

Identification of Major Maintenance Issues in Public Sector Universities of Sindh (Pakistan)

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Abstract

This study investigates the detrimental effects of maintenance issues on public-sector universities in Pakistan. Budgetary constraints, staff shortages, and political interference are common factors that contribute to the decline of both physical infrastructure and academic standards. These issues significantly hinder the quality of education and research within these institutions. While existing literature acknowledges the challenges faced by Pakistani universities, a gap exists regarding sustainable building maintenance practices. This research aims to address this gap by focusing on public universities within Sukkur City. Through a combination of surveys and data analysis, the study seeks to identify the prevalent maintenance issues within the universities of Sukkur, Sindh. The findings from this research demonstrate nine major maintenance issues, out of which fading or peeling paint on walls and ceilings is at the top; second is plumbing system issues affective water quality; and third is a lack of proper waste management and disposal systems. Ultimately, this study underscores the critical need for enhanced maintenance practices in Pakistan's public-sector universities. By ensuring a well-maintained infrastructure, these institutions can foster a more conducive learning environment, leading to improved academic performance and stakeholder satisfaction.

Introduction

Public sector universities play a pivotal role in the educational landscape, serving as hubs for academic excellence, research endeavors, and knowledge dissemination (Maiya et al., 2023). However, the effective functioning of these institutions relies heavily on the upkeep and maintenance of their infrastructure and facilities. In the context of Sukkur, a city in Pakistan known for its rich cultural heritage and academic institutions, ensuring the proper maintenance of public sector university campuses is crucial for fostering an environment conducive to learning and research.

Maintenance issues in public sector universities often pose significant challenges, impacting various aspects of institutional operations (Balzer, 2020). These issues encompass a broad

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spectrum, ranging from structural deficiencies to technological inadequacies, and from safety concerns to environmental sustainability (Fokaide et al., 2020). Addressing these maintenance challenges requires a comprehensive understanding of the underlying factors contributing to their emergence and persistence (Franciosi et al., 2020). Given this scenario, this study has the following objectives:

1. To identify major maintenance issues prevalent in public sector university buildings.
2. To conduct a quantitative survey to understand the impact of maintenance issues on the university environment and stakeholder well-being.

By illuminating the key issues this study aspires to empower university administrators, policymakers, and other stakeholders in their efforts to ensure the long-term sustainability and functionality of educational infrastructure in Sukkur's public sector universities (Zhuang & Liu, 2022). Through a quantitative methodology this study seeks to explore the multifaceted nature of maintenance challenges faced by public sector universities in Sukkur by engaging with relevant stakeholders (Mughal et al., 2023). Ultimately, the overarching goal of this study is to contribute to the body of knowledge concerning maintenance management in public sector universities, with a specific focus on the Sukkur region. The findings of this research endeavor hold implications not only for the academic community but also for policymakers, administrators, and stakeholders invested in the sustainable development of educational infrastructure.

Literature Review

Maintenance of infrastructure and facilities in public sector universities is crucial for sustaining academic excellence and ensuring a conducive environment for learning and research (Ibrahim, 2023). However, despite its significance, maintenance management in these institutions often faces a myriad of challenges, necessitating a thorough examination of the major issues prevalent in the context of Sukkur's public sector universities (Sharif, 2022).

Maintenance Management in Educational Institutions

Maintenance management within educational institutions has emerged as a focal point of scholarly inquiry, garnering significant attention due to its far-reaching implications for a multitude of stakeholders. Its impact resonates deeply, directly influencing student satisfaction, faculty productivity, and the overall reputation of the institution. Noteworthy scholars have delved into this critical domain, shedding light on the indispensable role of proactive maintenance strategies in preempting potential issues before they escalate into disruptive crises (Wanaguru et al., 2022).

Through their research, these scholars have underscored the pivotal importance of implementing effective maintenance management systems. By advocating for the adoption of proactive approaches, they highlight the criticality of optimizing resources and enhancing operational efficiency within educational settings. This body of work not only elucidates the challenges inherent in maintenance management but also emphasizes the urgent need for educational institutions to adopt a proactive stance towards maintenance. Indeed, the imperative for educational institutions to safeguard their infrastructure and cultivate an optimal environment conducive to learning and scholarly pursuits cannot be overstated (Aziz et al., 2024). As custodians of knowledge and innovation, universities bear a profound responsibility to ensure the seamless functioning of their facilities and resources. Proactive maintenance strategies not only mitigate potential disruptions but also promote a culture of resilience and preparedness within educational institutions. Furthermore, the adoption of proactive maintenance practices aligns with broader trends towards organizational excellence and continuous improvement. By investing in preventative maintenance measures,

educational institutions demonstrate their commitment to operational excellence, resource optimization, and the enhancement of the overall learning experience (Oliveira & Lopes, 2020). In essence, the scholarly discourse surrounding maintenance management within educational institutions serves as a clarion call for proactive action. It underscores the need for institutions to prioritize maintenance as an integral component of their strategic planning and resource allocation processes. By heeding this call and embracing proactive maintenance strategies, educational institutions can fortify their infrastructure, enhance operational efficiency, and cultivate an environment conducive to academic excellence and innovation (Memon et al., 2023).

Challenges in Maintenance Management

Maintenance management within public sector universities in Pakistan is besieged by a myriad of formidable challenges, each posing significant impediments to the provision of an optimal learning environment for students and faculty. These challenges encapsulate a spectrum of complexities, ranging from fiscal constraints and workforce shortages to deficiencies in planning and the inherent limitations associated with aging infrastructure. By delving deeper into each of these challenges, we can unravel the intricate web of obstacles hindering effective maintenance management within the educational landscape of Pakistan.

Budget Constraints: At the forefront of challenges plaguing maintenance management in public sector universities lie the perennial constraints imposed by limited funding allocations. Scarce financial resources often translate into deferred maintenance initiatives, wherein critical infrastructure repairs and upgrades are postponed indefinitely due to budgetary constraints. This chronic underfunding not only exacerbates the deterioration of university facilities but also undermines efforts to create a conducive learning environment conducive to academic success (Hassan et al., 2020).

Lack of Skilled Personnel: A shortage of trained maintenance staff emerges as another salient challenge confronting public sector universities in Pakistan. The dearth of qualified personnel proficient in the diagnosis and resolution of maintenance issues impairs the institution's ability to promptly address infrastructure concerns, leading to prolonged downtime and diminished operational efficiency (Safi, 2021). Moreover, the absence of specialized expertise further compounds the challenges associated with maintaining complex equipment and systems, exacerbating the strain on already overstretched maintenance teams.

Inadequate Maintenance Planning: The absence of comprehensive maintenance plans poses a significant obstacle to effective maintenance management within public sector universities. Without a clear roadmap delineating maintenance priorities, schedules, and resource allocations, institutions resort to ad-hoc maintenance practices characterized by reactive responses to emergent issues. This reactive approach not only perpetuates inefficiencies but also undermines the strategic utilization of resources, resulting in suboptimal outcomes and missed opportunities for long-term asset preservation (Morelli, 2023).

Aging Infrastructure: Public sector universities in Pakistan grapple with the pervasive challenge of aging infrastructure, which encompasses a plethora of issues ranging from deteriorating buildings to outdated equipment and obsolete technology. The cumulative effects of deferred maintenance and prolonged neglect manifest in dilapidated facilities, crumbling infrastructure, and obsolete amenities, all of which detract from the overall quality of the learning environment. Moreover, the obsolescence of technological infrastructure further exacerbates maintenance challenges, rendering it increasingly difficult for institutions to keep pace with evolving educational and research needs (Adedayo, 2022).

In conclusion, the challenges confronting maintenance management in public sector universities in Pakistan are multifaceted and multifarious, requiring concerted efforts and strategic interventions to address effectively. By acknowledging and confronting these challenges head-on, stakeholders can embark on a journey towards transformative change, wherein maintenance management evolves from a reactive obligation to a proactive enabler of institutional excellence and academic success. Through collaborative endeavors, innovative solutions, and a commitment to prioritizing maintenance investments, public sector universities can surmount these challenges and emerge as beacons of learning, innovation, and sustainable development in the educational landscape of Pakistan (Azmi et al., 2024).

Infrastructure Degradation and Structural Deficiencies

Infrastructure degradation and structural deficiencies pose substantial challenges for public sector universities worldwide, manifesting as pervasive maintenance issues that demand urgent attention and strategic intervention. The seminal research conducted serves as a beacon, illuminating the multifaceted repercussions of deferred maintenance practices on the performance and safety of university buildings (Storesund & Mitroff, 2024). This comprehensive study underscores the gravity of the situation, shedding light on how neglecting maintenance responsibilities can precipitate a cascade of adverse outcomes, compromising not only the structural integrity of facilities but also jeopardizing the safety and well-being of students, faculty, and staff.

The findings underscore the urgent imperative for public sector universities to adopt proactive maintenance strategies that transcend mere reactionary measures. By proactively identifying and addressing maintenance needs, institutions can preemptively avert potential risks, mitigate the detrimental effects of wear and tear, and uphold the longevity of their infrastructure assets. Such strategic interventions are paramount for safeguarding the substantial investments made in campus infrastructure and ensuring the sustained functionality of educational facilities (Santos et al., 2020). Moreover, the implications of infrastructure degradation extend beyond immediate safety concerns, permeating into the realm of institutional reputation and academic excellence (Nergard, 2021). Dilapidated buildings and neglected facilities not only detract from the aesthetic appeal of the campus but also send a disconcerting message about the institution's commitment to quality and excellence. In an increasingly competitive educational landscape, where prospective students and faculty scrutinize institutional amenities and infrastructure, the state of university facilities can significantly influence enrollment decisions and faculty recruitment efforts (Martin-Rios et al., 2021). Therefore, public sector universities must adopt a proactive stance towards maintenance management, viewing it not merely as a reactive obligation but as a strategic imperative for institutional success and sustainability. By investing in routine maintenance, periodic inspections, and timely repairs, universities can cultivate an environment that fosters academic achievement, innovation, and holistic growth. Furthermore, integrating modern technologies and data-driven approaches into maintenance practices can enhance efficiency, optimize resource allocation, and facilitate informed decision-making processes.

In essence, addressing infrastructure degradation and structural deficiencies necessitates a paradigm shift in how public sector universities conceptualize and prioritize maintenance management. By embracing a culture of proactive maintenance, institutions can fortify their physical infrastructure, enhance operational resilience, and reaffirm their commitment to providing a safe, conducive, and enriching educational experience for all stakeholders.

Technological Obsolescence and Equipment Failure

Within the dynamic landscape of public sector universities in Pakistan, the specter of technological obsolescence and equipment failure looms large, casting a shadow over critical domains such as laboratories, research centers, and IT infrastructure. This pervasive challenge stems from a confluence of factors, including limited resources, rapid technological advancements, and inadequate maintenance practices, which collectively impede the seamless functioning of academic and research activities. The ramifications of technological obsolescence and equipment failure reverberate throughout the academic ecosystem, manifesting in recurrent breakdowns, operational disruptions, and compromised research endeavors (Peek et al., 2020).

The repercussions of such failures are particularly pronounced in laboratories and research facilities, where precision instruments and cutting-edge technologies are indispensable for conducting experiments, analyzing data, and advancing scientific knowledge. Inadequate maintenance practices exacerbate these challenges, exacerbating the frequency and severity of equipment failures, and impeding the pursuit of scholarly excellence (Fresnoza, 2021). In light of these challenges, there exists an urgent imperative for public sector universities in Pakistan to embrace technology-driven maintenance approaches that transcend conventional reactive strategies. Proactive measures, such as predictive maintenance and condition monitoring, offer a viable pathway towards preemptively identifying and mitigating equipment failures before they escalate into debilitating disruptions. By harnessing the power of data analytics, sensor technologies, and predictive algorithms, universities can gain invaluable insights into the health and performance of their equipment, enabling them to schedule maintenance activities proactively, optimize resource allocation, and minimize downtime. Moreover, the adoption of technology-driven maintenance approaches holds the promise of transforming maintenance management into a strategic asset for universities, rather than a burdensome obligation (Sibiya, 2023). By leveraging real-time data and predictive analytics, institutions can transition from a reactive, break-fix mentality to a proactive, predictive maintenance paradigm, thereby enhancing operational efficiency, reducing costs, and ensuring the uninterrupted continuity of academic and research activities. Furthermore, embracing technology-driven maintenance approaches aligns with broader trends towards digital transformation and industry 4.0 principles, wherein data-driven decision-making and automation play pivotal roles in optimizing organizational performance and competitiveness. By integrating advanced technologies into maintenance practices, public sector universities can position themselves at the vanguard of innovation, fostering a culture of continuous improvement and excellence across all facets of their operations (Nwankwo & Chinedu, 2021).

In conclusion, addressing the challenges of technological obsolescence and equipment failure requires a concerted effort on the part of public sector universities in Pakistan to embrace technology-driven maintenance approaches. By leveraging predictive maintenance, condition monitoring, and other advanced technologies, institutions can proactively safeguard their equipment assets, enhance operational resilience, and uphold their commitment to academic excellence and research innovation in an increasingly dynamic and competitive landscape (Amaral et al., 2021).

Environmental Sustainability and Energy Efficiency

Promoting environmental sustainability and energy efficiency has emerged as a pressing imperative for public sector universities across the globe, reflecting a broader commitment to responsible stewardship of natural resources and mitigation of climate change impacts. Scholars, exemplified by the seminal work that fervently advocate for the integration of green maintenance practices as a

cornerstone of sustainable campus management strategies. These green maintenance practices encompass a diverse array of initiatives aimed at minimizing environmental impact, conserving resources, and optimizing operational efficiency, thereby fostering a culture of sustainability within university campuses.

Central to the adoption of green maintenance practices is the deployment of energy-efficient lighting systems, which represent a significant opportunity for reducing electricity consumption and curbing carbon emissions. By transitioning to LED lighting technologies and implementing smart lighting controls, public sector universities can achieve substantial energy savings while simultaneously enhancing illumination quality and occupant comfort. Furthermore, the adoption of daylight harvesting techniques and occupancy sensors can further augment energy efficiency by dynamically adjusting lighting levels based on natural light availability and occupancy patterns (Sharma et al., 2022). In addition to lighting upgrades, the incorporation of sustainable building materials holds immense potential for enhancing the environmental performance of university infrastructure. From renewable resources such as bamboo and reclaimed wood to energy-efficient materials like recycled steel and low-emission paints, the use of sustainable building materials can significantly reduce embodied carbon emissions and minimize the environmental footprint of construction projects. Furthermore, investments in high-performance building envelopes, such as triple-glazed windows and advanced insulation systems, can enhance thermal comfort, minimize heat loss, and reduce reliance on mechanical heating and cooling systems, thus further enhancing energy efficiency and operational resilience (Abdullah & Lim, 2023). The adoption of green maintenance practices not only aligns with institutional sustainability goals but also yields tangible benefits in terms of cost savings, operational efficiency, and reputational enhancement. By reducing energy consumption, minimizing waste generation, and promoting environmental stewardship, public sector universities can position themselves as leaders in sustainable campus management, attracting environmentally conscious students, faculty, and stakeholders. Furthermore, by demonstrating a commitment to environmental responsibility, universities can enhance their standing in sustainability rankings, attract funding opportunities, and contribute to the global transition towards a low-carbon, resource-efficient future (Hafez et al., 2023).

In conclusion, the adoption of green maintenance practices represents a transformative opportunity for public sector universities to advance environmental sustainability, enhance operational efficiency, and foster a culture of responsibility and innovation (Anwar et al., 2020). Through strategic investments in energy-efficient lighting systems, sustainable building materials, and holistic campus management strategies, universities can play a pivotal role in mitigating climate change, conserving natural resources, and shaping a more sustainable future for generations to come.

Stakeholder Engagement and Collaboration

In the intricate web of maintenance management within public sector universities, the importance of stakeholder engagement and collaboration cannot be overstated. It is within this collaborative framework that the seeds of operational excellence, efficiency, and innovation are sown, nurturing a culture of collective responsibility and continuous improvement. Drawing upon the insights the imperative of fostering robust stakeholder engagement and facilitating seamless collaboration emerges as a linchpin for optimizing maintenance processes and achieving overarching organizational objectives.

At the heart of effective maintenance management lie the diverse stakeholders who contribute their expertise, resources, and perspectives towards the common goal of ensuring the integrity,

functionality, and sustainability of university infrastructure. From university administrators who set strategic priorities and allocate resources to facility managers who oversee day-to-day operations, and from maintenance personnel who execute maintenance tasks with precision to external service providers who offer specialized expertise, each stakeholder plays a vital role in the maintenance ecosystem (Salimova et al., 2021). Central to the ethos of stakeholder engagement is the recognition that maintenance management is a collective endeavor that transcends individual roles and departments. It is through active engagement and collaboration that silos are dismantled, barriers are overcome, and synergies are harnessed to drive innovation and excellence. By fostering open channels of communication, promoting cross-functional collaboration, and cultivating a shared sense of ownership and accountability, public sector universities can unlock the full potential of their maintenance operations and realize tangible benefits in terms of efficiency gains, cost savings, and service quality improvement (Allal-Chérif et al., 2022). Furthermore, stakeholder engagement extends beyond internal actors to encompass external partners, including vendors, contractors, and community stakeholders. Collaboration with external service providers enables universities to tap into specialized expertise, access cutting-edge technologies, and leverage economies of scale to enhance the effectiveness and efficiency of maintenance activities. Moreover, engaging with local communities fosters mutual understanding, promotes social responsibility, and engenders goodwill, thereby enriching the university's reputation and strengthening its ties with the broader ecosystem (Pizzutilo & Venezia, 2021). Crucially, effective stakeholder engagement is underpinned by a culture of knowledge sharing, wherein insights, best practices, and lessons learned are disseminated across the organization. By cultivating a culture of continuous learning and improvement, universities can capitalize on past experiences, avoid recurring pitfalls, and adapt to evolving maintenance challenges. Furthermore, by investing in training and professional development programs, universities can empower stakeholders with the skills, knowledge, and competencies required to excel in their respective roles and contribute meaningfully to the collective success of the maintenance enterprise (Ramont, 2022).

In conclusion, stakeholder engagement and collaboration represent indispensable pillars of effective maintenance management within public sector universities. By fostering a culture of collective responsibility, open communication, and knowledge sharing, universities can harness the collective wisdom and expertise of stakeholders to optimize maintenance processes, enhance operational efficiency, and achieve overarching organizational goals. In doing so, universities can position themselves as leaders in sustainable campus management, driving innovation, excellence, and resilience in an ever-evolving educational landscape (Agwoje & Okeleke, 2023).

Overview of Public Sector Universities in Pakistan

Public sector universities in Pakistan serve as bastions of higher education, catering to a diverse and burgeoning student population aspiring for academic enrichment and professional advancement. These institutions stand as beacons of knowledge dissemination, offering a comprehensive array of academic programs spanning numerous disciplines, ranging from arts and humanities to science, engineering, and beyond. Through their multifaceted curricula and cutting-edge research initiatives, public sector universities play a pivotal role in shaping the intellectual landscape of the nation and contributing to its socio-economic development.

Central to the mission of public sector universities is the mandate to provide quality education and foster a culture of scholarly inquiry and innovation (Wright et al., 2022). Endowed with the responsibility of nurturing the minds of the future, these institutions endeavor to impart not only theoretical knowledge but also practical skills, critical thinking abilities, and ethical values that

equip students to thrive in an increasingly complex and interconnected world. Moreover, public sector universities are entrusted with the task of conducting groundbreaking research and generating new knowledge that addresses pressing societal challenges, drives technological innovation, and propels the nation towards the forefront of global competitiveness. However, the laudable aspirations of public sector universities are often met with formidable challenges, chief among them being the perennial issue of inadequate funding and resources (Amon et al., 2021). Despite their pivotal role in advancing the nation's educational and research agendas, public sector universities grapple with limited financial allocations from the government, which often fall short of meeting the escalating demands for infrastructure development, faculty recruitment, student support services, and research funding. As a result, these institutions are forced to contend with budgetary constraints that impede their ability to invest in critical areas such as infrastructure maintenance, facility management, and technological upgrades (Omodan, 2024). The repercussions of inadequate funding and resources reverberate throughout the fabric of public sector universities, manifesting in a myriad of infrastructure challenges that undermine their ability to fulfill their academic and research mandates. Maintenance of campus facilities, including buildings, laboratories, libraries, and recreational spaces, emerges as a pressing concern, as limited financial resources hamper the timely repair, renovation, and modernization of aging infrastructure. Moreover, inadequate funding exacerbates the strain on essential support services, such as security, transportation, and utilities, further complicating the task of maintaining a conducive learning environment for students and faculty (Millet, 2020). In the face of these challenges, public sector universities are compelled to adopt a pragmatic approach to infrastructure maintenance and facility management, prioritizing critical needs and maximizing the efficient utilization of available resources. This necessitates a judicious allocation of funds, strategic planning, and proactive maintenance practices aimed at extending the lifespan of existing infrastructure assets, optimizing operational efficiency, and mitigating risks of costly breakdowns and disruptions. Moreover, public sector universities must explore innovative financing mechanisms, forge strategic partnerships with the private sector and philanthropic organizations, and advocate for increased government support to address the systemic underinvestment in higher education infrastructure (Tomasko et al., 2023).

In conclusion, public sector universities in Pakistan occupy a central position in the nation's educational landscape, serving as crucibles of learning, innovation, and societal transformation. While they strive to uphold their commitment to academic excellence and research prowess, these institutions confront formidable challenges stemming from inadequate funding and infrastructure constraints (Ahmad et al., 2021). Nevertheless, through prudent financial management, strategic planning, and collective efforts by stakeholders, public sector universities can surmount these challenges and continue to fulfill their vital role in shaping the future of the nation. The comprehensive literature review conducted herein offers a nuanced understanding of the intricate landscape of maintenance management within public sector universities (Ameer, 2024). Through the elucidation of key challenges pertaining to infrastructure degradation, technological obsolescence, environmental sustainability, and stakeholder engagement, this review serves as a foundational resource for policymakers, administrators, and stakeholders vested in the sustained success of Sukkur's public sector universities.

Research Methodology

This research aimed to comprehensively explore maintenance issues in public sector university buildings within Sukkur, employing a quantitative survey methodology. This methodology was selected due to its capability to generate numerical data, facilitating rigorous statistical analysis.

Quantitative methodologies are widely valued for their ability to produce empirical evidence and generalizable findings. Smith (2018) and Nielsen et al. (2020) have emphasized the strength of quantitative methods in similar research domains, highlighting their utility in producing reliable and valid data.

The primary objective was to identify and categorize the most prevalent maintenance concerns within these university buildings in Sukkur. The initial phase involved an exhaustive literature review to document existing knowledge on building infrastructure maintenance issues, forming the foundation for the study. The literature review is a critical phase in research, providing context and identifying gaps (Creswell, 2021). It ensures that the study is grounded in existing scholarship and builds on previous findings.

Subsequently, a meticulously crafted survey instrument was developed based on the identified maintenance issues. This questionnaire was divided into two distinct sections. The first section captured respondent demographics, while the second section presented a comprehensive list of maintenance issues designed to pinpoint the most pervasive concerns, directly addressing the objective of the study. Effective survey design is essential for collecting accurate and relevant data. Creswell (2021) underscores the importance of constructing well-validated instruments to ensure research reliability and validity.

To ensure the instrument's validity and reliability, subject matter experts validated the questionnaire, followed by a pilot study to meticulously assess its reliability. The data from the pilot study resulted in a Cronbach's alpha value of 0.83, indicating good internal consistency and reliability according to the guideline of reliability (Creswell, 2021). Ensuring the validity and reliability of research instruments is crucial for the integrity of data. Moreover, the feedback from the pilot study was incorporated to refine the instrument before full-scale implementation.

Upon data collection, comprehensive analysis was conducted using the Statistical Package for the Social Sciences (SPSS). The objective of the study was addressed by calculating the mean and standard deviation, which helped in understanding the perception of respondents of the survey. The use of statistical software like SPSS is standard practice for analyzing quantitative data, facilitating accurate and efficient analysis. The calculation of mean and standard deviation is a common method to summarize data and interpret respondents' perceptions (Field, 2018).

By employing a quantitative survey methodology, the research effectively harnessed the strengths of statistical analysis to explore maintenance issues in public sector university buildings. This approach, supported by a robust literature base, ensures that the findings are empirical, reliable, and broadly applicable.

Data Collection and Analysis

The purpose of conducting the survey was to collect pertinent data aligned with the objectives outlined in this research study. The questionnaire developed for the study aimed to comprehensively explore the major maintenance issues in the public sector universities of Sukkur. The sample size, targeted respondents and the demographic of the respondents are discussed in the subsequent sections

Sampling Size

In the research study sample size is a selected numbers of research participants whom a researcher will get the information regarding the research topic. Random sampling techniques were meticulously employed to procure a representative sample from the population of interest in Sukkur's public sector university buildings. A total of 110 samples were collected for this study.

The determination of the sample size adhered to established methodologies for finite population sampling, employing formulas such as the Cochran formula ($n = N / (1 + Ne^2)$), where n represents the sample size, N signifies the population size, and e denotes the desired level of precision.

The total population of Aror University Sukkur amounts to 674 individuals, while the total population of Sukkur IBA University stands at 7641 as illustrated in table below:

Table 1: population of aror and sukkur IBA university

University	Students	Faculty	Staff	Total
Aror University	523	57	94	674
Sukkur IBA University	6716	250	675	7641
Total	7239	307	769	8315

Utilizing the sample size formula developed by Cochran, the determination of an appropriate sample size is given as under

$$n = \frac{N}{1 + Ne^2}$$

$$n = \frac{(8315)}{1 + (8315 * 0.1^2)}$$

$$n = 83.15 \cong 84$$

This methodological approach ensured the attainment of a statistically significant sample size, facilitating robust insights into prevalent maintenance issues within the specified context of public sector university buildings in Sukkur.

Demographic Information of the Respondent

A total number of 110 valid questionnaires were selected which were filled out by the concern respondents of the data within the universities of Sukkur Sindh.

Table 2: demographic characteristics of respondent's position/role

Demographic characteristic	Responses	Percentage
Student	75	68%
Faculty	14	13%
Staff	21	19%

Table 2 presents a detailed breakdown of the demographic characteristics based on the positions or roles of respondents. It delineates the participation of individuals belonging to different roles within the university context. Among the respondents, the highest participation rate was from students, totaling 75 responses, followed by faculty members with 14 responses, and staff members contributing 21 responses. This distribution translates to percentage participation of 68%, 12%, and 19%, respectively, for students, faculty, and staff roles.

Results and Discussion

Identification of Major Maintenance Issue

The study examined data collected from a total of 110 respondents to identify and analyze major maintenance issues prevalent among 30 distinct maintenance issues within the buildings of public

sector universities in Sukkur. Utilizing Statistical Package for the Social Sciences (SPSS) V-27 software, the acquired dataset underwent analysis. Descriptive statistics were organized in descending order based on their mean rank values. Maintenance issues with mean values equal to or greater than 3.5 were deemed significant and classified as major maintenance issues, as suggested by Memon et al., (2023). The resultant major maintenance issues observed within the buildings of public sector universities in Sukkur are delineated and presented in table 3.

This analytical approach allowed for a comprehensive examination of the maintenance concerns reported by respondents, enabling the identification and prioritization of significant issues. The utilization of SPSS software facilitated a systematic evaluation, enabling researchers to focus on major maintenance problems based on their mean rank values. By setting a threshold of 3.5 for significance, the study aimed to highlight the most critical maintenance issues faced within the buildings of public sector universities in Sukkur. The subsequent arrangement and presentation of these major issues in table provide a clear and structured overview, allowing stakeholders and researchers to understand and address these prominent concerns effectively within the university building maintenance framework.

Table 3: Maintenance issues in public sector universities of sukkur

Maintenance Issues in Public Sector Universities of Sukkur	Mean	Std. Dev
Fading or peeling paint on walls and ceilings	4.2205	.54027
Plumbing issues affecting water quality	4.2282	.48641
Lack of proper waste management and disposal systems	4.1256	.50257
Roof leaks or damage	4.1615	.55109
Water damage to ceilings and walls	4.0615	.50175
Plumbing leaks or damaged pipes	3.9487	.52589
Parking lot or road damage	3.9359	.49908
Outdated or failing fire sprinkler systems	3.7103	.59075
Broken or damaged classroom furniture (e.g., desks and chairs)	3.5974	.49254
Window and door damage or malfunction	3.5949	.51242
Structural damage (e.g., cracks in walls or foundation)	3.3692	.63804
Insufficient fire escapes or emergency exits	3.2692	.55063
Poor insulation causing temperature control problems	3.1923	.68486
Poorly maintained or damaged staircases	3.1795	.38624
Elevator breakdowns causing accessibility issues	3.1667	.37509
Inefficient or outdated heating and cooling systems	3.1410	.35030
Inadequate ventilation in classrooms or common areas	3.1282	.33648
Insufficient lighting in common areas and classrooms	3.1026	.34527
Fire safety system issues (e.g., malfunctioning alarms, extinguishers)	3.0897	.56260
Elevator maintenance problems (e.g., stuck or malfunctioning elevators)	3.0641	.81128
Leaky or damaged windows	3.0128	.54638
Mold or mildew growth	3.0046	.55829
Accessibility issues for individuals with disabilities (e.g., non-functional ramps or elevators)	2.9744	.45511
HVAC system malfunctions	2.9487	.88122
Broken or malfunctioning security systems (e.g., cameras, access control)	2.9103	.84031
Clogged or malfunctioning toilets and drains	2.8333	.79637
Electrical system problems (e.g., faulty wiring, power outages)	2.8205	.93619
Flooring issues (e.g., broken tiles, worn-out carpets)	2.6795	.98684
Pest infestations (e.g., rodents, insects)	2.5205	.79762

Table 4 presents a comprehensive overview indicating the existence of a total of 9 significant maintenance issues, each scoring 3.5 or higher on the measurement scale. It was established that factors exhibiting mean scores surpassing the threshold of 3.5 are deemed as major maintenance issues. The analysis conducted in this study identified 9 specific concerns within the dataset that met or exceeded this predefined criterion, signifying their critical importance within the context of building maintenance in the examined public sector universities of Sukkur.

Discussion on Major Maintenance Issues

The table 4 underscores the identification and classification of these 9 prominent maintenance issues. Each of these issues obtained a mean score indicative of their substantial impact or prevalence within the maintenance landscape of the university buildings. All the major maintenance issue identified from the study are discussed below:

Table 4: Major Maintenance Issues in Building of Public Sector Universities of Sukkur

Major Maintenance Issues in Building of Public Sector Universities	Rank
Fading or peeling paint on walls and ceilings	1
Plumbing issues affecting water quality	2
Lack of proper waste management and disposal systems	3
Roof leaks or damage	4
Water damage to ceilings and walls	5
Plumbing leaks or damaged pipes	6
Parking lot or road damage	7
Outdated or failing fire sprinkler systems	8
Broken or damaged classroom furniture (e.g., desks and chairs)	9

Fading or Peeling Paint on Walls and Ceilings

The issue of fading or peeling paint on the walls and ceilings within public sector universities in Sukkur significantly impacts the aesthetic appeal and upkeep of the infrastructure. This diminishes the overall ambiance of the learning environment and reflects poorly on the institution's maintenance standards.

From a theoretical perspective, principles of facility management and environmental psychology offer insight into this phenomenon. According to Maslow's Hierarchy of Needs, the physical environment plays a critical role in fulfilling the basic need for safety and security (Abbas, 2020). A well-maintained environment contributes to a sense of well-being and enhances the learning experience by reducing stress and distraction (Engineer et al., 2021). Furthermore, Herzberg's Two-Factor Theory suggests that inadequate physical conditions in the workplace can lead to dissatisfaction (Alshmemri et al., 2017). In educational institutions, maintaining the quality of the infrastructure is essential to prevent dissatisfaction among students and faculty, which can negatively impact their motivation and engagement.

Addressing this concern requires a comprehensive assessment of paint quality, application methods, and regular maintenance schedules to ensure a visually pleasing and conducive atmosphere for students and faculty (Ndou & Aigbavboa, 2023).

Plumbing Issues Affecting Water Quality

The occurrence of plumbing system issues, particularly those that compromise water quality within university premises, poses a grave concern (Kalan et al., 2021). It directly impacts the health and

well-being of occupants. Addressing this issue is crucial not only for maintaining health standards but also for ensuring a conducive learning environment.

From a theoretical perspective, the Health Belief Model (HBM) provides a useful framework for understanding the importance of addressing plumbing issues. The HBM posits that individuals are more likely to engage in health-promoting behaviors if they perceive a high level of threat from a health issue and believe that taking specific actions would reduce the threat (Abraham & Sheeran, 2005). In this context, regular inspections, repairs, and an overhaul of the plumbing infrastructure can be seen as actions that reduce the perceived threat of water contamination and its associated health risks.

Additionally, the theory of risk management highlights the necessity of identifying, assessing, and prioritizing risks to mitigate potential negative outcomes (Tummala & Schoenherr, 2011). Proactively addressing plumbing issues through water quality testing and adopting modern plumbing technologies exemplifies effective risk management. This approach not only mitigates health risks but also aligns with best practices in maintaining a safe and hygienic environment.

Moreover, Systems Theory, which emphasizes the interdependence of various components within an organization, underscores the importance of maintaining robust infrastructure systems (Haimes, 2018). Plumbing systems are a critical component of the overall infrastructure, and their failure can disrupt daily operations, thereby affecting the educational process. Ensuring the integrity of these systems through regular maintenance and modernization is essential for the smooth functioning of the university.

Implementing a proactive approach to plumbing issues involves regular inspections, prompt repairs, and the adoption of modern technologies to safeguard against water contamination. This strategy ensures a safe and hygienic environment, supports the overall well-being of students and staff, and contributes to a more effective and conducive learning environment (Kalan et al., 2021).

Lack of Proper Waste Management and Disposal Systems

The absence or inadequacy of efficient waste management and disposal systems in public sector universities within Sukkur is a pressing issue (Bhatti et al., 2021). Inadequate waste handling not only jeopardizes environmental sustainability but also poses health hazards within the campus vicinity (Mudu et al., 2021).

From a theoretical perspective, the principles of environmental psychology and sustainable development are highly relevant. The Theory of Planned Behavior (Ajzen, 1991) suggests that individuals' actions are guided by their intentions, influenced by attitudes, subjective norms, and perceived behavioral control. Implementing structured waste management protocols and recycling initiatives can foster positive attitudes and norms towards sustainability among students and staff, thereby promoting environmentally responsible behaviors. Moreover, the Transtheoretical Model of Behavior Change (Marshall & Biddle, 2001) highlights the stages of change individuals go through when adopting new behaviors. Universities can utilize this model to develop educational campaigns and interventions that guide students and staff through the stages of awareness, preparation, action, and maintenance of proper waste management practices.

The concept of Environmental Health, as outlined by the World Health Organization (WHO), emphasizes the direct impact of environmental conditions on human health and well-being. Inadequate waste management can lead to the proliferation of pests, the spread of diseases, and the contamination of natural resources, all of which negatively affect the health of the university community (Ejaz et al., 2010). Therefore, establishing and adhering to structured waste management protocols is crucial for mitigating these health risks.

Additionally, the principles of Sustainable Development, as defined by the Brundtland Commission, stress the importance of meeting the needs of the present without compromising the ability of future generations to meet their own needs. Efficient waste management and recycling initiatives contribute to environmental sustainability by reducing landfill waste, conserving resources, and minimizing pollution. This aligns with the broader goal of creating an environmentally conscious educational institution.

Establishing and adhering to structured waste management protocols, including recycling initiatives, proper segregation, and responsible disposal methods, is paramount. These practices cultivate a clean and healthy environment and foster a culture of environmental consciousness and responsibility within the university community. By addressing this issue, universities can contribute to the broader goals of public health and sustainable development (Phrohayak et al., 2024).

Roof Leaks or Damage

The prevalent issue of roof leaks or damage within the university buildings of Sukkur not only undermines the structural integrity but also poses risks to the safety of occupants and infrastructure. Timely roof inspections, routine maintenance, and prompt repairs are indispensable measures to mitigate water ingress, prevent further deterioration, and uphold the safety and functionality of the buildings (Olanrewaju et al., 2022).

From a theoretical perspective, the principles of preventive maintenance and safety management are highly relevant. The Reliability-Centered Maintenance (RCM) approach emphasizes the importance of preventive maintenance to ensure the reliability and safety of building infrastructure (Anderson & Neri, 2012). By conducting regular roof inspections and maintenance, universities can proactively identify and address potential issues before they escalate into major problems, thereby ensuring the longevity and safety of the buildings. The Risk Management Theory also highlights the importance of identifying, assessing, and prioritizing risks to mitigate potential negative outcomes (Haywood, 2022). Roof leaks can lead to significant damage, including mold growth, electrical hazards, and structural weakening. Implementing a proactive risk management strategy through regular inspections and prompt repairs can mitigate these risks and ensure a safe learning environment.

Furthermore, Systems Theory underscores the interdependence of various components within an organization (Burke & Morley, 2023). The roof is a critical component of the building's envelope, and its failure can have cascading effects on other systems, such as electrical and plumbing. Ensuring the integrity of the roof through routine maintenance and timely repairs is essential for the overall functionality and safety of the university buildings.

The application of Maslow's Hierarchy of Needs also provides a psychological perspective. The need for safety and security is fundamental, and a well-maintained physical environment contributes to the well-being and productivity of students and staff (Abbas, 2020). A leaking or damaged roof can create an environment of uncertainty and discomfort, which can negatively impact the educational experience.

Water Damage to Ceilings and Walls

The repercussions of water damage to ceilings and walls within the university premises in Sukkur are multifaceted. Not only does it compromise the visual appeal of the facilities, but it also engenders structural weakening and fosters an environment conducive to mold growth, potentially posing health risks (Zainab et al., 2023).

From a theoretical perspective, the principles of preventive maintenance and environmental health are highly relevant. The Reliability-Centered Maintenance (RCM) approach emphasizes the importance of preventive maintenance to ensure the reliability and safety of building infrastructure (Aziz, 2023). By implementing effective waterproofing measures, conducting timely repairs, and engaging in proactive maintenance, universities can prevent water ingress and subsequent damage, thereby preserving the integrity and safety of the buildings.

The Risk Management Theory highlights the importance of identifying, assessing, and prioritizing risks to mitigate potential negative outcomes (Hopkin, 2018). Water damage can lead to structural weakening, which poses safety hazards, and create conditions conducive to mold growth, which can adversely affect indoor air quality and health. A proactive risk management strategy involving regular inspections and timely interventions can mitigate these risks and ensure a safe environment for students and staff.

Moreover, the Theory of Environmental Health, as outlined by the World Health Organization (WHO), emphasizes the direct impact of environmental conditions on human health and well-being. Water damage and mold growth can lead to respiratory issues and other health problems (Acharya & Joshi, 2020). Ensuring effective waterproofing and timely repairs is crucial for maintaining a healthy indoor environment and safeguarding the health of the university community.

The principles of Systems Theory further underscore the interdependence of various components within an organization (Haywood, 2022). Water damage to ceilings and walls can affect other building systems, such as electrical and HVAC, leading to broader operational issues. Ensuring the integrity of these structural elements through regular maintenance and repairs is essential for the overall functionality and safety of the university buildings. Implementing effective waterproofing measures, timely repairs, and proactive maintenance are pivotal to curtailing water damage and ensuring a safe and aesthetically pleasing environment for academic pursuits (Britz, 2021).

Plumbing Leaks or Pipe Damage

The occurrence of plumbing leaks or pipe damage presents a significant challenge within the public sector universities in Sukkur, impacting the operational efficiency and safety of the premises (Mustafa, 2021). These issues lead to water wastage, potential structural damage, and disruptions in daily activities.

From a theoretical perspective, the principles of preventive maintenance and resource management are highly relevant. The Reliability-Centered Maintenance (RCM) approach emphasizes the importance of preventive maintenance to ensure the reliability and safety of building infrastructure (Mustafa, 2021). Regular plumbing inspections, immediate repairs, and potential system upgrades are essential strategies to prevent leaks and ensure the longevity of the plumbing system.

The Risk Management Theory highlights the necessity of identifying, assessing, and prioritizing risks to mitigate potential negative outcomes (Abdel-Basset et al., 2019). Plumbing leaks can cause significant water damage, leading to structural weakening, mold growth, and disruptions in the educational environment. Implementing a proactive risk management strategy through regular inspections and prompt repairs can mitigate these risks and ensure a safe and functional campus.

Furthermore, the principles of Sustainable Resource Management underscore the importance of conserving resources and minimizing waste (Tàbara & Pahl-Wostl, 2007). Plumbing leaks result in significant water wastage, which is both environmentally and economically unsustainable. Upgrading the plumbing system to more efficient and sustainable technologies can contribute to resource conservation and cost savings, aligning with broader sustainability goals.

The Systems Theory also emphasizes the interdependence of various components within an organization (Zainab et al., 2023). Plumbing systems are integral to the overall infrastructure, and their failure can affect other systems, such as water supply, heating, and sanitation. Ensuring the integrity of the plumbing system through regular maintenance and timely repairs is essential for the overall functionality and safety of the university buildings.

Additionally, the application of the Theory of Planned Behavior suggests that promoting awareness and positive attitudes towards regular maintenance and sustainable practices among the university community can enhance compliance and proactive behavior in reporting and addressing plumbing issues. Regular plumbing inspections, immediate repairs, and potential system upgrades are indispensable to prevent leaks, conserve resources, and maintain a conducive environment for educational pursuits (Salehi, 2022).

Parking Lot or Road Damage

The prevailing condition of damaged parking lots or roads within the university compounds in Sukkur impedes vehicular movement and compromises safety for pedestrians and vehicles alike. Urgent repairs, resurfacing, and structural enhancements are imperative to ensure safe and efficient transportation within the campus premises, fostering an environment conducive to learning and mobility (Abdelfattah, 2023).

From a theoretical perspective, the principles of infrastructure maintenance and safety management are highly relevant. The Theory of Preventive Maintenance emphasizes the importance of regular inspections and timely repairs to maintain the functionality and safety of infrastructure (Eti et al., 2006). Addressing parking lot and road damage through regular maintenance and structural enhancements can prevent accidents and ensure smooth transportation within the campus.

The Risk Management Theory also highlights the necessity of identifying, assessing, and prioritizing risks to mitigate potential negative outcomes (Abdel-Basset et al., 2019). Damaged roads and parking lots pose significant risks to both pedestrians and vehicles, potentially leading to accidents and injuries. Implementing a proactive risk management strategy involving urgent repairs and resurfacing can mitigate these risks and enhance overall campus safety.

Moreover, the principles of Urban Planning and Transportation Theory underscore the importance of designing and maintaining infrastructure that supports safe and efficient mobility (Rui & Othengrafen, 2023). Ensuring well-maintained parking lots and roads within the university premises contributes to a functional and accessible campus environment, which is essential for the daily operations and mobility of students, faculty, and staff.

Outdated or failing fire sprinkler systems within public sector universities in Sukkur pose a significant safety concern (Naqvi, 2022). Ensuring the reliability and functionality of fire safety equipment is paramount to safeguarding the lives of students, faculty, and staff. Regular inspections, necessary upgrades, and adherence to fire safety standards are essential to mitigate potential risks and uphold a secure learning environment (Salaheldin et al., 2021).

Broken or Damaged Classroom Furniture (e.g., desks and chairs)

The prevalent issues concerning classroom furniture, such as broken desks and chairs, adversely affect the comfort, productivity, and overall learning experience of students (Agyapong & Glalah, 2021). Timely repairs, replacements, and a structured maintenance regimen for furniture are pivotal in creating an ergonomic and conducive environment that facilitates focused and comfortable learning within the academic setting (Ratnasingam, 2022).

From a theoretical perspective, the principles of ergonomics and learning environment design are highly relevant. Ergonomics, the study of people's efficiency in their working environment, emphasizes the importance of designing and maintaining furniture that supports physical comfort and reduces strain (Hamidi, 2020). Ensuring that desks and chairs are ergonomic and in good condition can significantly enhance students' comfort and focus, leading to better learning outcomes. The Theory of Planned Behavior (Hagger et al., 2022) suggests that individuals' actions are guided by their intentions, which are influenced by attitudes, subjective norms, and perceived behavioral control. Providing well-maintained and comfortable furniture can foster positive attitudes toward the learning environment, thereby enhancing students' motivation and engagement. Moreover, the Self-Determination Theory (Standage & Ryan, 2020) posits that fulfilling basic psychological needs—such as the need for competence, autonomy, and relatedness—is essential for fostering intrinsic motivation. A well-maintained classroom environment with functional and comfortable furniture can contribute to students' sense of competence and support their intrinsic motivation to learn.

The principles of Facility Management also underscore the importance of regular maintenance and timely repairs to ensure the functionality and safety of the physical environment (Alexander, 1996). A structured maintenance regimen for classroom furniture can prevent disruptions in the learning process and create a stable and supportive environment for students. By incorporating these theoretical perspectives, the importance of addressing broken or damaged classroom furniture becomes evident. Timely repairs, replacements, and a structured maintenance regimen are critical not only for ensuring comfort and productivity but also for fostering a conducive learning environment that supports students' physical and psychological well-being (Ratnasingam, 2022).

Conclusion

This study was aimed to identify the major maintenance issues in building of public sector universities in Sukkur and assess the impact of major maintenance issues in on university environment and wellbeing of the stakeholders. This research concluded as the result of this objective of the study led to the conclusion that there is dire need of timely managing maintenance issues which will not only help in economic life of the buildings but also serves the improved university environment and stakeholder wellbeing and Nine major maintenance issues Fading or peeling paint on walls and ceilings, Plumbing issues affecting water quality, Lack of proper waste management and disposal systems, Roof leaks or damage, Water damage to ceilings and walls, Plumbing leaks or damaged pipes, Parking lot or road damage, Outdated or failing fire sprinkler systems, Broken or damaged classroom furniture (e.g., desks and chairs) have the highest mean value rank among the other factors and are considered major maintenance issues.

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