MAJ MALAYSIA ARCHITECTURAL JOURNAL

Malaysia Architectural Journal

Journal homepage:
https://majournal.my/index.php/maj
e-ISSN : 2716-6139

Sustainable Urban Cities: How to Design Livable Cities

Wajiha Siddiqui[1]*, Sadia Siddiqui[2], Muhammad Mehdi[3], and Muhammad Nafeel Qureshi[4]

[1]Lecturer at the Architecture Program, Department of Visual Studies, University of Karachi; and Associate Architect at WM Creative Studio – Relab, Pakistan
[2]Postgraduate student, Building Beyond Borders at Hasselt University, Belgium; and Research Associate at WM Creative Studio – Relab, Pakistan
[3&4] Adjunct Faculty at the Architecture Program, Department of Visual Studies; and Principal Architect at WM Creative Studio – Relab, Pakistan

ARTICLE INFO

Article history:
Received: 30 April 2024
Received in revised form
Accepted: 15 October 2024
Available online: 23 June 2025

Keywords:
City Density; Climate Change; Sustainable Housing Projects; Architecture Design Phases; Risk Management.

ABSTRACT

With over 55% of people living in cities worldwide, cities lack resources to cater to residents' basic needs. According to the UN-Habitat report, by 2050, around 68% of the world's population will live in cities. The population density of South Asian cities, like Karachi, is estimated at 5779 people per square kilometer. Notably, areas affected by extreme weather occurrences are home to over 65% of Karachi's population. The unprecedented development, mass migration, illegal settlements, and land mafias have resulted in the expansion of informal and lower-income housing complexes. This puts forth a question about the sustainability of cities and whether cities can cater to the demands of the ever-expanding population while fulfilling the requirements for sustainable development. Given that 80 percent of the population lives on lots that are 120 square yards or less, the quality of life is not desirable. The metropolis is among the least livable cities as per the Economic Intelligence Unit's Global Livability Ranking 2021. The huge housing demand overlooks livability when it comes to providing shelter to the urban poor. As a result, urban sprawl while resultant, does not serve the purpose. The continuous erosion of ecology and socially inappropriate housing complexes speak for themselves. Even though the demands of middle and upper-income groups are met by the architecture community, sustainability is catered at its face value. The essence of sustainability, which keeps social, economic, and ecological benefits in mind, is never taken into account for housing needs. This research analyzes the factors that can contribute to sustainable housing development without compromising on the ecology of the region, the social norms of the community, and the economic growth of the city. A mixed-methods approach examines the factors through multi-criteria decision-making methods to make the process efficient and consistent, and to achieve sustainable urban sprawl for livable cities.

* *Wajiha S. Mehdi*
E-mail address: wajiha.siddiqui@uok.edu.pk

1. Introduction

Human civilization for ease of living has exploited the natural environment, leading to the development of various developments serving as housing, workplaces, and social hubs. This continuous high demand for construction consumes 50% of non-renewable resources, earning itself the title of an industry that has sustainability as its least priority. The fact that construction industry is the major contributor to air *(Causes of Air Pollution from the Built Environment, 2019)*, water, and land pollution (23%,40%, and 50%, respectively) and the dominant negative player in climate change (50%), it needs to opt for sustainable ways to mitigate the damage *(Willmott Dixon, 2010; IEA et al., 2022)*. Globally, the construction sectors are the biggest industries that are projecting an increase in both emissions and energy use. The 2019 Global Status Report for construction indicates building sector emissions increased by 2% from 2017 to 2018 and energy consumption in 2018 increased by 1% from 2017. As a result, more action is required to reduce emissions and deliver a low-carbon, sustainable built environment *(Global Alliance for Building and Construction et al., 2019).*

In addition to the impact on the environment, the construction sector is significant for social and economic development in meeting sustainable objectives. The construction industry provides cost-effective and culturally enrooted solutions to uplift communities, even creating various job opportunities and facilitating industries, eventually contributing to GDP growth *(Chileshe, 2011; Rafindadi et al., 2014)*. In Pakistan, urban areas are experiencing unprecedented demand for housing crises. According to the "Asian Coalition of Housing Rights", there was a 350000 shortage of urban housing in 2017 based on the census. 62% of the population belongs to lower-income groups, 25% to lower-middle-income, and 10% to upper-middle-income groups. An estimated 150,000 units are supplied and demanded annually *(Hasan & Arif, 2018)*. Karachi, currently ranked seventh in the world *(Cox, 2015),* has one of the fastest rates of population growth when it recorded a 115% increase in population from 1998 to 2011, reaching 21.2 million *(Cox, 2012).* According to *(Hasan, 2015),* there is a need for about 120,000 homes annually, of which 42,000 are for the formal sector and 32,000 are for the informal sector. The rapidly growing housing demand results in unplanned development and unstable practices, which are disrupting ecology and exploitation of natural resources *(Cengiz, 2013).* Such unsustainable development can be seen in the shape of urban floods, unprecedented heatwaves, and deaths of those living in informal settlements *(Durrani et al., 2016; Aslam et al., 2021).*

This research focuses on ecological preservation, livability, economic growth, and maintaining the integrity of social values while aiming to address issues related to urban housing projects *(Tang & Lee, 2016).* The main aim is to identify and analyze the impact of critical factors in the architecture design phase as in this phase decisions are taken not only for the construction phase but for the whole project life cycle *(Othman & Abdelwahab, 2016),* to mitigate risk factors and integrate sustainability into housing development for fostering sustainable urban sprawl and designing livable cities.

1.1 Problem Statement

The WMO's 2020 report has highlighted anthropogenic climate change as a primary cause of extreme weather disasters by UN Secretary-General Antonio Gutterres *(World Meteorological Organization, 2021)*. Even the Institute of Economics & Peace indicates that 1.2 billion people will migrate by 2050 due to climate change *(Institute of Economics & Peace, 2020).* The challenges caused by the pandemic, Pakistan's real estate market continues to thrive, which leads to environmental damage like the destruction of mango orchards *(Haq, 2021).* Urban sprawl is a key factor in climate disasters and energy crises, resulting in 8% of global carbon emissions from the emissions of steel and concrete production *(Ghoneim et al., 2022).* Although the architects are just a few (0.03 per thousand head of the Pakistani population), even those do not serve the masses as the public sector does not invest enough for the housing of the lower income groups *(State of Architecture & Town Planning Profession in Pakistan PCATP, 2020).* To ensure sustainable housing development, identify and mitigate risks in the initial stages of the project lifecycle, resulting in sustainable practices to develop livable cities. Lifecycle, resulting in sustainable practices to develop livable cities.

1.2 Research Objectives

The main objective of the research is to cultivate sustainable design to achieve sustainable urban sprawl by identifying and mitigating critical factors in the initial stage of the project life cycle in Pakistan.

2. Literature Review

The continuous rise of housing development despite its harmful impact on the environment, is due to its significant contribution to the financial sector. Owning a house or multiple homes is considered a lucrative investment. It cannot be neglected that besides becoming a means to provide shelter, the industry also opens a lot of economic and livelihood opportunities for the people. However, one cannot turn a blind eye to the environmental degradation caused by the construction industry, that is, pollutes 50% of drinking water, exploits 60% of materials and resources available, and consumes 50% of energy as well *(Willmott Dixon, 2010; IEA et al., 2022).*

Sustainable alternatives need to be explored by mitigating critical factors by integrating risk management into the project life cycle. Given the fact that Pakistan has a shortage of housing of at least 12 million, housing is the most lucrative medium for the construction industry to invest in *(Jabeen et al., 2015; Naya Pakistan Housing Program, 2022)*. However, the lack of transparency in the sector has led to corruption as well as unprecedented growth. In the last few years, one can see a rise in housing schemes, malls, and also informal settlements *(Real Estate Market in Pakistan: Growing beyond Regulations, 2016)*. Often violating regulations and neglected infrastructure such as water supply and gas. Not just in Karachi, but cases of illegal or non-approved housing schemes are common throughout Pakistan *(Capital Development Authority, 2021).*

To ensure that the greed for profitability does not sow seeds for unsustainable housing projects, inculcating risk management in an earlier stage of the design process is essential *(Othman & Abdelwahab, 2018)*. A detailed review of the design process will aid in developing the understanding as to where in the design phase should risk management be implemented to reap its full benefits when it comes to sustainable housing projects.

2.1 *Architecture Design Process for Housing*

Before understanding the whole process of architectural design, a basic understanding of the Architecture Design Process for Housing *(Chintis, 2019)* is necessary as the research is more focused on Risk Management implementation in the Housing sector.

One of the reasons for housing over the rest of the construction sectors is attached to its usage. Commercial sectors are not accommodated 24/7, whereas homes are inhabited always and have a significant impact on the social, psychological, and physiological well-being of the inhabitants.

The Architecture Design Process is a lot similar to what is written below only with a few differences.

i. Before the design phase even starts, the client/s are informally enquired about their requirements, expectations, and needs.
ii. A detailed brief is designed based on all requirements, such as the number of bedrooms needed, the kind of environment they want to live in, and their additional requirements in case the house will have differently able member/s or if they want a certain space that caters to their religious rituals.

iii. The brief is then cross-checked by the client/s and then a conceptual sketch or initial ideation drawing is submitted *(Wardah & Khalil, 2016).*

iv. On approval and further consultation with the client/s, the architect is then required to make a contract, spatial specifications, technical drawings BOQs, dates of deliverables, and design/consultation fees and schedule.

v. Unlike commercial construction projects, housing projects are usually dealt with on a person-to-person basis, that is, the contracts usually do not have very stringent rules as most people deal informally with housing projects. The informal nature of housing dealings makes it a very vulnerable construction sector and that is why it is easily exploited as well.

2.2 Project life cycle

The project reaches its conclusion after going through several, well-planned phases. These phases are dependent on the decisions that are always made earlier on in the project. An initial idea initiates a project which gets developed over time. While each project has its phases or follows a certain life cycle, the Royal Institute of British Architects (RIBA) has defined 7 stages, in the Plan of Work 2020 *(RIBA, 2020),* that could work as a guideline for any project as per Fig 1.

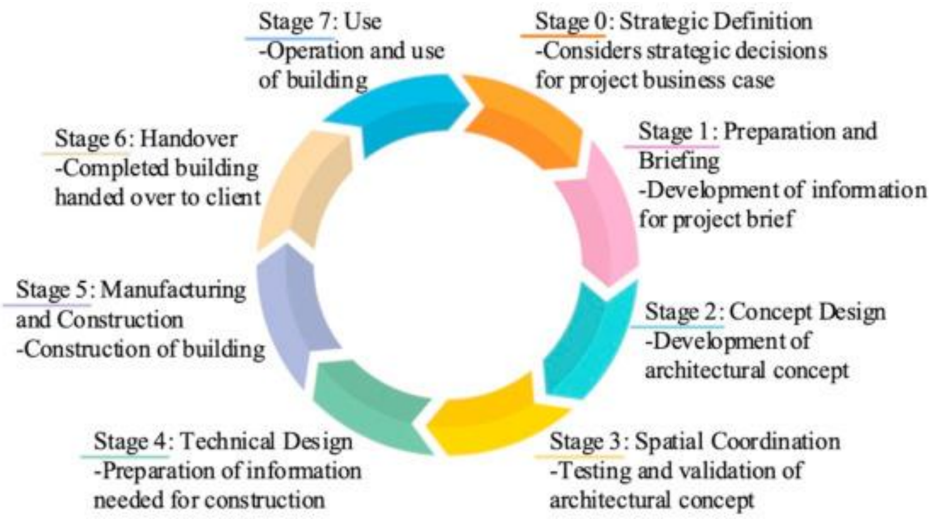

Fig. 1 Project Life Cycle Assessment in Building Design Process by RIBA

The most basic phase is the understanding of the client's requirements. After concluding the requirements, the first phase is to prepare a brief whereby the outcomes of the project and its sustainability, a budget, their aims, and their requirements regarding the space are stipulated. Further, surveys are conducted and feasibility reports are formulated with details of the site survey, project execution and budget, and the program of the project. The architectural design concept is the second stage of the process whereby a conceptual design is formulated keeping in mind the requirements of the client and the instructions set by the project brief *(Chintis, 2019).* During this phase, the brief is developed further, aligning it with the practicalities and requirements of the client. The third stage is where spatial coordination is carried out both architecturally and structurally. The project advances to the technical stage after this, in which the technical details regarding the construction are to be finalized. Construction and manufacturing begin after the technical design phase after which the design takes a physical form and is handed over to the client concluding the contract of the project. The last stage is the usage and maintenance of the project.

While these seven stages clearly outline the whole process of the design phase, the main stages of these 7 are concept design, spatial coordination, and technical design.

2.3 Sustainability

According to USEPA, Sustainability is defined as a way through which nature and humans can coexist without burdening the environment to ensure a safer and healthier future for the upcoming generations *(Sustainability and the U.S. EPA, 2011*). Though it is believed, that sustainability is more than just "environmentalism". While resources that are utilized or consumed by humans are directly or indirectly related to ecology, sustainability is also dependent on social and economic means.

The fact that real estate consumes the most water, energy, and raw materials and blatantly adds to the pollution and environmental degradation and still does not prioritize sustainability in their projects calls for scrutiny of the sector. To grasp sustainability concerning housing, one needs to understand the Quadruple Bottom Line (QBL), a framework of sustainability that studies or analyzes the sustainability of the project on 4 dimensions; Social, Economic, Environmental, and institutional *(Mironiuc et al., 2021).* Observing the consequences of the construction industry in general and the housing sector in particular, the seeking "Sustainable Development Goals (SDG)" to mitigate the harmful effects of development on ecology, create equitable societies, and curb income inequality *(United Nations Department of Economic and Social Affairs, 2018).* The depletion of natural reserves, the contamination of water resources, the encroachment of lands for food and housing needs, and the overburdening of the earth with pollution are pieces of evidence enough to show the unsustainable lifestyles of humans. Now that the negative impact of human practices is creating unsustainable communities, it is the need of the hour to find ways to lessen the adverse effects of the damages that have already been done.

2.4 Risk Management Process

Before understanding the process of risk management, it is necessary to understand what risk is. Risk can be of 2 types, one that is measurable or calculated, therefore it can be mitigated as the solution can be found beforehand, while the other is the one difficult to identify, for example, an unforeseeable natural calamity.

The risk management process should be inculcated from the very start of the project. From conceptualization to implementation, during the construction to the acquisition, from occupancy to post-construction maintenance, the risk management process should be part of the complete project cycle.

Risk is not strictly focused on monetary loss or economic constraints but the risk management process of architecture will keep the health, environmental, and social problems in check as well *(Arc. Agoha & Basil Onyekozuru, 2019).*

In the past risk was focused primarily on financial matters such as investment to gain a return. Construction too involves financial investments, some parts of the construction industry do focus on risk management but that focus is limited and superficial.

The risk management process has its stages. Firstly, the risks are identified and analyzed. Assessment of the exposure to that risk is made and a category is assigned as per the degree of that risk. Further, the approach to tackle the risk and how intense it is measured. The solution to mitigate it and its response is calculated. The probability of its recurrence is calculated and it is monitored throughout the project life cycle.

2.5 Conceptual Framework

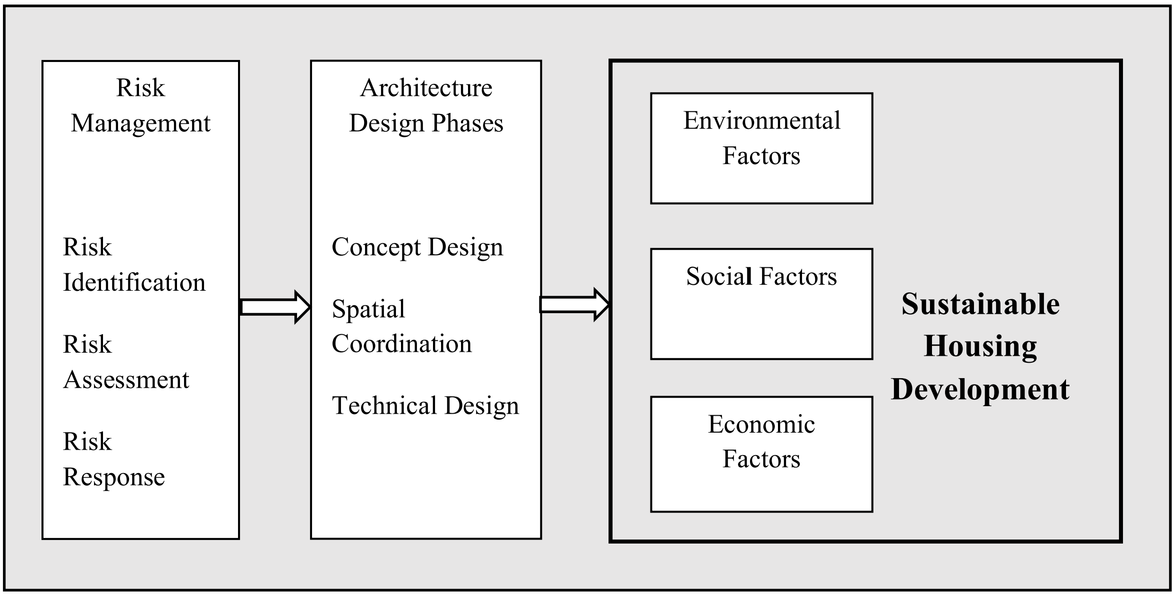

Figure 2 Conceptual Framework

3. Methodology

In this research, a mixed research methodology is used to collect and evaluate the data for the findings of the research. The mixed method approach assists researchers with diverse research method approaches and engages in multiple research techniques to acquire answers to the research question *(Mackey & Bryfonski, 2018)*. In this research, before the quantitative research methodology is applied, qualitative is used to select the participants for this study.

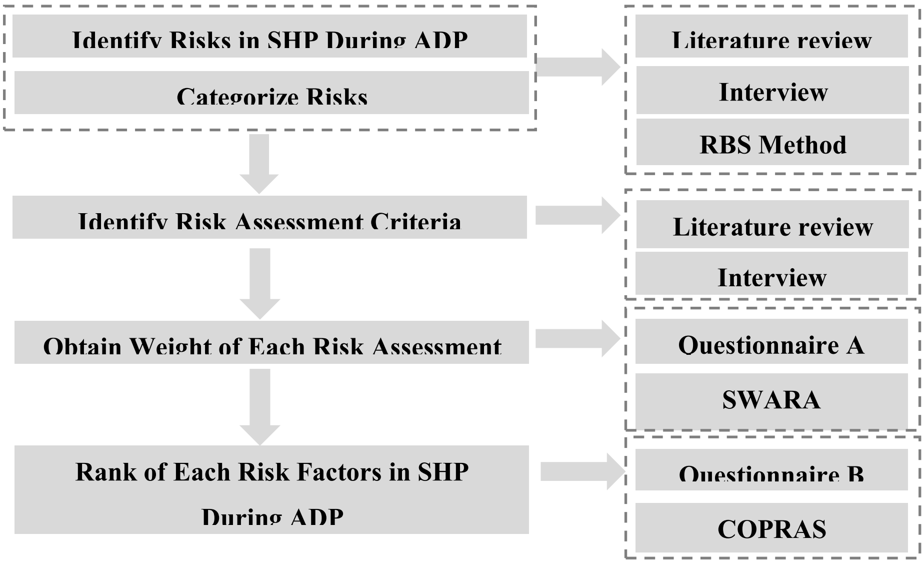

Figure 3 Research Methodology

Fig.3 explains the research methodology in 4 main parts which are further data that has been gathered and analyzed.

3.1 Identification and Categorization of Risks: Literature, Interview and RBS

The Risk Breakdown Structure in Table 1. is developed through literature review and experts' opinion. And categorized into 3 categories concept design phase, spatial coordination, and technical design.

Table 1: Classification of the key risks affecting sustainable housing projects during the design process according to SDGs

Risk ID	Risk Grouping	Risks Identification	Economic	Social	Environmental	Reference and Explanation according to sustainability
CD1001	Concept Design Phase	Land Selection	X	X	X	Ensuring that the land selected is not illegally acquired nor comes under protected lands (Hasan & Arif, 2018)
CD1002		Site Analysis/ Documentation	X	X	X	Documenting the surroundings and keeping climatic conditions in check (Jackson, 2002; Othman & Abdelwahab, 2018)
CD1003		Social Inequality	X	X		Inclusivity is a necessity. Encroachment of land, segregation, poor infrastructure, and environmental quality, are all these factors that breed social inequality (Winston & Pareja Eastaway, 2008; Hasan & Arif, 2018)
CD1004		Public Objection	X	X	X	In most cases, the public is the stakeholder, therefore public participation is imperative for sustainable development (A. A. E. Othman & Abdelwahab, 2018).
CD1005		Incomplete environmental analysis			X	For humane, sustainable development, the environment is the most important aspect. Incomplete environmental analysis will jeopardize the design (Aslam et al., 2021; A. A. E. Othman & Abdelwahab, 2018; Winston & Pareja Eastaway, 2008)
CD1006		Lack of consideration of environmental requirements	X	X	X	With artificial means of controlling the air ventilation system, the environment is the least concern. In reality, negligence toward environmental requirements is neither cost-effective nor a healthier alternative (Aslam et al., 2021; A. A. E. Othman & Abdelwahab, 2018; Winston & Pareja Eastaway, 2008).
CD1007		Poorly defined design brief	X	X	X	The design brief should be thoroughly designed, respecting clients' needs, environmental considerations, available costs, and the laws. As detailed the brief will be, the easier will be the implementation process will be the changes (Jackson, 2002)
CD1008		Absence of communication/ coordination between the govern	X	X		Redundant rules and regulations often cause compromise on the sustainability of the projects. The laws should be updated about the changing times and requirements of the built environment (A. Othman & Abdelwahab, 2016)

CD1009		Not updated B- laws	X	X	X	By-laws are taken for granted. Most bylaws are outdated and need revision but due to a lack of communication, laws get compromised (Rietz et al., 2020)
SC1001	Spatial Coordination Phase	Non-compliance with by-laws and building codes & standards	X	X	X	Lack of accountability results in the non-implementation of by-laws and building regulations (Ching & Winkel, 2021).
SC1002		Commissions for Approval	X	X		By ignoring bylaws, firms have to pay an added commission to get their designs approved, thus an added cost burden as well as an illegal option to regularize construction (Siddiqui et al., 2020).
SC1003		Lack of coordination between design participants	X	X		All participants in the designs should work cohesively to avoid discoordination which can result in a flawed design (A. A. E. Othman & Abdelwahab, 2018).
SC1004		Failure to develop design according to client brief	X	X	X	Everyone on the team should be familiar with the design requirements of the clients, if the team and clients will not be on the same page, it will result in dissatisfaction with the client (Siddiqui et al., 2020)
SC1005		Inadequate design development	X	X	X	Thorough design development will result in an efficient design and construction process. Inadequacy in design development will rely on the trial and error method, thus adding cost, and not considering sustainability (Jackson, 2002).
SC1006		Uncoordinated and inadequate design documents	X	X		Design documents should include all documents related to by-laws, building authority requirements, and all phases of design. Negligence toward any of the stated documents can cause one to modify the design in later stages (Jackson, 2002; A. A. E. Othman & Abdelwahab, 2018).
SC1007		Lack of passive design consideration for environmental conditions	X	X	X	Dependence on artificial means of ventilation has done a considerable amount of damage to the environment and the well-being of the inhabitants. Design should encourage passive solutions (Bakar et al., 2009; Chohan et al., 2015).
SC1008		Less consideration in planning to accessibility to amenities (shops, school, market, parking lots, playground/park)		X	X	Amenities should be accessible, preferably by walk, to curb the transportation cost and discourage vehicular movement. (Bakar et al., 2009; Chohan et al., 2015)
SC1009		Lack of consideration in the design process for accessibility (pedestrian/vehicular)	X	X	X	Both, pedestrian and vehicular movement should be taken into consideration for easier circulation (Chohan et al., 2015).
SC1010		Lack of design consideration of energy-efficient	X	X	X	Both active and passive energy systems should be inculcated in design to reduce cost and aid the environment (Chohan et al., 2015).
SC1011		Lack of design consideration of biodiversity in open spaces/ landscape		X	X	The disruption of biodiversity is an environmental hazard, design should be inclusive of nature for emotional and health well-being (Chohan et al., 2015)

SC1012		Lack of design consideration for the disposal	X	X	X	Waste management is imperative for the design, not making it a part of the design can turn open areas into dumping grounds (Chohan et al., 2015).
TD1001	Technical Design Phase	Affordability gap	X	X		Consideration of clients' budgets is necessary. While sustainability is important, the choice of material, design, and construction techniques should not overrun the defined budget of the client/stakeholder (Hasan & Arif, 2018; Mitlin, 2001).
TD1002		Design changes by the client	X	X		Briefs should be comprehensive, failing to do so will result in multiple changes by the clients which can add to the cost (Jackson, 2002; A. A. E. Othman & Abdelwahab, 2018)
TD1003		Design variations by the architect	X			If the brief is well formulated, it is less likely to have changed in the future. Ambiguous briefs can cause design variations by the architects, increasing the cost of the project (Jackson, 2002; A. A. E. Othman & Abdelwahab, 2018).
TD1004		Design errors and omissions	X	X	X	Project management should be inculcated in the designing of the brief phase; not doing that can cause errors and omissions in design (Hyun et al., 2020; A. A. E. Othman & Abdelwahab, 2018)
TD1005		Skill gaps in design team performance	X	X	X	If the hired team lacks knowledge regarding sustainable development and how it can be implemented in the projects. (Jackson, 2002; A. A. E. Othman & Abdelwahab, 2018).
TD1006		The design process takes longer than estimated	X	X		As the contract does not always specify a practical time frame, resulting in an unnecessary financial burden (Jackson, 2002; A. A. E. Othman & Abdelwahab, 2018).
TD1007		Time Limits-Tight schedule	X	X	X	A realistic time frame should be designed and followed, otherwise, it will not be economically feasible (Jackson, 2002; A. A. E. Othman & Abdelwahab, 2018).
TD1008		Design cost overruns	X	X		Choice of materials, labor, design team, construction team; all forms of expenses should be included in cost estimation to avoid design cost overrun (Jackson, 2002; A. A. E. Othman & Abdelwahab, 2018)
TD1009		Stakeholders Change project requirements at a later stage	X	X	X	Design requirements should be finalized during the design process, any change during later stages will increase cost, and cause waste of materials and time (A. A. E. Othman & Abdelwahab, 2018).
TD1010		Outdated specification-materials and technology	X	X		Updates in techniques and material expertise are compulsory for smooth design and construction processes (A. A. E. Othman & Abdelwahab, 2018).
TD1011		Commercial pressure and contractor selection	X	X		Instead of following the tender process for the selection of a contractor, opting for a contractor who is acquainted (Jackson, 2002).

3.2 Identification and Categorization of Risks: Literature, Interview and RBS

The identified risk assessment criteria in Table 2. were developed through a literature review and further validated by experts' opinions.

Table 2. Risk Assessment Criteria

Risk Assessment Criteria	Description	
C1: Threat	A threat is described as an occurrence that could harm a project's goal (time, cost, quality). (Jaber, 2019; Valipour et al., 2017)	Cost (–)
C2: Consequence	Consequence is the effect of an incident or occurrence (Jaber, 2019; Valipour et al., 2017)	Cost (–)
C3: Risk Uncertainty	Knowledge about the nature of the probability distribution function of risk measures is scarce. (Jaber, 2019; Valipour et al., 2017)	Cost (–)
C4: Reaction against an event	The ability to respond appropriately to mitigate. (Jaber, 2019; Valipour et al., 2017)	Benefit (+)
C5: Risk probability	The degree of the likelihood of the risk occurrence (Jaber, 2019; Valipour et al., 2017)	Benefit (+)
C6: Risk manageability	The extent to which a risk can be managed and controlled. (Jaber, 2019; Valipour et al., 2017)	Benefit (+)

3.3 Weighing/Prioritizing the Criteria identified: SWARA Method

The identified risk is given ranking through SWARA (Stepwise Weight Assessment Ratio Analysis), to assess risk it needs to be prioritized through risk criteria *(Zolfani & Šaparauskas, 2013; Valipour et al., 2017)* The questionnaire survey is conducted to obtain weight for each criterion.

i. Calculate the coefficient values (kj): $kj = (Sj + 1)$

ii. Determine the recalculated weight(qj): $qj = \frac{kj-1}{kj}$

iii. Calculate the relative weight (wj): $wj = \frac{qj}{\sum qj}$

3.4 Ranking of the Identified Risks: COPRAS

To identify each risk impact on the sustainable housing project ranking is developed through COPRAS (Complex Proportional Assessment Method), which is useful with a maximum number of criteria and within a single evaluation, addressing both qualitative and quantitative issues and problems *(Valipour et al., 2017)*. The questionnaire survey was shared by experts to meticulously gauge the identified risk concerning the identified criteria.

i. Sum of Weighted Normalized Decision Matrix:

$S + i = \sum yij +$ Sum of Beneficial

$S - i = \sum yij -$ Sum of Non-Beneficial

ii. Determine the Relative Significance of alternatives: $\boldsymbol{Qi} = \boldsymbol{S} + \boldsymbol{i}\frac{(s-min)(\sum S-i)}{Si\sum(\frac{S-min}{S-i})}$

iii. Calculate Quantitative Utility: $\boldsymbol{Ui} = \left[\frac{Qi}{Qimax}\right] \times \mathbf{100}$

4. Result and Data Analysis

In Table 3 It shows the responses are collected from registered architects, engineers, contractors, project managers, and academics. The results show the majority of the respondents had an education standard of under graduation or higher which indicates the results' credibility.

Table 3: Demographic Profile of Respondents

Demographic Profile of Respondents	Frequency	%
Organization		
Construction Industry	113	87%
Academic	17	13%
Position		
Architect	59	45%
Engineers	20	15%
Project Managers	13	10%
Builders/Contractors	10	8%
Academic	17	13%
Others (Design Team & Site Supervisors)	11	8%
Qualification		
Post Graduate	3	2%
Graduate	33	25%
Under Graduate	86	66%
Diploma	8	6%
Intermediate or 'A' Level	0	0%
Metric or 'O' Level	0	0%
Work Experience (Yrs)		
0-5 (Yrs)	22	17%
6-10 (Yrs)	34	26%
11-15 (Yrs)	54	42%
16-20 (Yrs)	13	10%
21 & above (Yrs)	7	5%

4.1 Respondents' Work Experience

The responses collected were mainly from the construction industry 87% (113 respondents) and others were academic 13% (17 respondents). Figure 4 shows the majority have experience in the housing sector and are mostly involved in single-unit housing followed by multi-housing prototypes. 11 and above years had to experience apartment and housing schemes. The result indicates respondents' expertise in the housing sector and the information offered by them can be regarded as genuine and trustworthy.

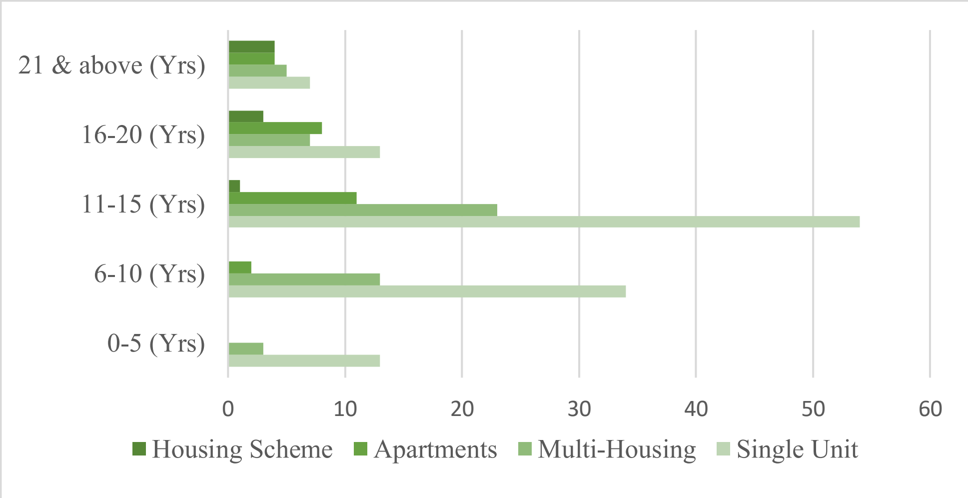

Figure 4 Respondents' Work Experience in the Housing Sector

4.2 Weighing/Prioritizing the Criteria identified: SWARA Method

The risk assessment criteria were identified from the literature review and categorized as beneficial and non-beneficial confirming it by taking experts' opinions. In total 7 risks were identified of which 3 were beneficial (benefit), that is C4, C5, and C6, and 3 were non-beneficial (cost), which were C1, C2, and C3, which ranked, and each risk weight obtained to be specific after applying SWARA method, shown in Table 4. Further SWARA method is applied to obtain weight for each risk assessment criterion through survey questionnaire A, respondents rank the importance of each criterion based on their experience. This outcome is generated on experts' feedback and shown in Table 4. that shows out of 6, the top 3 highest risk criteria are 0.1774, 0.1726, and 0.1722 are Threat (C1), Risk Probability (C5) and Consequences (C2) followed by 0.1663, 0.1597, and 0.1519 which are Risk Manageability (C6), Risk uncertainty (C3) and reaction against an event (C4), respectively.

Table 4. SWARA method to weight/prioritize each risk assessment criteria

Risk Assessment Criteria	**Comparative importance of average value Sj**	**Coefficient kj**	**Recalculated qj**	**Weight *wj***	**Rank**
C1:Threat	0.5192	1.5192	0.3418	0.1774	1
C5: Risk Probability	0.4981	1.4981	0.3325	0.1726	2
C2:Consequences	0.4962	1.4962	0.3316	0.1722	3
C6:Risk Manageability	0.4712	1.4712	0.3203	0.1663	4
C3:Risk Uncertainty	0.4442	1.4442	0.3076	0.1597	5
C4: Reaction Against Event	0.4135	1.4135	0.2925	0.1519	6

4.3 Ranking of the Identified Risks: COPRAS Method

The risk has been identified through a literature review as shown in table 1 and further, these identified risks are thoroughly classified in the risk breakdown structure based on literature review and interviews with experts. A total of 32 architecture design risks were identified for sustainable housing development and grouped into 3 categories through experts' opinions. The risk assessment criteria determined and assessed the outcome in table 5 and 6 are applied in the COPRAS method to develop risk factors ranking. The survey questionnaire B was distributed to respondents to evaluate risk factors on each criterion. The beneficial criteria are maximized while non-beneficial criteria are minimized. In table 5 the sums of the weighted normalized values $S + i$ indicate beneficial and $S - i$ for non-beneficial criteria.

Table 5 COPRAS method shows the sum of weighted normalized values of beneficial and non-beneficial values

Risk ID	$S + i$	$S - i$
CD1001	0.0120	0.0063
CD1002	0.0075	0.0070
CD1003	0.0076	0.0118
CD1004	0.0049	0.0070
CD1005	0.0102	0.0045
CD1006	0.0121	0.0042
CD1007	0.0111	0.0064
CD1008	0.0089	0.0083
CD1009	0.0077	0.0058
SC1001	0.0096	0.0067
SC1002	0.0063	0.0070
SC1003	0.0137	0.0095
SC1004	0.0094	0.0074
SC1005	0.0107	0.0102
SC1006	0.0056	0.0067
SC1007	0.0096	0.0058
SC1008	0.0122	0.0111
SC1009	0.0089	0.0092
SC1010	0.0146	0.0099
SC1011	0.0119	0.0105
SC1012	0.0102	0.0086
TD1001	0.0077	0.0102
TD1002	0.0063	0.0073
TD1003	0.0104	0.0089
TD1004	0.0121	0.0101
TD1005	0.0092	0.0067
TD1006	0.0095	0.0070
TD1007	0.0118	0.0080
TD1008	0.0129	0.0092
TD1009	0.0105	0.0137
TD1010	0.0120	0.0098
TD1011	0.0078	0.0118

In table 6. The priority value or relative significance value Qi is determined. Further, calculated quantitative utility Ui for each risk factor to determine to rank. In Figure 4. Shows the Relative significance of the top ten risks in ADP for SHP which is explained later through a case study of the Naya Nazimabad Pakistan housing project.

Table 6. COPRAS method showing the rank of significant risk factors in sustainable housing projects

Risk Grouping	Risk ID	Risks Identification	Relative Significance Qi	Quantitative Utility Ui	Rank
Concept Design Phase	CD1001	Land Selection	0.02216	80.51%	3
	CD1002	Site Analysis/ Documentation	0.01665	60.48%	23
	CD1003	Social Inequality	0.01309	47.55%	32
	CD1004	Public Objection	0.01410	51.22%	29
	CD1005	Incomplete environmental analysis	0.02456	89.22%	2
	CD1006	Lack of consideration of environmental requirements	0.02752	100.00%	1
	CD1007	Poorly defined design brief	0.02122	77.10%	4
	CD1008	Absence of communication/ coordination between govern	0.01666	60.53%	22
	CD1009	Not updated B- laws	0.01885	68.50%	11
Spatial Coordination	SC1001	Non-Compliance with by-laws and building codes & standards	0.01920	69.74%	10
	SC1002	Commissions for Approval	0.01551	56.35%	25
	SC1003	Lack of coordination between design participants	0.02049	74.44%	7
	SC1004	Failure to develop design according to client brief	0.01808	65.67%	16
	SC1005	Inadequate design development	0.01700	61.76%	21
	SC1006	Uncoordinated and inadequate design documents	0.01516	55.08%	27
	SC1007	Lack passive design consideration for environmental conditions	0.02073	75.31%	6
	SC1008	Less consideration in planning for accessibility to amenities	0.01800	65.40%	18
	SC1009	Lack of consideration in the design process for accessibility	0.01587	57.65%	24
	SC1010	Lack of design consideration of energy-efficient	0.02108	76.58%	5
	SC1011	Lack of design consideration of biodiversity in open spaces/ landscape	0.01802	65.47%	17
	SC1012	Lack of design consideration for the disposal	0.01767	64.21%	19
Technical Design	TD1001	Affordability gap	0.01405	51.06%	30
	TD1002	Design changes by the client	0.01508	54.77%	28
	TD1003	Design variations by the architect	0.01766	64.14%	20

TD1004	Design errors and omissions	0.01842	66.93%	15
TD1005	Skill gaps in design team performance	0.01877	68.19%	12
TD1006	Design Process takes longer than estimated	0.01867	67.85%	13
TD1007	Time Limits-Tight schedule	0.01993	72.40%	8
TD1008	Design cost overruns	0.01992	72.38%	9
TD1009	Stakeholders Change project requirements at a later stage	0.01525	55.40%	26
TD1010	Outdated specification- materials and technology	0.01852	67.30%	14
TD1011	Commercial pressure-Bidding and contractor selection	0.01331	48.36%	31

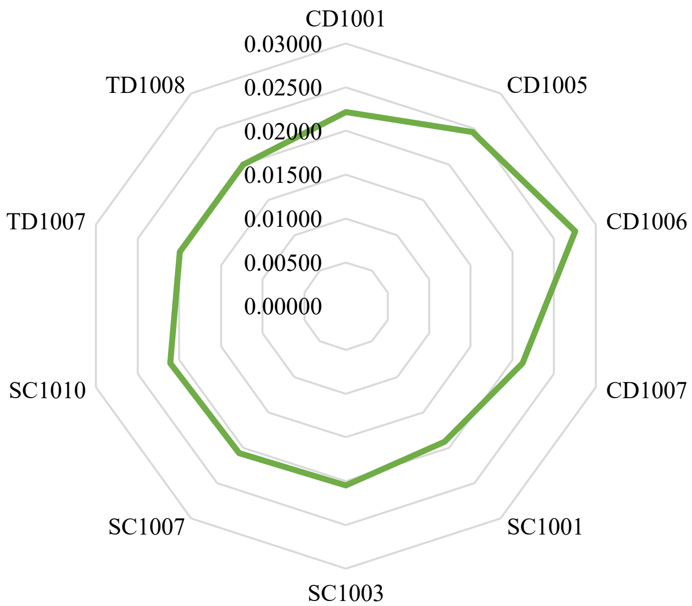

Figure 4. Relative Significance of Top Ten Risks in ADP for SHP

4.4 Case Study: Naya (New) Nazimabad, Pakistan

With the expanding population of the metropolis, urban sprawl was inevitable; to resonate with the essence of the old housing community Nazimabad built for middle-income groups in 1952, the developers Javedan Corporation along with Arif Habib Groups initiated the project of Naya Nazimabad in 2012. Though the idea sounds noble, in reality, Javedan Corporation had a massive land of 1300 acres near the Manghopir. Initially, the cement plant was established there but it did not survive, thus instead of letting the land go to waste, building a housing scheme seemed more lucrative.

Divided into a total of 8 blocks, the scheme is planned in such a way that each block has to have its basic amenities, such as a park and a mosque. An allocated commercial area with each block is also part of the program. This massive project can accommodate 100,000 people when completed. Around 30000 abodes will be built here. The residential plot sizes are 120, 160, 240, and 400 square yards.

4.4.1 Analysis and Assessment

Assessing the case of Naya Nazimabad as per the top 10 risk factors:

i. Risk Factors Ranked 1 (Lack of consideration of environmental requirements) and 2 (Incomplete environmental analysis): Built on a natural lake, which worked as a rain collector, was encroached on for a housing scheme as a result the biodiversity of the region was affected. But also choked rainwater drain, is never cleaned, thus adding to the problem. After the 2020 torrential rain, the whole block C of Naya Nazimabad was severely flooded *(Khan, 2021)*. From the damages done as a result of the 2020 monsoon, it is clear that the environmental analysis was never taken into account during designing.

ii. Risk Factors Ranked 3 (Land Selection): Land selection is important but in the case of Naya Nazimabad, it was not taken seriously. If an industrial space is later converted into a residential project, some residents complain about the putrid smell from the nearby industries in the area. Also, the encroachment of the natural lake is proof enough that environmental considerations were not given priority for the project *(EIA Report, 2020)*.

iii. Risk Factors Ranked 4 (Poorly defined design brief), 5 (Lack of design consideration of energy-efficient), and 6 (Lack of passive design consideration for environmental conditions): The houses were designed keeping the requirements of middle-class families, and encouraging air conditioning. Also, the fact that each block has its own park, mosque, or commercial area instead of a couple of blocks sharing common amenities, creates segregation even among those living in the housing scheme. Social segregation is never encouraged for social sustainability. The city has a shortage of water, yet one can see fountains within the scheme. Instead of biodiversity in the landscape, the lush lawns are designed which need a lot of water for maintenance.

iv. Risk Factors Ranked 7 (Lack of coordination between design participants) and 8 (Time Limits-Tight schedule): It is not apparent whether the participants were coordinated before designing, but the scheme took years to take shape, yet it is apparent that the time, to conduct detailed surveys regarding the area, ecology, and people, was not utilized or the design participants did not consider these issues as too significant to invest much time.

v. Risk Factors Ranked 9 (Design cost overruns) and 10 (Non-Compliance with by-laws and building codes & standards): When deciding the cost, the expense related to post-construction should also be a part of the design project. In this case, many inhabitants who invested in the housing scheme had to bear the loss caused by torrential rains. Had the risk calculated beforehand, instead of flooding, the water could have been stored by rainwater harvesting *(Sarah Nizamani et al., 2020)*

It is obvious that the Pakistan Environmental Protection Act 1997 was not considered while designing the scheme, had it been the case, the natural lake would not have been encroached upon *(Pakistan Authority, 1997)*.

5. Recommendations & Conclusion

Housing is one of the most lucrative yet exploitative markets. Its need cannot be denied but it is a fact that now conventional housing cannot be accepted. The changing climatic conditions, environmental degradation, and the increment of urban sprawl require sustainable and ecologically liveable housing solutions.

To do that risk factors are to be identified and catered to throughout the architecture design and construction process, with timely accountability as stipulated in the research.

The majority of the highest risks are identified during the concept design phase which can be mitigated at the start of the project cycle. The other high risks are identified in later stages (spatial coordination and technical design) for housing projects which can be mitigated through passive and efficient design awareness such as vernacular design workshops and LEED (Leadership in Energy and Environmental Design) design courses.

To execute the project with maximum efficiency, the risks identified with maximum repercussions in Table 1 are to be dealt with first. Some risks might require one to completely reevaluate their choices. If one takes into consideration the land selection of the case study included in the research, it can be deduced that the selected land should have been avoided completely.

Though as per Pakistan Environmental Protection Act 1997, degradation of natural lands is not allowed and is a crime punishable by law, land is exploited frequently. Such laws should be stringent and should implement heavy fines to deter the people from exploiting or encroaching on natural land.

The Naya Nazimabad project completely neglected the by-laws and environmental implications. The identified risk cd1002 sc1001 (referring to table 1) could have avoided the economic, environmental and social damages had these been identified beforehand.

Besides designers and architects, BOR (Board of Revenue) should involve environmentalists, sociologists, economists, psychologists, urban planners, and researchers (academia). This is to ensure that the selected land for housing is acquired based on social equity, environmental well-being, and income-generating opportunities.

Table 5 and 6 clearly indicates that the lack of environmental consideration is the leading risk factor which has to be catered to for a housing project to be sustainably sound. While incomplete environmental analysis, poor land selection, incomplete or ambigous design brief and lack of energy efficient design strategies are the four major risks that contribute to the unsustainability of the housing projects.

Environmentalists should be involved in developing proper analysis and for better documentation of selected land latest technology like GIS (Geographic Information System) should be used. Even geologists should be part of the teams for a preliminary inspection of the land.

Bylaws need to be updated as per SDG's goals and new standards & codes based on energy efficiency should be developed, such as green roofs, rainwater harvesting, sewerage water treatment, etc. Huge penalties and action should be taken against non-compliance against both developers and architects.

The quantification of risks factors further highlights how neglection of passive design strategies, non-participation or coordination between the design participants or stake holders, tight schedules and design cost overruns are also factors worth considering. It is for these reasons, it is desirable to inculcate project management from the very beginning for the housing project.

Acknowledgment

This research was not funded by a grant.

The authors want to acknowledge the support of statistical data analysis by Usama Yaseem, Data Analyst at IRD Global (International Research and Development).

References

Arc. Agoha & Basil Onyekozuru. (2019). Risk Management in Architecture Professional for National Development in Nigeria. *AARF Publications Journals*, *7*(9). https://www.academia.edu/49082801/RISK_MANAGEMENT_IN_ARCHITECTURE_PROFESSION_FOR_NATIONAL_DEVELOPMENT_IN_NIGERIA

Aslam, B., Gul, S., & Asghar, M. F. (2021). Evaluation of environmental degradation as an unprecedented threat to human security in Pakistan. *Liberal Arts and Social Sciences International Journal (LASSIJ)*, *5*(1), 197–211.

Capital Development Authority. (2021, May 5). *ILLEGAL/ UN-AUTHORISED HOUSING SCHEMES IN ISLAMABAD*. https://www.cda.gov.pk/housing/unauthorised_schemes.asp

Causes of Air Pollution from the Built Environment. (2019). https://worldgbc.org/clean-air-buildings/causes

Cengiz, A. E. (2013). Impacts of Improper Land Uses in Cities on the Natural Environment and Ecological Landscape Planning. In *Advances in Landscape Architecture*. IntechOpen. https://doi.org/10.5772/55755

Chileshe, N. (2011). Delivering sustainability through construction and project management: Principles, tools and practices. *Creating Sustainable Communities in a Changing World; Roetman, P., Daniels, C., Eds*, 111–118.

Chintis, C. (2019). Architecture Explained: The Phases of Designing & Building a Project. *WC STUDIO Architects*. https://wc-studio.com/journal/2019/7/5/working-with-an-architect-understanding-phases-of-design-construction

Cox, W. (2015). *Largest 1,000 Cities on Earth: World Urban Areas: 2015 Edition | Newgeography.com*. http://www.newgeography.com/content/004841-largest-1000-cities-earth-world-urban-areas-2015-edition

Durrani, M., Amir, M., Jabbar, S., & NASRULLAH, F. D. (2016). DOCUMENTING THE UNPRECEDENTED 2015 KARACHI HEAT WAVE DISASTER. A HINT OF WORSE TO COME? *Medical Channel*, *22*(2).

EIA Report. (2020). *Ultimate net environment assessment at a glance, Naya nazimabad Gymkhana Karachi*. https://www.scribd.com/document/443621087/EIA-report

Ghoneim, R., Mete, G., & Hobley, A. (2022, May). Steel and cement can drive the decade of action on climate change. This is how. *Industrial Analytics Platform*. https://iap.unido.org/articles/steel-and-cement-can-drive-decade-action-climate-change-how

Global Alliance for Building and Construction, International Energy Agency, & United Nation Environmental Programme. (2019). *2019 Global Status Report for Buildings and Construction*. https://www.unep.org/resources/publication/2019-global-status-report-buildings-and-construction-sector

Haq, S. (2021, December 27). An unstoppable real estate boom. *The Express Tribune*. http://tribune.com.pk/story/2335932/an-unstoppable-real-estate-boom

Hasan, A. (2015). Land contestation in Karachi and the impact on housing and urban development. *Environment and Urbanization*, *27*(1), 217–230. https://doi.org/10.1177/0956247814567263

Hasan, A., & Arif, H. (2018). *Pakistan: The causes and repercussions of the housing crisis*. International Institute of Environment and Development. https://pubs.iied.org/10864iied

IEA, IRENA, UNSD, World Bank, & WHO. (2022). *Tracking SDG7: The Energy Progress Report* (CC BY-NC 3.0 IGO).) https:// creativecommons.org/licenses/by-nc/3.0/igo/

Institute of Economics & Peace. (2020). *Ecological threat register 2020: Understanding ecological threats, resilience and peace*. http://visionofhumanity.org/reports

Jabeen, A., Sheng, H. X., & Aamir, M. (2015). Housing Crises in Pakistan: Review of Population Growth and Deficiencies in Housing Laws and Policies. *International Journal of Sciences*, *24*(3), 25.

Jaber, A. Z. (2019). Assessment risk in construction projects in Iraq using COPRAS-SWARA combined method. *Journal of Southwest Jiaotong University*, *54*(4).

Khan, M. A. (2021, December 11). *Urban Informality and Climate Change—Analyzing Karachi's Rain – YCR*. https://youthcfr.com/2021/12/11/urban-informality-and-climate-change-analyzing-karachis-rain/

Mackey, A., & Bryfonski, L. (2018). Mixed Methodology. In A. Phakiti, P. De Costa, L. Plonsky, & S. Starfield (Eds.), *The Palgrave Handbook of Applied Linguistics Research Methodology* (pp. 103–121). Palgrave Macmillan UK. https://doi.org/10.1057/978-1-137-59900-1_5

Mironiuc, M., Ionașcu, E., Huian, M. C., & Țaran, A. (2021). Reflecting the Sustainability Dimensions on the Residential Real Estate Prices. *Sustainability*, *13*(5), 2963.

Naya Pakistan Housing Program. (2022, March 7). https://nphp.com.pk/

Othman, A., & Abdelwahab, N. (2016, July 31). *A Field Study Investigating the Role of Integrating Risk Management into the Architectural Design Process As an Approach towards Delivering Sustainable Construction Projects*.

Othman, A., & Abdelwahab, N. M. A. (2018). Achieving sustainability through integrating risk management into the architectural design process. *Journal of Engineering, Design and Technology*, *16*(1), 25–43. https://doi.org/10.1108/JEDT-09-2017-0087

Pakistan Authority. (1997). *Pakistan Environmental Protection Act (PEPA), 1997* [M-302/L-7646]. The Gazette of Pakistan. https://na.gov.pk/uploads/documents/Pakistan=Environmental-Protection-Act-1997.pdf

Rafindadi, A. D., Mikić, M., Kovačić, I., & Cekić, Z. (2014). Global perception of sustainable construction project risks. *Procedia-Social and Behavioral Sciences*, *119*, 456–465.

Real Estate Market in Pakistan: Growing beyond Regulations (p. 38). (2016). PRIME Institute.

RIBA. (2020). *RIBA Plan of Work 2020 Overview*. RIBA. https://www.architecture.com/knowledge-and-resources/resources-landing-page/riba-plan-of-work

Sarah Nizamani, Shah Munir Khan, & Shujaat Hussain. (2020). *Preliminary Survey Report After Monsoon Rains in Karachi*. Institute of Business AdministrationKarachi, Pakistan. https://docslib.org/doc/5218680/preliminary-survey-report-after-monsoon-rains-in-karachi

State of Architecture & Town Planning Profession in Pakistan PCATP. (2020). Pakistan Council of Architects and Town Planners. https://www.google.com/search?q=State+of+Architecture+%26+Town+Planning+Profession+in+Pakistan+PCATP&oq=State+of+Architecture+%26+Town+Planning+Profession+in+Pakistan+PCATP&aqs=chrome..69i57.15225j0j15&sourceid=chrome&ie=UTF-8

Sustainability and the U.S. EPA (with National Research Council 2011). (2011). The National Academies Press. https://doi.org/10.17226/13152

Tang, H.-T., & Lee, Y.-M. (2016). The Making of Sustainable Urban Development: A Synthesis Framework. *Sustainability*, *8*(5), Article 5. https://doi.org/10.3390/su8050492

United Nations Department of Economic and Social Affairs. (2018). Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable. In *The Sustainable Development Goals Report 2018*. United Nations. https://doi.org/10.18356/7d014b41-en

Valipour, A., Yahaya, N., Md Noor, N., Antuchevičienė, J., & Tamošaitienė, J. (2017). Hybrid SWARA-COPRAS method for risk assessment in deep foundation excavation project: An Iranian case study. *Journal of Civil Engineering and Management*, *23*(4), 524–532. https://doi.org/10.3846/13923730.2017.1281842

Wardah, E., & Khalil, M. O. (2016). Design process and strategic thinking in architecture. *Proceedings of 2nd International Conference on Architecture, Structure and Civil Engineering*.

Willmott Dixon. (2010). *The Impacts of Construction and the Built Environment* (FM-RE-07). https://www.google.com/search?q=the+impacts+of+construction+and+the+built+environment&sxsrf=ALeKk02qADc3658fU_Mvg89KocdbZJzXRA%3A1624056886220&ei=NiTNYMD3DJTzgQbpuq0I&oq=&gs_lcp=Cgdnd3Mtd2l6EAEYAzIHCCMQ6gIQJzIHCCMQ6gIQJzIHCCMQ6gIQJzIHCCMQ6gIQJzIHCCMQ6gIQJzIHCCMQ6gIQJzIHCCMQ6gIQJzIHCCMQ6gIQJzIHCCMQ6gIQJzIHCCMQ6gIQJzIHCCMQ6gIQJzIHCCMQ6gIQJ1AAWABgnZQOaAFwAngAgAHmAYgB5gGSAQMyLTGYAQCgAQGqAQdnd3Mtd2l6sAEKwAEB&sclient=gws-wiz

Winston, N., & Pareja Eastaway, M. (2008). Sustainable housing in the urban context: International sustainable development indicator sets and housing. *Social Indicators Research*, *87*(2), 211–221.

World Meteorological Organization. (2021, April 20). *2021 is "make or break year" for Climate Action*. https://public.wmo.int/en/media/news/2021-%E2%80%9Cmake-or-break-year%E2%80%9D-climate-action

Zolfani, S., & Šaparauskas, J. (2013). New Application of SWARA Method in Prioritizing Sustainability Assessment Indicators of Energy System. *Engineering Economics*, *24*, 408–414. https://doi.org/10.5755/j01.ee.24.5.4526