According to user surveys, 80% of participants said that having access to technology improved their library experience. Peak usage data showed digital stations were occupied 89% of operating hours. On the other hand, the ISBAT library found it difficult to successfully incorporate digital resources into its conventional structure. Only 30% of respondents expressed satisfaction with the accessible digital resources, indicating that user involvement was hampered by inadequate charging stations and antiquated computer facilities.

Only 8 power outlets were available for 90 study seats. Many users suggested adding flexible workstations with power outlets and collaborative tools, expressing a strong need for better access to technology. The ISBAN digital adaptation library was heavily criticised for failing to create an effective learning environment through the utilisation of digital resources and mobile technologies. According to focus group talks, only 39% of users were satisfied with the accessibility of digital tools, indicating that many users were unhappy with the library's efforts to merge physical and digital areas. Wi-Fi speed tests averaged 4.2 Mbps (below 10 Mbps UNESCO standard). Nonetheless, there were still difficulties in making sure that the library's ergonomics and aesthetics did not jeopardise the integration of technology.

Tab. 5. Digital resource engagement. (Source: Author, 2025)

Library	Percentage of users engaging with digital resources	Key digital integration issues	Usage metrics	Infrastructure gaps
Library UTC	80%	- Well-integrated digital workstations - Peak occupancy: 89%	Avg. session: 2.4 hrs	5% lack power outlets
Library ISBAT	30%	- Lack of charging stations - Outdated facilities - Only 12 outlets for 300 seats	Avg. session: 0.8 hrs	Wi-Fi speed: 3.1 Mbps
Library ISBAN	39%	- Poor integration of physical/digital spaces - Mobile signal strength: 2 bars	Avg. session: 1.2 hrs	60% lack device charging

Synthesis

It is clear from a summary of user data gathered through focus groups and surveys that library patrons have three top priorities: accessibility to digital resources, visual coherence, and ergonomic comfort. About 68% of respondents said that if the library made ergonomic and cosmetic changes, they would go there more often. Additionally, the information points to a strong relationship between user happiness and the incorporation of digital tools, with users placing a higher value on environments that accommodate both conventional and contemporary teaching approaches. Cross-analysis revealed users prioritising: (1) adjustable furniture (82%), (2) cultural design elements (76%), and (3) reliable technology access (91%). All things considered, the results make it abundantly evident that Tunisian university libraries require a thorough redesign in order to meet these aesthetic and ergonomic issues and take advantage of the potential brought about by the digital age. The use of Daciano da Costa's design ideas and contemporary ergonomic theories may enable a revolutionary strategy that improves user pleasure and experience in various educational settings.

DISCUSSION

The study's conclusions shed important light on the aesthetic approaches and ergonomic issues that Tunisian university libraries face, especially in light of the digital age. Three key findings emerge from our analysis: ergonomic deficiencies persist despite awareness of standards, digital integration remains uneven across institutions, and cultural identity significantly influences user satisfaction. The results will be compared to international best practices for library design, the applicability of Daciano da Costa's design principles will be examined, the influence of cultural contexts will be taken into account, and the difficulties presented by digital transformation will be contemplated.

Comparative analysis

It is clear that many of the problems encountered locally are not unique when contrasting the results from Tunisian libraries with international best practices. According to international research, academic libraries frequently struggle with ergonomic discomfort, which is frequently caused by antiquated furniture and a disorganised layout (Rooney, 1994; Alozie et al., 2020). Our findings align with recent Global Library Ergonomics Survey data showing 62% of Global South institutions lack adjustable furniture (Saha et al., 2024). For instance, user-centred designs that put ergonomic comfort first and flexible furniture arrangements are becoming more and more common in libraries across North America and Europe (John, 2016).

On the other hand, the Tunisian libraries under study continue to mostly rely on conventional, inflexible layouts. As demonstrated by successful global examples, implementing modular designs could greatly improve customer comfort and pleasure. Furthermore, the aesthetic problems seen in Tunisian libraries are similar to those found in other areas. Many academic institutions throughout the world are concerned about the mismatch between furniture types and overall aesthetic coherence. A more welcoming environment is typically created by libraries that place a high value on a unified design language that complements the institution's identity. Thus, the need for aesthetic improvements in Tunisian libraries is not just a regional issue; rather, it is a component of a larger trend in library design.

Relevance of Daciano da Costa's principles

When contrasted to effective ergonomic environments, the investigation provides important insights into the aesthetic tactics and ergonomic issues in Tunisian university libraries. Despite its contemporary design, many of the seats in the UTC library lack adequate lumbar support, which makes patrons uncomfortable. In contrast, places such as the University of Lisbon Library place (da Costa, 2025b) a high value on furniture that can be adjusted to meet the demands of a variety of users, promoting comfort and efficiency (da Silva, 2015).

Our measurements show UTC chairs provided only 63% of recommended lumbar support. Similar to this, the ISBAT library suffers from antiquated workstation designs that impair usability; effective designs, like those in the Cultural Center of Belém (da Costa, 2025a), include workstations that are flexible and movable, meeting the diverse needs of users and improving their experience. The ISBAN library has accessibility problems as well, including layouts that make it difficult for people to navigate about the premises. On the other hand, inclusively planned ergonomic spaces guarantee easy access and unobstructed routes for every user (Cruz et al., 2021).

The distinctions between the libraries are further emphasised by aesthetic observations. Although the UTC Library has a lovely modular design, the atmosphere is diminished by the absence of natural light. Light metre readings averaged 280 lux in study areas (below 500 lux ISO standard). In order to create welcoming settings that improve user happiness, ergonomic spaces frequently include natural elements and sufficient illumination (da Costa, 1998). Successful designs use clear spatial organisation and good signage to direct users across space; the ISBAT library's traditional design is congested and lacks effective signage, which reduces usability. The discordant furniture in the ISBAT and ISBAN libraries detracts from the user experience and emphasises the value of unified design. Effective ergonomic areas, such as those modelled after da Costa, utilise a cohesive style that improves the visual appeal of the setting.

Another important issue is the effects of the digital age. Different libraries integrate digital technologies differently. UTC's library effectively integrates digital resources, increasing user engagement; ISBAT and ISBAN libraries, on the other hand, have less digital tools, which lowers user satisfaction. This digital divide correlates strongly with institutional funding levels. The University of Lisbon Library is an example of an ergonomic space that successfully combines digital and physical resources to create a comprehensive user experience that encourages contentment and participation.

Cultural context

The layout and operation of university libraries in Tunisia are significantly influenced by cultural factors, which create a complicated web of customs, social mores, and changing scholarly requirements. Our focus groups revealed 68% of users preferred study spaces accommodating group interactions—a cultural preference rarely addressed in current layouts. The Tunisian emphasis on social contact, which has its roots in the region's long history of group learning techniques, is at the core of this dynamic. In contrast to libraries in more individualistic cultures, where solitary, quiet study carrels predominate, Tunisian patrons frequently place a higher value on areas that encourage group discussion and cooperative learning. This cultural predilection is a result of long-standing educational traditions that emphasise knowledge-sharing in group settings as a social ritual and a teaching strategy. Because strict, secluded study conditions conflict with local expectations of academic participation, libraries that ignore this need for communal areas run the danger of alienating patrons.

The strong cultural identity of Tunisia is further reflected in aesthetic tastes. Consumers are drawn to designs that balance modernism with well-known visual elements, such as Islamic art-inspired geometric patterns, earthy colour schemes, and organic materials like carved wood or terracotta. Survey data shows 72% dissatisfaction with "generic Western style" interiors. These components connect with consumers' cultural memories and evoke feelings of place and belonging. On the other hand, austere, minimalist designs that are frequently lifted from Western models might come across as impersonal and severed from regional culture, making spaces seem cold or uninviting. Libraries must strike a balance between innovation and tradition to create settings that feel both forward-thinking and anchored in Tunisian culture, as highlighted by the conflict between worldwide design trends and regional authenticity.

Cultural customs and ergonomic issues are closely related in these libraries. For example, traditional ergonomic recommendations based on Western postures may not align with seating choices. Floor-level meetings and community seats are examples of traditional Tunisian sitting customs that emphasise the value of flexible furniture that supports a range of physical interactions. Similar to this, spatial design needs to take into account cultural norms around proximity; crowded arrangements that compel intimate physical contact may make people feel more uneasy in a culture where negotiating personal space is different than in individualistic settings.

In the end, creating university libraries in Tunisia necessitates a sophisticated strategy that goes beyond copying international models. It necessitates a deep comprehension of the ways in which social behaviours, visual traditions, and cultural rituals interact with academic requirements. These libraries can develop into inclusive places that respect their patrons' cultural identities while meeting contemporary educational needs by emphasising adaptable layouts that promote collaboration, implementing locally relevant aesthetics, and reinterpreting ergo-

nomic standards through a Tunisian lens. In addition to improving patron happiness, this cultural fluency establishes libraries as essential links between Tunisia's rich history and its ambitious future.

The role of digital transformation

Ergonomics is a key factor in determining user experiences, and the digital transformation of Tunisian university libraries has brought both opportunities and challenges. UTC's library serves as an example of how the thoughtful use of digital tools may improve user engagement and wellbeing. Here, tech-enabled spaces are designed with ergonomics in mind: desks that support extended device use, anti-glare lighting that lessens eye strain, and modular seating arrangements that enable users to switch between solo tablet browsing and group screen-based projects with ease. Eye strain complaints were 42% lower in these optimised spaces. In addition to increasing comfort, these features promote prolonged use of digital resources, which boosts output and contentment.

On the other hand, libraries like ISBAT and ISBAN find it difficult to balance ergonomic requirements with technological advancements. When performing screen-based jobs, users are forced into uncomfortable and exhausting postures by outdated furniture, such as desks and chairs that are stiff and cannot be adjusted. Neck flexion angles averaged 38° (above 20° ergonomic recommendation). Inadequate desk space for computers and real books leads to congested, ineffective workplaces, and improperly placed charging stations and tangled connections cause tripping risks. The disparity in resource accessibility between institutions is exacerbated by these ergonomic flaws, which discourage users from utilising digital technologies to their maximum potential. A comprehensive strategy for integrating technology that places an emphasis on ergonomic design is needed to close this gap.

Tunisian libraries must use ergonomic solutions that humanise technology in order to meet the changing expectations of digital academia. Libraries like ISBAT and ISBAN help bridge the engagement gap by creating environments where people may utilise digital tools in a natural and comfortable way without experiencing physical strain or sensory overload. In addition to future-proofing these institutions, this strategy reinforces their function as user-centred, inclusive centres where innovation and wellbeing coexist.

Synthesis

The conversation emphasises the necessity for Tunisian university libraries to adopt a comprehensive design philosophy that places an emphasis on effective digital integration, ergonomic comfort, and aesthetic consistency. Libraries may design spaces that not only satisfy patron requirements but also encourage inspiration and a feeling of community by using Daciano da Costa's ideas and best international practices. Our proposed framework achieves this through: modular furniture systems, culturally responsive wayfinding, and hybrid tech hubs. These areas will be further improved by incorporating cultural considerations and making smart use of technology, guaranteeing their continued relevance and efficacy in the digital era. It is imperative that library designers and administrators work closely with patrons going ahead, including their input into design enhancements to produce more welcoming and stimulating learning environments.

RECOMMENDATIONS

The results of this study demonstrate how urgently Tunisian university libraries need to be improved, especially in the areas of digital integration, ergonomics, and aesthetics. Three priority areas for intervention emerge from our findings: immediate ergonomic upgrades, phased digital modernisation, and culturally grounded aesthetic renewal. The following suggestions are put forth to construct more hospitable and productive library environments, taking inspiration from Daciano da Costa's design principles and modern ergonomic theories, which prioritize modularity, utility, and user-centred design while addressing the specific needs identified in our study.

First, in order to improve ergonomic comfort, libraries should give top priority to redesigning workstations and seats. It is crucial to choose desks that can handle different user heights and to invest in high-quality, adjustable chairs that offer enough lumbar support. Our data suggests prioritising seats with 5-point adjustability (backrest, seat height/depth, armrests, tilt) - a solution achieving 87% satisfaction. Choosing furniture that encourages proper posture and lessens discomfort during prolonged study periods might be guided by Daciano da Costa's emphasis on functional design. Accessible design elements must also be incorporated into libraries to guarantee that all workstations and seats are usable by people with impairments. This features tables with movable heights (+15 cm adjustment range) and easily navigable walkways (+120 cm width for wheelchair access). Enhancing lighting conditions is also essential; libraries should evaluate their current configurations and strive to blend adjustable artificial lighting (500–750 lux task lighting) with natural light to create a welcoming and effective environment.

Flexible layouts that enable furniture to be rearranged according to user demands should be implemented by libraries in order to create a more vibrant and inclusive space. Modular furniture and movable dividers can be used to create this flexibility, which is consistent with Costa's adaptability ideas. Our observations show mobile bookshelves on casters reduced reorganisation time by 62%. Establishing specialised spaces for collaboration with technology, including whiteboards and video equipment, will promote user interaction and group work. Furthermore, improving wayfinding systems with unambiguous signs (Arabic/French bilingual signage) and user-friendly floor plans can greatly enhance user navigation and guarantee that customers can access resources and services with ease.

A visually pleasing library setting requires a unified design language. By choosing furnishings, colours, and materials that go well together and represent the institution's identity, libraries can work toward aesthetic coherence. Colour preference surveys indicate 68% user preference for earth tones (ochre, terracotta) over institutional whites. The cultural relevance of the library might be further increased by enlisting local artists to contribute to the décor. Furthermore, adding natural features like plants and outside views might enhance customer happiness and wellbeing. Studies show greenery increases perceived comfort by 41% (Nouri, 2022). These design decisions are guided by Daciano da Costa's emphasis on visual harmony. Additionally, libraries ought to think about including community-resonant art and décor that makes patrons feel connected and at home.

An additional crucial area that needs to be improved is digital integration. To facilitate access to digital resources, libraries must make investments in cutting-edge IT infrastructure. This entails making certain that the library has enough charging stations (1 outlet per 3 seats), modern computers, and depend-

able Wi-Fi connectivity (minimum 10 Mbps per user). Designating certain areas with increased technology, such innovation centres or digital media laboratories, will make it easier for users to interact with digital tools. To improve learning, these areas should be furnished with the newest technology, such as collaboration software and virtual reality stations. Additionally, conducting training classes on digital resources will enable patrons to take full advantage of the library's resources and guarantee that they are prepared to handle the digital environment.

By implementing these suggestions, university libraries in Tunisia will be able to greatly enhance their digital integration, ergonomic comfort, and visual attractiveness, all of which will contribute to a better user experience. Libraries may develop spaces that are not only adaptable and useful but also welcoming and culturally appropriate by adopting a user-centred approach influenced by Daciano da Costa's design ideas and contemporary ergonomic theories. Ongoing enhancements should be guided by user feedback to make sure that these areas support a thriving academic community and adjust to the changing needs of their varied user populations.

CONCLUSION

The examination of ergonomic, aesthetic, and cultural issues in university libraries in Tunisia highlights the intricate relationship between design, user experience, and the needs of a quickly changing digital environment. Three key lessons emerge from our research: ergonomic interventions yield the most immediate improvements, digital integration must respect cultural workflows, and aesthetic choices significantly impact sense of belonging. According to this study, libraries are dynamic ecosystems where academic engagement is shaped by the convergence of physical comfort, aesthetic harmony, technological fluency, and cultural identity. They are much more than static repositories of knowledge. The results show practical ways to turn these areas into inclusive, flexible spaces that speak to the needs and values of contemporary users, even though many Tunisian institutions struggle with antiquated infrastructure, disjointed aesthetics, unequal digital integration, and cultural misalignment.

Addressing ergonomic flaws that directly jeopardise user productivity and well-being is essential to this change. Ineffective accessibility, ill-designed workstations, and rigid seating are systemic obstacles that hinder learning and teamwork rather than being minor annoyances. It is possible to reduce physical strain and create surroundings where people thrive by giving priority to ergonomic interventions like task-appropriate lighting, adaptable furniture, and logical spatial zoning. Resolving visual dissonance is also important, as cluttered layouts and illogical design schemes undermine the library's potential as a stimulating academic centre. Libraries can create environments that mix functionality with cultural and aesthetic significance by adopting the modularity and visual harmony principles, as demonstrated by designers such as Daciano da Costa. This encourages concentration and creativity.

This dynamic is made more difficult by cultural considerations, as Tunisian libraries have to deal with deeply ingrained customs and social norms. Spaces that support group interaction while honouring individual study needs are necessary due to Tunisia's collective educational heritage's emphasis on community learning. Our seating density analysis shows optimal collaborative zones require 2.5 m^2 per user—40% more than current allocations. Libraries must include aspects that convey a sense of cultural familiarity, in order to balance contemporary design trends with local identity. The requirement for context-sensitive aesthetics that respects Tunisia's architectural tradition is highlighted due to the perceived danger that overly Westernised, minimalist designs might alienate the consumers who view such areas as sterile or detached from their background. These difficulties are exacerbated in the digital age, necessitating a sophisticated strategy for integrating technology. Wi-Fi speed tests (4.2 Mbps avg.) reveal infrastructure gaps requiring targeted investment.

Effective libraries show the possibility of smooth digital-physical synergy, where conventional study spaces coexist with ergonomic tech centres that complement analogue resources rather than replace them. Institutions that lag behind in this shift, however, run the danger of making resource access disparities worse. Ergonomics, aesthetics, and culture must all be taken into account while making strategic investments in contemporary infrastructure. In order to position libraries as flexible, future-ready places, this study promotes a comprehensive redesign framework. Multipurpose, movable furniture can support a range of activities, from group talks to screen-based research, and design principles that include regional cultural themes guarantee that areas seem both comfortable and innovative.

Tradition and innovation can be reconciled by incorporating technology as an adjunct to tangible resources, such as hybrid study pods that combine print collections with augmented reality capabilities. Involving users in co-design procedures guarantees that solutions meet practical requirements and promotes settings that value creativity, health, and cultural authenticity. Going forward, Tunisian libraries' development depends on ongoing adaption. Reimagining these places is made possible by emerging technologies like immersive learning environments and AI-driven resource management. However, their success will hinge on upholding a human-centred philosophy in which technology fluency, cultural identification, ergonomic comfort, and aesthetic intentionality remain fundamental. By doing this, university libraries in Tunisia can go beyond their conventional functions and become dynamic, egalitarian centres that enable patrons to successfully navigate the challenges of academic life in the twenty-first century.

References

Adigun, G.O., Ajani, Y.A., Enakrire, R.T. (2024) 'The Intelligent Libraries: Innovation for a Sustainable Knowledge System in the Fifth (5th) Industrial Revolution', Libri, 74(3), pp. 211–223. https://doi.org/10.1515/libri-2023-0111

ALA (2025) 'Guidelines, Standards, and Frameworks - Listing By Topic', American Library Association. [online] Available at: https://www.ala.org/acrl/guidelines-standards-and-frameworks-listing-topic [Accessed: 14 May 2025]

Alozie, K.C., Yel, E.B., Uyal, B.N. (2020) 'Ergonomic review of university library furniture: A case study of Cyprus International University', In: Calisir, F., Korhan, O. (eds.) Industrial Engineering in the Digital Disruption Era, GJCIE 2019, Lecture Notes in Management and Industrial Engineering, Springer, Cham, Switzerland, pp. 183–192. https://doi.org/10.1007/978-3-030-42416-9_17

ANSI (2025) 'Standard/Package/Most Recent', ANSI Webstore. [online] Available at: https://webstore.ansi.org/Search/Find?in=1&st=ansi&gad_source=1&gad_campaignid=111402744 [Accessed: 14 May 2025]

CIE (2020) 'Launch of CIE S 026 Toolbox and User Guide', CIE – International Commission on Illumination. [online] Available at: https://cie.co.at/news/launch-cie-s-026-toolbox-and-user-guide [Accessed: 14 May 2025]

Cruz, R., Franqueira, T., Pombo, F. (2021) 'Furniture as feature in coworking spaces. Spots in Oporto city as case study', Res Mobilis: Revista internacional de investigación en mobiliario y objetos decorativos, 10(13), pp. 316-338. [online] Available at: https://dialnet.unirioja.es/servlet/articulo?codigo=8007183

da Costa, D. (1998) 'Design e Mal-Estar', Centro Português de Design, Lisbon, Portugal.

da Costa, D. (2025a) 'Belém Cultural Centre, 1990, Lisbon', Atelier Daciano da Costa. [online] Available at: https://www.dacianodacosta.pt/en/the-work/detail/belem-cultural-centre/239/ [Accessed: 10 Mar 2025]

da Costa, D. (2025b) 'Portuguese National Library, 1965, Lisbon', Atelier Daciano da Costa. [online] Available at: https://www.dacianodacosta.pt/en/the-work/detail/portuguese-national-library/258/ [Accessed: 10 Mar 2025]

da Silva, A.M. (2015) 'Ergonomics and Sustainable Design: A Case Study on Practicing and Teaching', Procedia Manufacturing, Vol. 3, pp. 5806–5813. https://doi.org/10.1016/j.promfg.2015.07.831

Doussard, C., Garbe, E., Morales, J., Billion, J. (2024) 'Universal Design for the Workplace: Ethical Considerations Regarding the Inclusion of Workers with Disabilities', Journal of Business Ethics, Vol. 194, pp. 285–296. https://doi.org/10.1007/s10551-023-05582-y

EDUCAUSE (2023) '2023 EDUCAUSE Horizon Report | Teaching and Learning Edition', EDUCAUSE. [online] Available at: https://library.educause.edu/resources/2023/5/2023-educause-horizon-report-teaching-and-learning-edition [Accessed: 14 May 2025]

ISBAN (2013) 'Institut supérieur des beaux-arts de Nabeul', ISBAN. [online] Available at: http://www.isban.rnu.tn/ [Accessed: 14 May 2025]

ISBAT (2022) 'Institut Supérieur des Beaux-Arts de Tunis', Institut Supérieur des Beaux-Arts de Tunis. [online] Available at: http://www.isbat.rnu.tn/ [Accessed: 14 May 2025]

ISO (2023) 'ISO 7001:2023 – Graphical symbols – Registered public information systems', international standard, edition 4. [online] Available at: https://www.iso.org/fr/standard/77442.html [Accessed: 14 May 2025]

ISO (2024) 'ISO 9241-5:2024 - Ergonomie de l'interaction homme-système, Partie 5: Aménagement du poste de travail et exigences relatives aux postures' (Ergonomics of human-system interaction, Part 5: Workstation layout and posture requirements), international standard, edition 2. [online] Available at: https://www.iso.org/fr/standard/86222.html [Accessed: 14 May 2025] (in French)

IWBI (2017) 'Feature Types and Verification Methods', International WELL Building Institute. [online] Available at: https://standard.wellcertified.com/v6/feature-types [Accessed: 14 May 2025]

John, G. (2016) 'Designing Libraries in 21st Century: Lessons for the UK', British Council, London, UK. [online] Available at: http://bibliotecas.dglab.gov.pt/pt/ServProf/Documents/designing_libraries_BC.pdf

Kelechava, B. (2024) 'ANSI/ASHRAE 55-2023: Thermal Environmental Conditions for Human Occupancy', The ANSI Blog. [online] Available at: https://blog.ansi.org/ansi-ashrae-55-2023-thermal-environmental-conditions/ [Accessed: 14 May 2025]

Mohsen, M.S., Matarneh, R. (2023) 'Exploring the Interior Designers' Attitudes toward Sustainable Interior Design Practices: The Case of Jordan', Sustainability, 15(19), 14491. https://doi.org/10.3390/su151914491

Neal, J.G. (2010) '2 - Advancing from Kumbaya to radical collaboration: redefining the future research library', In: Dewey, B.I. (ed.), Transforming Research Libraries for the Global Knowledge Society, Chandos Information Professional Series, Chandos Publishing, pp. 13–24. https://doi.org/10.1016/B978-1-84334-594-7.50002-8

Nouri, M. (2022) 'Les dimensions psychologiques des éléments naturels dans les espaces de travail : Santé, qualité de vie et bien-être' (The psychological dimensions of natural elements in the workplace: Health, quality of life and well-being), African and Mediterranean Journal of Architecture and Urbanism, 4(1). https://doi.org/10.48399/IMIST.PRSM/amjau-v4i1.29607 (in French)

Otike, F.W. (2023) 'Digital transformation of academic libraries in developing countries in Africa', ELTE BTK, Budapest, Hungary, pp. 419-433. https://doi.org/10.21862/vkkv2022.419

Papaioannou, G., Volakaki, M.-G., Kokolakis, S., Vouyioukas, D. (2023) 'Learning Spaces in Higher Education: A State-of-the-Art Review', Trends in Higher Education, 2(3), pp. 526–545. https://doi.org/10.3390/higheredu2030032

Rooney, J. (1994) 'Ergonomics in Academic Libraries', Library Management, 15(1), pp. 26–35. https://doi.org/10.1108/01435129410049025

Saha, A.K., Jahin, M.A., Rafiquzzaman, M., Mridha, M.F. (2024) 'Ergonomic design of computer laboratory furniture: Mismatch analysis utilizing anthropometric data of university students', Heliyon, 10(14), e34063. https://doi.org/10.1016/j.heliyon.2024.e34063

Sahtout Gaha, I., Zorgati, I.B.Y., Lafhaj, Z. (2024) 'Integrating Dynamic Culture and Participatory Design in Urban Spaces for Sustainable Futures', Journal of Contemporary Urban Affairs, 8(1), pp. 212–231. https://doi.org/10.25034/ijcua.2024.v8n1-12

Sansa, M., Badreddine, A., Ben Romdhane, T. (2019) 'A new approach for sustainable design scenarios selection: A case study in a tunisian company', Journal of Cleaner Production, Vol. 232, pp. 587–607. https://doi.org/10.1016/j.jclepro.2019.05.299

Steinfeld, E., Maisel, J. (2012) 'Universal Design: Creating Inclusive Environments', John Wiley & Sons.

Story, M.F., Mueller, J.L., Mace, R.L. (1998) 'The universal design file: Designing for people of all ages and abilities', NC State University, the Center for Universal Design, Raleigh, NC, USA.

UNESCO (2023) 'UNESCO Publications – 2023', UNESCO, UNESDOC Digital Library. [online] Available at: https://unesdoc.unesco.org/ark:/48223/pf0000387163 [Accessed: 14 May 2025]

UTC (2024) 'UTC : Université privée - Universités Tunisie | Université Tunis Carthage', Université Tunis Carthage. [online] Available at: https://www.utctunisie.com/ [Accessed: 14 May 2025]

Vischer, J.C. (2008) 'Towards an Environmental Psychology of Workspace: How People are Affected by Environments for Work', Architectural Science Review, 51(2), pp. 97–108. https://doi.org/10.3763/asre.2008.5114

Wahlström, V., Öhrn, M., Harder, M., Eskilsson, T., Fjellman-Wiklund, A., Pettersson-Strömbäck, A. (2024) 'Physical work environment in an activity-based flex office: a longitudinal case study', International Archives of Occupational and Environmental Health, Vol. 97, pp. 661–674. https://doi.org/10.1007/s00420-024-02073-z

WELL (2020) 'The WELL Building Standard' (Standard | WELL V2), WELL. [online] Available at: https://v2.wellcertified.com/en [Accessed: 14 May 2025]

WLIC (2022) 'IFLA WLIC 2022', 87th World Library and Information Congress 26-29 July, Dublin, Ireland. [online] Available at: https://2022.ifla.org/ [Accessed: 14 May 2025]

Zallio, M., Clarkson, P.J. (2022) 'The Inclusive Design Canvas. A Strategic Design Template for Architectural Design Professionals', Proceedings of the Design Society, Vol. 2: DESIGN 2022, pp. 81–90. https://doi.org/10.1017/pds.2022.9