Jurnal Kejuruteraan 36(3) 2024: 1167–1184
https://doi.org/10.17576/jkukm-2024-36(3)-27

Adaptation of An Architectonic Traditional Building: A Systematic Review

Joan Atheel Ahmed[a,b*], Wardah Fatimah Mohammad Yusoff[b], & Mohd Farid Mohamed[c]

[a]*Department of Computer Engineering, Faculty of Engineering, University of Mosul, Iraq*

[b]*Department of Architecture and Built Environment, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, Malaysia*

[c]*Department of Architecture and Built Environment, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, Malaysia*

[*]*Corresponding author: p125112@siswa.ukm.edu.my*

Received 31 May 2023, Received in revised form 3 March 2023
Accepted 3 April 2023, Available online 30 May 2024

ABSTRACT

Taking into consideration the historical, cultural, social, and economic worth, historic structures are an essential component of the built environment. It is crucial to preserve historic structures in a sustainable manner, and to restore them so they continue to function effectively in the long run. The focus to attain standards such as BREEAM, LEED, etcetera, have been developed to fulfil more comprehensive strategic objectives when constructing new buildings, however, these requirements are insufficient when they are utilised for adjustments to older buildings. Few people are aware of the qualities of historic houses, and there are not many historic buildings that have aspects that increase their sustainability and dispel the notion that they are of lesser quality. Nonetheless, due to the unique characteristics of historic structures, it is necessary to modify and analyse the current traditional buildings and add new parameters that are not addressed by any of the grading systems under consideration. The current research aims to analyse the academic articles on design solutions for adaptability in buildings, and adaptation of an architectonic traditional building worldwide. Accordingly, this study has extracted from 24 articles that are based on a myriad of articles which have been analysed and collected from "Scopus, Web of Science, Google Scholar, IEEE, and Science Directs" under systematic literature review (PRISMA).

Keywords: Traditional building, Sustainability, Smart sustainable, Adaptations, Architectonic, PRISMA

INTRODUCTION

In the industrialized world, adapting obsolete and ancient buildings for the same users or new uses is considered to be an economically effective strategy to eliminate building redundancy (Guerrero Baca & Soria López 2018). The original space can sometimes be kept as redundant until demand for a future use remerges because conversion methods are occasionally uneconomical, and demolition looks unsustainable. Construction costs for building systems are high and unnecessary when physical robustness and flexibility are available because building systems have a finite lifespan. It is essential to consider how to utilize the existing building stock for exclusive or mixed-use constructions. This is encouraging more innovation in the development of new buildings to accommodate variations in usage for the building's existence. The difficulties can be found in 'environmental factors' (Geraedts 2008), 'technological advancements', 'planning and policy issues', 'social requirements', 'political influences' (Wicaksana 2016), and 'economic considerations'.

To solve these systemic issues, buildings must adapt in terms of the 'goal' they serve, the 'capacity' to provide the services that are required for the occupant community, and the 'flow' of responding to external as well as internal influences (Slaughter 2001). However, structures that are unable to handle the difficulties will quickly become outdated, require extensive renovations, or perhaps need to be demolished, none of which may result in a sustainable future. In essence, it is commonly understood that flexible structures are necessary for sustainable architecture (Building et al. 2005), and may concentrate on unique

remedies whereby, if possible, are adaptable to the changing needs of the client. The difficulty of comprehending sustainable issues across long time scales, however, poses a barrier to the implementation of a policy of life span flexibility. Therefore, there is an increasing need to create new structures that may be flexible and adaptable throughout the buildings lifespan while also increasing the user's happiness.

CURRENT CHALLENGES

The challenges facing the built environment fall under the headings of 'environmental considerations', 'innovations in technology', 'planning and policy issues', 'social necessities', 'political factors', and 'economic considerations. Structures must evolve in terms of their 'role', 'availability', and 'circulation' to create the necessary performance for the community which they carry influences structures must evolve in terms of their 'role', 'availability', and 'circulation' to create the necessary performance for the community where they carry influences to address the building designs' macro-level difficulties. Notably, the past and present rarely provide proactive responses to probable future developments, thus, rendering the structures prematurely out-of-date or necessitating expensive renovations or demolition. The lack of proactive responses to probable future changes in the earlier and existing building designs render these structures to be prematurely obsolete or to necessitate significant renovation or removal. However, the sustainability agenda does not always value starting from scratch; currently, building owners, developers, and politicians are increasingly becoming more interested in adaptable buildings.

The Study's Aim and Research Questions The present study's objective is to conduct a literature review on design solutions for adaptability in buildings, supporting the creation of a sustainable built environment. In the first part of the study, many important points need to be looked at more closely.

The research for this article aims to respond to the following queries:

Q1: Which journals are currently publishing research on "Adaptation of traditional building"?

Q2: What are the most cited articles, countries, and which authors? And what are the most recent or popular subjects in "Adaptation of traditional building" among academics?

Q3: What are the gaps, findings and future works of previous articles?

After a brief explanation of the problems of adapting a traditional building's architecture, a scientific review and bibliometric analysis are carried out. The remaining portions of the study are divided into four sections: methodology (which includes the review protocol and defining search terms), results (which includes descriptive, bibliometric, and meta-analysis), analyzing and evaluation of 24 articles (which includes gaping, finding and future recommendation), and the discussion and conclusion.

METHODOLOGY

The designers choose to complete a systematic literature review (SLR) to accomplish the study's research objectives, focusing on the top publications that publish project adaptation traditional architectural and sustainability research. The origin of SLR, according to Cook et al. (1997), is in the medical and healthcare industries, where the approach has served as the foundation for policy decisions. SLR is typically seen as more transparent than many conventional and less systematic ways of conducting literature reviews since other researchers can more easily replicate the research setup and verify the study's conclusions. Over the past 20 years, organization and management experts have started to incorporate SLR into their study approaches (Pilbeam 2013). Ahola et al. (2014) and Müller et al. (2014) are two recent examples of studies that have used SLR to map the concept of governance in the context of project research.

The use of bibliometric methodologies in the research and technology sector demonstrates great variety across professional specialties and extends much beyond the fundamental concept of simple directories of research output or reference categorization. In the academic field, ranking and other useful evaluations based on bibliometric indexes were frequently produced, with major scientific, social, and political ramifications (Ellegaard 2018; Harvey 2008). Performing a systematic review of the literature is fundamentally related to bibliometric analysis. Many scientists view it as an essential step in the scientific process and a starting point (Murata et al. 2014). A flexible analytical technique, bibliometrics can be used in a wide range of situations, which includes every element of typical citation impact measurements (Kaur et al. 2013; Grandjean et al. 2011). Quantitative research is a methodical approach for classifying all publications that are published in a certain scientific field according to their amount,

interconnectedness, productivity, clarity, and references, and then evaluating the academic achievement of the scientific field.

In this study, content and bibliometric evaluations were conducted using both quantitative and qualitative methods. As a result, the following analyses were carried out: (1) Descriptive analysis, (2) bibliometric authors' citation analysis, (3) bibliometric papers' co-citation analysis, (4) bibliometric references' co-citation analysis, (5) bibliometric journals' co-citation analysis, and (6) keywords and co-citation analysis. Table 1 below shows the VOS viewer and Pivot Chart were used to conduct the bibliometric and formation analyses. The systematic review required several procedures. The Scopus, Web of Science, Google Scholar, IEEE, and Science Directs databases have been chosen because they provide the most complete overview of research outputs in the world and are thought to have the largest collections of academic research publications of a sufficient calibre. The article title, abstract, and keywords in this study all contain the keywords "Adaptation of traditional building". A total of 334 papers were produced as a result. Figure 1 illustrates the various stages of data screening. The information was checked before being exported to CSV Excel and submitted to the VOS viewer for bibliometric analysis. The processes for data extraction and conversion are shown in Table 1, CVS Excel was also converted to the Scopus format. Scopus, Web of Science, Google Scholar, IEEE, and Science Directs databases were thoroughly searched in step 1 to collect the data. The documents were then improved, classified, and encoded after two rounds of selection.

The most cited articles, journal distribution, and year publishing trend were all reported. In stage 2, four scient metric tests were performed, including: (1) Journal co-citation analysis: to list the journals with the highest citations along with the study areas which they encapsulate. This analysis reveals the breakdown of the evaluated documents that are cited and the published journals, to identify established journals in the Adaptation of the traditional building", (2) Countries/ analysis: to represent the international research network for traditional building adaptation between countries and international organizations so that the readers will be able to grasp the relationships between the major research groups and institutions around the world rapidly; (3) Keywords co-occurrence analysis: to group the "Adaptation of traditional building" keywords into different study themes and to map out the co-occurred time zone of the clusters. The knowledge structure of "Adaptation of traditional buildings" is clarified using network analysis of co-occurring terms, which is also utilized to provide research clusters and future research prospects.

TABLE 1. Illustrates the detailed research process, consisting of several steps.

No. of Steps	The detailed research process, consisting of several steps
Step 1	keywords research on "Adaptation of traditional building"
Step 2	Comprehensive retrieval from Scopus, web of science, google scholar, IEEE, and Science directs databases
Step 3	Duplicates filtering and form inspection
Step 4	Document refine following inclusion/exclusion criteria
Step 5	Literature retrieval and selection
Step 6	Descriptive analysis
Step 7	Vos Viewer coding and scient metric analysis -Visualization of co-cited journal - Visualization of Countries/ analysis -Visualization of text data co-occurrence of keywords -Visualization of Co-cited of the cited authors
Step 8	Content analysis of the previous research topics
Step 9	Current research gaps, finding and future recommendation
Step 10	Discussion
Step 11	Conclusion
Step 12	Perspectives for Future Research

There were 334 papers in total based on the author's searches. The author independently evaluated the abstracts of these 334 articles and classified them as either relevant or irrelevant to this study to eliminate irrelevant articles from the study's collection. Accordingly, the sample was reduced, and the author deemed it irrelevant. The topics of the publications that were deleted varied, but they were all mostly related to the concept of sustainable development, leaving a final sample of 24 articles on 'traditional architectural building' and 'smart sustainability', as described in Table 7. The 24 papers were selected for retrieval and then subjected to many studies utilizing the Vos Viewer® tool for visualization. The article-based studies cover document type, co-authorship, co-occurrence of keywords, organizational analysis, country of origin analysis, and citation analysis. The top keywords that were extracted from the articles were mapped as part of the keyword analysis that was also carried out. The collaboration linkages between the different authors who contributed to traditional building, adaption, architectonics, and smart sustainability were also demonstrated through an author mapping exercise.

REVIEW PROTOCOL

This study includes 334 articles from databases for in-depth reading and meta-analysis as well as for the final included articles for publication growth, as a journal outlet citation trend, and co-citation analysis to cover the most important subject areas; the papers of the latest database studies- up to 2022, have been published. Utilizing a complete science-metric analysis has been a smart strategy in the bibliometric evaluations and investigations Mendeley, MS-Excel, and the open-source tool VOS viewer are used to clearly show how to adapt an architectural assessment.

Three sections of research were conducted for this essay. The initial step was to extract documents from Scopus, Web of Science, Google Scholar, IEEE, and Science Directs databases. Since there were numerous duplicate articles in the library, step 2 involved locating and eliminating them.

Step one entailed establishing various research questions for this study based on the data structure, using Mendeley as a trustworthy reference manager. Step two included a comprehensive examination, applying quality assessment, an introduction of key scheduling ideas, and a comparison of scheduling methods. Step three included synthesis, analyzing findings, and reporting, while step four entailed using the VOS viewer, which had also been used in other studies to undertake a scient metric analysis of the academic publications. This necessitated using a variety of strategies, such as citation deep learning, founder, co-authorship, citation, and bibliography linking. After the information was gathered, the academics' important interests were discovered, and the possible future study fields were selected whereby the results were compiled to produce a discourse that addressed the study's goals.

DEFINING SEARCHING TERMS

Using a search strategy, the researchers were able to locate the content that was needed for this search strategy. This search strategy was created namely for the following database where the following search phrases were entered in Scopus: all searches covered the latest studies of the database up to 2022 and had included traditional architecture, which was also known as 'architectonic tradition', 'adaptation', as well as 'sustainable' and 'smart future'; all searches also included academic journals, literature reviews, and scientific papers that were only published in English.

Figure 1 below indicates the PRISMA statement served as the basis for the screening process (Moher et al. 2009). The main goal of the search was to collect all available research on engineering sustainability, architectural engineering, and the adaptation of an architectural tradition. The fields of sustainable future, traditional building, and smart building included the latest studies of the database up to 2022, whereby a search was conducted. The search did not include any articles that were published in the past years. All articles were included because the search was primarily focused on countries. At this level, a total of 1,107 articles that provided information were disregarded. Correspondingly, a total of 24 recordings have been gathered.

The study's basis mainly comprised the original research publications, reviews, and conference papers. To uphold the high standards of the review, every duplication was subject to a thorough evaluation. To confirm that the academic content that was used in the evaluation was of the highest caliber and relevance, the paper summaries were carefully examined and vetted. Later, each research report received a detailed analysis. The second exclusion requirement was to accept English-language papers only. The analysis excluded three articles that were authored in languages other than in English. Furthermore, 1,107 additional articles are removed from the research after the duplicate record filtration. Following a comparison of each item using the above-mentioned inclusion and exclusion standards, 24 were selected.

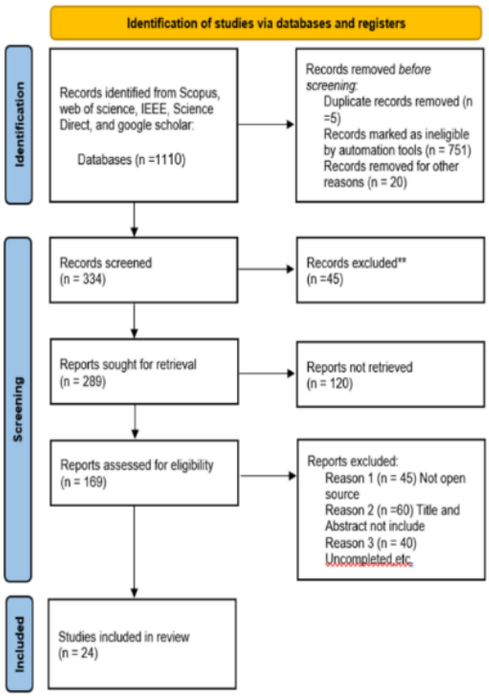

FIGURE 1. The inclusion and removal of literature during every stage. (PRISMA document)

Overall, 24 publications with the greatest ranking for the adaptation of traditional buildings, from the highest engineering sector are directly related to the "Adaptation of traditional buildings" in the historical building, Figure 2 below indicates these articles have been chosen for the data extraction phase. Table 7 below shows lists all the reviewed papers, and the following attributes are extracted:

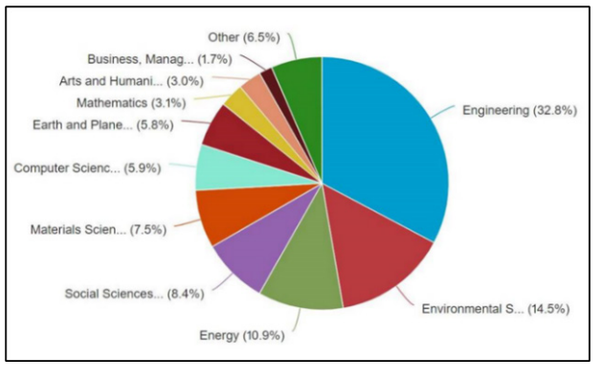

FIGURE 2. Documents by subject area

The paper should be a scientific article, journal article, or original paper. Case studies and published papers were included.

The paper should always be written in English and pertained to architecture, engineering, sustainability, and smart design. Many papers on the latest studies of the database up to 2022 were published.

Figure 3 below indicates the documents that were extracted originated from various nationalities.

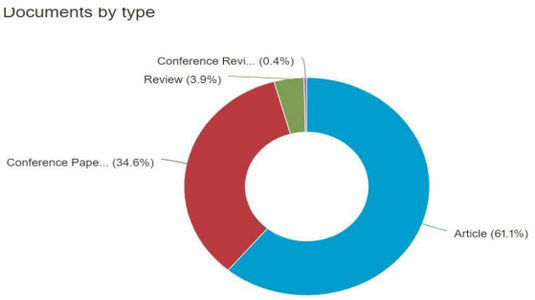

FIGURE 3. Documents by articles

Bibliometric research involves a clear, repeatable search process; this section discusses the data mining technique. Data was acquired in October 2022 from the Scopus and Web of Science databases. With the aid of only a few past studies, many similar studies in a range of sectors, including "Smart Sustainable" and "Traditional Architectonic building", have been carried out. One of the most widely used searchable indexes may be found in a digital library such as Scopus or Web of Science which has a huge amount of information, important citations, and abstracts (Amrutha & Geetha 2020). The ability to combine bibliographic final findings from databases into one excel (CSV) file that contains the citation matrix, publication details, affiliation details, and references, among other things, is a benefit of such databases.

After looking at relevant publications, descriptions, and classifications, a key topic search phrase for the issue was carried out to create the "Traditional Architectonic building". In contrast, the scheduling difficulty leads to the search for the essential theme term. In this study, we examined all of the journal papers that contained the terms 'traditional architectural building' and 'smart sustainability' in the titles, keywords, or abstracts.

RESULTS

DESCRIPTIVE ANALYSIS

It is a type of information processing that makes it easier to describe data sets or to sum them up constructively, enabling the creation of structures that perfectly meet the needs of the information. It is one of the most important steps in the process of statistical data analysis. An analysis of 1,107 documents was conducted to determine the basic continuous pattern of publishing on this topic, "Smart Sustainable, Traditional Building, Adaptation, and Architectonic".

During the latest studies of the database up to 2022, 1,107 publications on traditional building, adaptation, architectonics, and smart sustainability had been published in Scopus, Web of Science, Google Scholar, IEEE, and Science Directs databases; yet when the search criteria were applied only 334 articles were discovered.

According to (Khan et al. 2022), co-citation is when two documents are concurrently cited in the reference list of the referring article. Through co-citation analysis, the mental framework of a research area is examined from the viewpoint of the cited articles. One of the best methods for determining how similar the two papers' contexts are, is through co-citation. Utilizing a VOS viewer, co-citation analysis was carried out, and the total numbering technique was used for analysis.

To address these issues, a systematic literature search of articles that have been published in six eminent scientific publications with a greater emphasis on traditional building, adaptation, architectonics, and smart sustainability, is conducted after applying a descriptive method using a Microsoft Excel pivot chart to identify the high journal published issue in the field. Table 2 below shows the Based on the examination of 24 publications published in these six publications until 2022, Figure 4 below indicates the top source journal forms a systematic literature review, starting with the Sustainability (Switzerland) journal and finishing with the SN Computer Science.

TABLE 2. Top six journals publishing research on "Adaptation of an architectonic traditional building.

Source Name	Sum of Issue
Sustainability (Switzerland)	31
Journal of Construction Engineering and Management	12
Environment, Development and Sustainability	8
Civil Engineering and Architecture	6
SN Computer Science	5

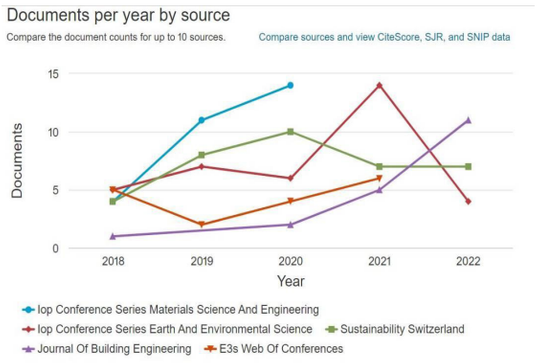

FIGURE. 4 Documents per year by source

Figure 5 illustrates the annual articles from 2018 to 2022 using the deceptive analysis or pivot chart, revealing that in 2020 and 2021 there was a huge increase in publications, with 2021 seeing almost the maximum amount. Because the number of annual articles has continued to rise, there are now much more publications altogether. It should be noted, though, that most of these articles require the users to pay to access them. It was once believed that research papers are published online to receive more citations than those that are printed in typical journals, but this is not the truth.

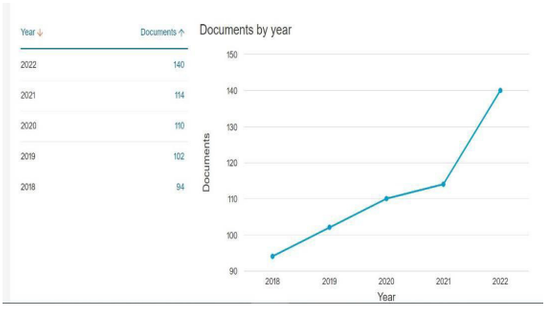

FIGURE 5. Annual articles from 2018-2022

BIBLIOMETRIC ANALYSIS

To visually represent the bibliographic data, we looked at the structural connections among the different units of analysis using VOS Viewer. The present investigation included co-authorship, co-occurrence, bibliographic coupling, and co-citation evaluations. VOS Viewer was chosen for this study because of its adaptability to different file types and its capacity to create maps using data information, bibliographic data, and text data. There is the file that VOS Viewer needs for simulation purposes.

ANALYSIS OF THE AUTHOR'S AND COUNTRIES' CO-AUTHORSHIP CONNECTIONS

The extent of collaboration between authors, institutions, and countries is demonstrated by the co-authorship network. Co-authorship generates synergy. Additionally, joint research generates original scientific results and superior academic articles. Typically, researchers work together to produce a scientific publication, and because of each researcher's input, the quantity and quality of the final product are higher. VOS viewer has been employed to carry out the analysis.

By producing a chart using bibliographic information from the VOS viewer using the available MS Excel file

type (Web of Science, Scopus, IEEE, Google scholar, and Science Directs) databases, out of the 75 countries, respectively, only 10 have the required quantity of documents and citations. Table 3 below shows the Subsequently, choosing a particular type of analysis and counting technique (citation – countries), Figure 6 below indicates the shows the literature distribution of traditional buildings, adaptation, architectonics, and smart sustainability in the numerous nations and places, where the description is based on the investigation background or the location of the research data in each study because many studies contain authors who are from various countries. This approach can capture architectural design, architectural adaption, and clever sustainability more accurately. Pertaining to the countries, and scientific production, the highest number came from China at 155 documents and Italy at around 59 documents, while the lowest number of documents in the group came from Poland at just 15.

TABLE 3. Top ten countries in the world that responded to this research area.

Country	Documents	Citations
China	155	559
Italy	59	350
United States	42	307
United Kingdom	37	226
India	22	220
Spain	20	210
Turkey	20	129
Indonesia	19	105
Germany	17	79
Poland	15	69

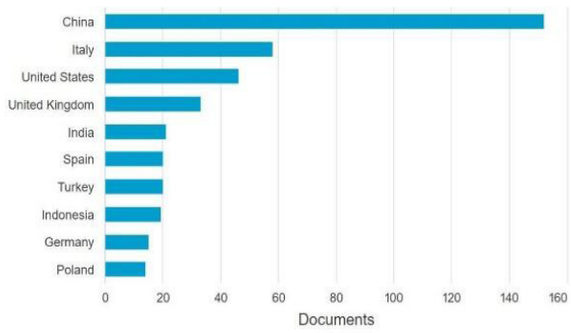

FIGURE 6. The countries contributed to the publications on traditional architecture, adaptation, and building.

INVESTIGATION OF CO-CITATIONS AT THE AUTHOR RANK

Table 4 below shows the Co-citation evaluations at the author's rank were also carried out. An author must have ten citations that had to be taken into account. The full counting approach was used to determine the co-citation sequences using the VOS viewer; 28 authors out of the 701 had complied with the requirement of 5 least citations. There were four clusters, each was represented by various colours, and were created by co-citing the referenced authors. 28 authors are co-cited in at least 10 studies from the study's data, as shown in Figure 7 and Figure 8. One of the biggest clusters, Cluster 1 (in red), shows the work of ten highly cited authors; among the 28 writers, there are six writers in Cluster 2 (in green). Among the groups, the most well-known authors are Duan y, Zhang, and Zhou. There are 9 authors in Cluster 3 (in blue). The writers in this cluster who received the greatest citations were ZHANG J and LIU Y. There are three writers in Cluster 4 (in Yellow); Gao Y and Lei b, are this cluster's best-known authors.

TABLE 4. Top ten authors in this research area

Author	Citations
wang x.	282
zhang j.	217
zhang x.	215
liu y.	213
duan y.	210
feng h.	210
gao y.	122
lei b.	122
li l.	122
ma c.	122

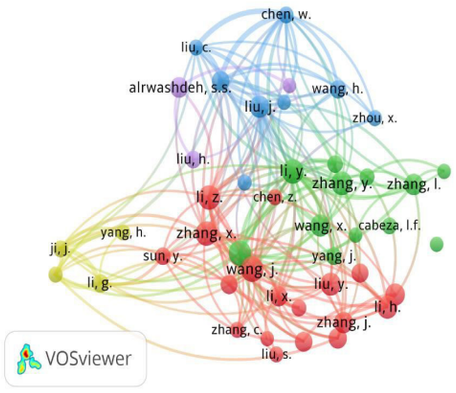

FIGURE 7. Co-citation of the cited authors

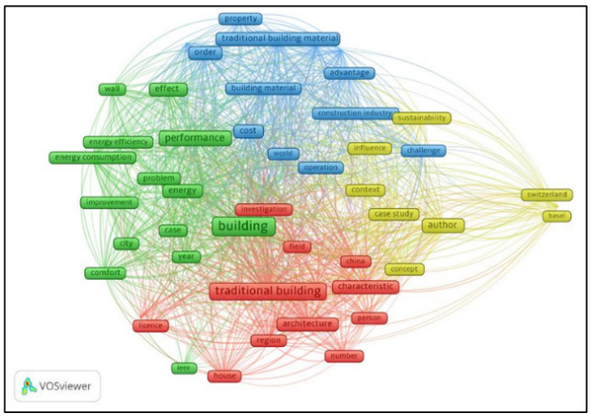

FIGURE 8. Most prolific authors in the fields of traditional construction, adaptation, and architecture

TABLE 5. Co-occurrence of keywords

Term	Occurrences	Relevance Score
Sustainability	253	3.4111
Architecture	248	3.576
Building	132	0.8718
Development	118	0.9062
Environment	109	0.9916
Construction	76	0.6697
Technology	73	0.4665
Characteristic	60	0.3058
Traditional Architecture	47	0.6185
Challenge	45	0.729

KEYWORD CO-OCCURRENCE NETWORK

To understand the information flow that takes precedence among researchers, the author keyword was carried out. To better understand the popular research trend in the area of "Adaptation of an architectonic traditional building", the authors performed an author systematic search using VOS viewer edition 1.6.15 to establish a network of words. The author's keyword co-occurrence network is shown in Figure 6. The map demonstrates the extent of research on the idea of "Adaptation of an architectonic traditional building". Table 5 below shows the Given that this method is based on the idea that keywords can be used to articulate text content, the co-occurrence of keywords is a useful technique to analyze scientific ideas. The relationship between two terms is represented by a numerical score, with a greater score suggesting a stronger association (strength link). The degree of relationship between two synonymous terms reveals how frequently these terms appear in the same article. These links' total count reveals how frequently these two terms appear together in searches(van Eck & Waltman 2013). If a keyword group appears in a piece of writing more than five times, it will appear on the bibliometric mapping since the VOS viewer has a setting that restricts the number of times a keyword can appear in a document, i.e., to five times. Figure 9 below indicates the color draws attention to the "Smart Sustainable", "Traditional Building", "Adaptation", and "Architectonic" terms' frequent co-occurrence.

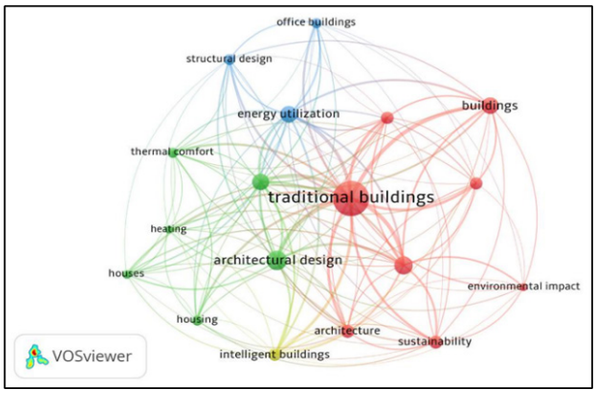

FIGURE 9. Map based on text data co-occurrence of keywords

HIGH-CITED ARTICLES

Analyzing the number of times an article, author, or journal is mentioned can help to assess how significant they are in their profession. This method is referred to as 'bibliometric analysis. An article, author, or publication is thought to be influencing the field if it receives a lot of citations from other sources. The authors, papers, or journals that receive the most citations are most likely to be the greatest or most well-known in their subject.

The selection process for highly cited publications considers these characteristics because citation rates differ by field and earlier articles receive more citations than the current ones. Table 6 below shows the number of publications cited at various levels of citation must be counted to create distributions for each subject with the year. Then, using the same percentage of publications, these estimates for each topic and year are performed to develop selection requirements, according to the PRISMA statement with description analysis for literature review, the researchers selected 24 articles that have the highest citation for the adaptation for traditional building.

TABLE 6. The highest citation articles

Title	Year	Cited by
(Alabsi et al. 2021)	2021	68
(Philokyprou & Michael 2021)	2021	12
(Mustamin Rahim et al. 2021)	2021	9
(Mileto et al. 2021)	2021	7
(Stefano et al. 2021)	2021	5
(Fakriah & Edytia 2021)	2021	4
(Sokienah 2020)	2020	4
(Sholihah et al. 2019)	2019	4
(Shireen et al. 2018)	2018	4
(Mohammadian & Shahbazi 2018)	2018	3
(Alabsi et al. 2016)	2021	2
(Al-hashimi 2016)	2016	2
(Guerrero Baca & Soria López 2018)	2018	2
(Teknologi et al. 2018)	2018	2
(Thi & Nguyen 2021)	2021	1
(Alyami & Alreshidi 2019)	2019	1
(Mostafa & Demery n.d.)	2019	1
(Baper 2018)	2018	1
(Fakriah & Edytia 2021)	2021	4

CONTENT ANALYSIS OF THE PREVIOUS RESEARCH TOPICS

Table 7 below shows the adaptation method must take cultural heritage into account. The development of traditional buildings took place in the seventeenth century. Literature demonstrates that structures are acknowledged as social representations in traditional buildings and are linked to convincing cultural systems of values and ideas; traditional architecture is directly linked to the local cultures, but it is also specifically adapted to the demands, ideals, and even the economy and lifestyles of the area (Carlos et al. 2015). Traditional architecture shows regional responses to famous historical structures, historical periods, and local environmental factors. Both, a theoretical period and a criterion for order to enhance the understanding, are specified. The accommodation is favorably described, and both parties are clearly identified by the result (Al-Jubouri et al. 2022). The evolution of modern architecture increasingly depends on traditional architecture, this indigenous implicit authority is eroding over time, especially in the trend of cultural integration, where cultures are fusing and losing their separate identities.

For contemporary buildings as well as another reason to challenge the concept that traditional vernacular architecture is of 'low quality' (Soleymanpour et al. 2015). The study of traditional architecture provides valuable insights into modern building design by pulling architectural inspiration from locally constructed traditional buildings. Because different climatic conditions demand that architectural styles respond to meet the various needs, architectural responses in traditional buildings vary according to the climate (Sahebzadeh et al. n.d.). This study will identify the traits of traditional architecture and how it reacts to climate and sustainability in order to analyze potential future sustainability features.

The Cambridge Dictionary defines adaptation as "the process of adapting to suit diverse conditions". Adaptation is the proactive process of making changes to successfully accommodate new and more effective environments. Adaptation to environmental and climate change as well as to the rapid change in quantity demanded, and adapting to technology's substantial interference in daily life are all examples of adaptable needs (Costantini 2017)

TABLE 7. An overview of the papers that are presented and discuss adaptation in a traditional

Author/ year	Research Problem	Finding	Future Agenda
(Alabsi et al. 2021)	There is a gap in the analysis of the variables affecting sustainability indicators and the assessment of the impact of each parameter on the sustainable development	Indicators like the compact urban fabric, the idea of simplifying space, integration with the local ecosystem, and effective resource use are among those that can be enhanced to better adapt to the local climate, according to the study's findings, which incorporate nature into the urban composition. These indicators demonstrate how to design a sustainable urban fabric.	The conclusions of this essay offer a theoretical starting point for more thorough research that takes future technological needs and advantages into account. for a more thorough and rigorous future investigation into climate change action climate impacts in cities.
(Philokyprou & Michael 2021)	Regarding words improved to conform to modern environmental protections and building codes, there is some conflict of interest.	The study's findings highlight how challenging it is to maintain and sustainably protect ancient homes. To establish a balance between the numerous qualities of traditional buildings, the project was conducted with components of traditional buildings, financial, cultural, and historic all taken into consideration.	More study is required, to assist with methods for adaptation and rehabilitation in heritage preservation activities. Historical structures adapt to lengthen their useful lives and modernize as cultures change and habits change.
(Mustamin Rahim et al. 2021)	No one has a thorough awareness of the features of historic houses, and there aren't many appealing qualities that increase sustainability in existing structures and dispel the stigma of historic architecture being "poor quality."	According to the author, the foundation (the foot), wall and room (the body), and roof (the roof) of North Maluku's architecture are all heavily affected by cultural and spiritual values, as well as by tangible and intangible values (the head).	The author suggested that traditional architecture should eventually incorporate many sustainable design concepts together with a passive system.
(Mohammadian & Shahbazi 2018)	In terms of the use of organic and regionally specific materials, modern structures have lost their individuality and authenticity with the traditional architectural legacy.	The author concludes that in this case, renovating dwellings using natural elements achieves many objectives, including demonstrating the possibility of respecting and keeping traditional architecture as a historical element and heritage while improving it.; utilizing locally extracted and worked natural resources by simply giving craftsmen work opportunities, supporting neighborhood events and the sustainability of the local economy, and using locally extracted and worked resources.	The future guidance highlights the advantages of utilizing natural resources rather than traditional industrial ones, but there hasn't been much of an increase in the usage of this type of resource.
(Stefano et al. 2021)	By integrating modern architecture's philosophy with already-existing culture, there is no balance between classical and contemporary architecture.	The concept of traditional and modern architecture is what the author believes Park planning and designing relates to. Thus, it is thought that fusing traditional and contemporary ideas will conserve historic structures while incorporating contemporary ideas. Traditional homes must continue to exist and be sustainable.	More quickly than we anticipated, we might be losing historic properties. Accordingly, we must do further research and analyze the regional guidelines and regulations that outline the future integration of traditional and modern homes.

continue ...

... cont.

(Fakriah & Edytia 2021)	Buildings lack environmental regulations as a result of global warming.	The results revealed that the traditional homes in Aceh have shown signs of being able to adapt to climate change in terms of material, structure, shape, orientation, space layout, exposure, circulation, and absorption.	Future residential plans ought to make use of the local expertise they held. More research needs to be done considering comparisons with related fields and the diversity of the data pool.
(Sokienah 2020)	They were working off of their experiences and understandings of the climate rather than having a thorough understanding of environmental principles.	They discover that traditional living gives a better living environment without the need for more equipment and energy use and that it is somewhat sustainable. These findings are in line with other studies in this field. Several steps, like using local building materials, orienting the structure toward the south, and Improving life quality.	Future research should focus on the steps involved in creating a new structure while taking the lessons learned from traditional design into consideration. Jordan is the location of the study.
(Alabsi et al. 2016)	The elements that affect parameters and how each indicator affects the sustainable development of the urban fabric are not thoroughly assessed.	The more important study findings provide a variety of factors that can be improved to better accommodate the local climate, such as the modular urban fabric, the idea of modernizing area, incorporation into the neighborhood environment, and land use quality, thereby incorporating nature into the urban structure.	From a scientific viewpoint, the findings of this study serve as a springboard for further investigation that considers future specifications and technical opportunities to construct more environmental architecture in the future and combines them with conventional elements.
(Cheng 2021)	There aren't any active solutions or strategies to design a holistic passive planning process that can completely satisfy their objectives for comfort, energy efficiency, and pollution control.	The effects of climate change on structures are significant. According to many studies, climate change will cause a rise in temperature and humidity, which will cause buildings to overheat, use more energy for cooling, and use less energy for heating.	Our future study will incorporate related technologies and approaches, like the Internet of Things and big data, as a supplement.
(Guerrero Baca & Soria López 2018)	There is negligence in the study of architectural heritage, especially traditional architecture, which falls within the framework of environmental and social sustainability to obtain a balance in the current buildings, heading towards more sustainability.	The environmental crisis, which is now acknowledged as one of the most significant issues that modern civilization must deal with immediately, has yet to fully infiltrate the process of historic rebuilding, which is being done with endless resources.	According to the upcoming report, effective development of built heritage is crucial and is undoubtedly currently being created. Cultural, financial, and environmental risk factors must be assessed, associated, and chosen to value our material and immaterial history for the present and the future.
(Mohson et al. 2021)	Traditional and modern building materials cannot be distinguished in terms of environmental sustainability using any theory or evidence.	The author observes Some of the structures' contemporary architecture was inspired by old architecture in a modern style to activate features of sustainability. This deliberate use of historic architectural styles was done to attain social and economic sustainability while simultaneously serving climate purposes, as is the case when quoting the concept of Mashrabiyas.	Future work must develop regional guidelines to ensure the assessment of sustainable structures, in addition to activating the benefits of renewable energy sources, such as solar energy, that are available in our nation on a long-term basis

continue ...

... cont.

(Thi & Nguyen 2021)	There is no clear picture of how current buildings will adapt to climate change and adapt to current technology.	The author concluded that the term "adaptive use" refers to a broad range of uses, such as alterations to the interior and exterior, plans and layouts, the texture and structure of the work, The diversity of indigenous variables, the advancement of unique.	Future work recommended that essential to evolve proactively to adjust to new conditions, satisfy present exploitation requirements, and provide the foundation for future tourism growth.
(Rajković et al. 2022)	The systematic approach to environmental repair in the building looks for the greatest quality of energy efficiency for the architecture, particularly in improving thermal losses in winter, which is the most common issue of a regional residence.	To sustain construction methods that, in general, take an ecological approach, the author finds that vernacular bioclimatic ideas need to be redefined. In addition, it offers cutting-edge approaches based on bioclimatic theories that address both facility energy requirements and contemporary climate challenges.	Future discussions on the significance of vernacular architecture study must be performed as investigations into historical customs and the modern day, but also as contributions to fresh ideas, innovations, and accomplishments for future built environments.
(M Rahim 2022)	There is a gap between the building and the climate which in turn affects the response and development of the traditional structure to environmental protection.	In adaptation to local climatic factors, the vernacular architecture contains characteristics like using local ingredients, a solar energy system, and a "key building" building technique. The architecture philosophy sees the feet (base), body (façade and apartment), and crown (top) of all building typologies as representations of the patient's psyche.	Even though the standards were more stringent in the past, they highlighted the sustainability factors, which are far more important than they are now, when structures tend to focus more on status or luxury and disregard sustainability parameters.
(Alobailan & Alawad 2022)	There is no complete understanding of the present condition of the research about the catalogue of the architectural characteristics that led to the creation of heritage homes and identifying significant research gaps or themes that have not yet been covered and require additional analysis and investigation.	This systematic review's main conclusion was to look at the state of the literature on the architectural significance of historic homes in the KSA. By illustrating the houses' effectiveness at the time of construction and their capacity to suit the requirements of their occupants, it seeks to explain the significance behind their formation.	It is noteworthy that over the past ten years, study on architectural values has been less popular, especially in the eastern and southern regions. This makes it possible for researchers to carry out such work, providing a vital resource for engineers and designers and suggesting cutting-edge solutions.
(Karimi et al. 2022)	No research has been done on historic building rating systems. The use of rating systems is believed to be able to improve the sustainability of historic buildings.	Many of the articles focus on energy efficiency as a way to improve the environmental sustainability of historic buildings, which reduces expenses and raises occupant happiness with the indoor environment.	Further investigation into the creation of a rating system for historic structures has the potential to be conducted, in keeping with the subject matter of this article.
(Ahmed Mustafa Al Jaff et al. 2017)	There is no relationship between the new buildings that will be constructed in the present and those that must be designed with integrity, satisfy current demands, and be sustainable while also blending in with the surrounding contemporary period.	Positive aspects: By preventing the rebirth of historical identity, which would trigger a cultural, political, and financial restoration, the contemporary building will be created. Aspects that have been criticized: Because the modern building in Arbil is a new construction, it does not share the same architectural features as its surrounds and has sharp lines.	Instead of being viewed as a bygone relic to be destroyed and consumed, cultural and historical assets should be viewed as a legacy to be passed down to future generations.

continue ...

... cont.

(Abbas & Khaznadar 2019)	The urban legacy of Erbil, a historic city, is currently threatened by some causes that threaten its survival. Accordingly, quick action is needed to conserve and control its history. There isn't a systematic strategy for selecting the appropriate use of historical structures.	The architecture of these places is very common in its nature and its function. What is left of these buildings requires a revival through restoration and development in a manner that preserves not only the cultural and artistic elements but also their architectural characteristics, while implementing modern standards for the performance of their function.	We should raise awareness of a community and its different institutions to contribute to preserving urban heritage and protecting it and to improve public awareness to preserve their urban heritage.
(Sektani et al. 2021)	Local perspectives and the ways that people experience and understand built heritage have not yet been thoroughly studied. Since local communities and traditions are essential to sustainability, revealing this makes a substantial contribution to the growth of the city.	In one of the first studies of its sort, the majority's opinions of built heritage and its effects on wellbeing were now concurrently investigated. An idea for a conceptual model was put forth and put to the test using case studies, which were based on an interdisciplinary literature survey.	Enhancing the quality of elevated historic homes and associated services is necessary to improve how multiple parties view architectural identity. Due to the underuse of these structures, which is acknowledged by all parties involved, built heritage must also be seen as helpful.
(Khoshnaw & Kissfazekas 2019)	The urban form of these districts has a high potential for sustainability, and the reasons why they are currently unattractive are primarily related to poor management.	In this study, the sustainable development of basically two neighborhoods in Erbil's central city was investigated. The population expansion and rise in vehicle traffic in recent years have had an impact on all aspects of people's cultural, and climatic life,	In this essay, the author suggested examining the traditional areas of Erbil's viability. In the following process of the study, a historical area of Erbil, such as its recently created neighborhoods, will be examined, and their environmental characteristics will be assessed.
(S. M 2019)	The issue is: How has Erbil's development affected the environment?	1. The city of Erbil was split into six distinct municipalities based on population and geography, and the city's initial urban growth occurred to the east and west. 2. This growth led to several climate changes, such as an elevation in the city's warmth, an increase in sandstorms, a decrease in weather, a problem with aquifer contraction, a problem with garbage, a problem with noise, and a problem with the size of the city's farming fields.	We suggest the following in light of the research authors, Create the required legislation and ordinances to stop such urban growth and stop residential areas from being built on any site. The execution of laws involves the involvement of many sectors, including the departments of economy, housing, and urban relations.
(A.Abbas 2017)	The interaction between the Erbil Citadel and the outlying neighbourhoods hasn't been thoroughly examined as a major problem for the major renovation of the citadel. In an integrated strategy, it contends that the revival of the Erbil Citadel and its surrounding neighborhood, or land border.	The study identifies a significant relationship between the Protected Area, which surrounds Erbil Citadel, and its environment. It investigates the theory that, at an earlier time in history, the City of Erbil was a single entity made up of two structurally and physically connected sections.	Furthermore, since the Erbil Citadel is a crucial urban component of Erbil, we advise that you visit it to take in its components, characteristics, and position.

continue ...

... cont.

(Baper 2018)	There is no theoretical foundation for the idea of continuity in creating an architectural identity that is created by looking at how Erbil city's historic buildings play a part in doing so.	Only one-fifth of Erbil's commercial buildings are related to historic structures, according to research findings (as a source of design). In other words, Erbil City's industrial avenues contain a variety of architectural styles that were created by technology and the forces of globalization.	Therefore, it is strongly advised to incorporate the visual components and architectural cues of architectural heritage that actively contribute to creating the national heritage of Erbil city's border zone into other areas of the city, such as residential properties.
(Ahmed Mustafa Al Jaff et al. 2017)	There is no relationship between the new buildings that will be constructed in the present and those that must be designed with integrity, satisfy current demands, and be sustainable while also blending in with the surrounding contemporary period.	Positive aspects: By preventing the rebirth of historical identity, which would trigger a cultural, political, and financial restoration, the contemporary building will be created. Aspects that have been criticized: Because the modern building in Arbil is a new construction, it does not share the same architectural features as its surrounds and has sharp lines.	Instead of being viewed as a bygone relic to be destroyed and consumed, cultural and historical assets should be viewed as a legacy to be passed down to future generations. This approach should be more integrated into society by reviving and protecting abandoned and uninteresting areas, to re-evaluate and defend the past and present.

DISCUSSION

We have evaluated our current research in this area and have provided the answers to the three research questions that are discussed in the background of the study. Given the destruction that has been caused by modern architecture, it is clear from the results that research on traditional buildings, adaptation, architectonics, and smart sustainability has begun to gain momentum and will quickly advance. In the past few years, there have been considerable advancements in the areas of traditional systems, adaptation, architectonics, and clever sustainability.

In 2014, studies saw a significant change as academics published their results in different journals, and the evaluation of the national technological prowess showed a unique view. The pattern indicates a general rising concentration of academic pursuits in Asia, which predominately includes important developing countries such as China and India.

Based on bibliographic data evaluated in the VOS viewer, the researchers created the conceptual model using bibliographic coupling and co-citation analysis. It reveals intriguing patterns and topics in the areas of traditional building, adaptation, architectonics, and smart sustainability as well as the formation of many groupings that assist in the recognition of the academic structure of the study area.

To identify the common thread of knowledge that is circulating among specialists in traditional building, adaptation, architectonics, and smart sustainability, the researchers employed a search strategy. The strategy demonstrates that researchers frequently employ the classic architectural building research paradigm and that its characteristics may be used alternately to promote the use of smart construction.

In addition, the great majority of scientists prefer to evaluate their suggested concepts using SLR. The results of the RQ (1 and 2) have highlighted the research of the most prolific and significant writers in the areas of traditional construction, adaptation, architectonics, and smart sustainability. Additionally, it depicts the growing concentration of research activity in this sector. According to the analysis, Wang X and Zhang J, who are both from China, have become the researchers in this subject who have the most significant discoveries. According to the research, Wang X's work is among the most widely mentioned in the subjects of traditional construction, adaptability, architectonics, and smart sustainability.

The results show a relationship between and the collaboration among the countries that apply the concepts. According to the author's collaborative structure, scholars within the same particular region are more engaged in collaborative work, which has a positive synergistic effect and improves academic productivity.

In addition to bibliometric study, qualitative content analysis of the titles and abstracts of publications released in Scopus, Web of Science, Google Scholar, IEEE, and Science Directs databases on the "Adaptation of traditional building" was also conducted. The major themes were the

research gap, findings, future work and recommendations. Table 7 presents the results.

Table 7 demonstrates that the survey of the 24 literatures has focused on historical structures and the preceding works on "Adaptation of Traditional Building". When it comes to the three traditional pillars of sustainability, namely economic, social, and environmental sustainability, the majority of the focus has been on converting a conventional architectural structure into a smart sustainable building in the future. Most of the articles focus on energy efficiency as a strategy to increase the environmental sustainability of historic buildings, which lowers costs and improves occupant satisfaction with the indoor environment.

Due to the distinctive qualities of historic structures, it is important to change existing criteria and add new ones that are not covered by any of the grading systems under consideration. The only sustainability system that has so far been adapted to historical structures is the Italian GBC HB, which focuses on the environmental side of sustainability, specifically boosting the energy savings of historic buildings Future evaluation schemes should be developed or updated in accordance with the specifications of cultural assets, and socio-cultural and economic considerations are equally important for the continued survival of cultural property.

method is described after this section. The mean RMS value for R action is higher than the HP and FP actions. For HP action, the mean RMS values for pre-post activity for position A are 4.58 (15%) and 5.18 μV (15%) respectively. For R action, the mean RMS values is 10.09 μV at %MVIC 30%. Meanwhile, for FP and HP action, the value is 6.37 μV at 20% and 4.58 μV at 15%, respectively.

CONCLUSIONS

In the bibliometric studies and reviews, a detailed science-metric analysis was used as an influential technique. Several significant arguments merit additional consideration because of the work's analyses. They are:

1. According to keyword analysis, the most frequently used terms among researchers are Smart Sustainable, Traditional Building, Adaption, Architectonic traditional, and Smart Future.
2. Among the present scheduling issues, a summary table of literature review on traditional architecture, a summary table of the most significant literature review on smart sustainability, and a summary table of the most significant literature review for adapting traditional buildings to smart sustainability.
3. The countries' scientific production, the higher number are from China, the UK, United States become 2nd and 3rd countries continuously while Germany 7th country in the series, furthermore, the minimum number of published documents in the group of countries is from Canada.
4. Among the proposed solution methods for solving the problems among all academic articles, include the latest studies of the database- up to 2022, the analysis, through qualitative and quantitative data, whereby the data collection analysis has yielded the greatest contribution.
5. In this work, the authors have presented a literature review and classified in tables the main objectives, constraints and methods of this problem to facilitate the literature tracing and to identify the trends for future research.

There were some constraints that must be considered in this study's process. In the beginning, English was used for both the search as well as the collection and analysis of the articles. Since historical structures fall under a broad umbrella that affects all cultures, there is probably a study that has been done in each of the nation's official language, which has been left out. The ability to access all the documents from the international rating systems was also restricted. Furthermore, the combination of the keyword's 'sustainability' or 'smart sustainability' with 'traditional buildings and 'adaptation' indicates that these terms were referenced in the publication's title, abstract, or full text (Science Direct) (Google Scholar).

It is crucial to adapt strategically to changed situations, fulfil current utilization requirements, and provide the groundwork for long-term sustainable growth. The adaptive use of traditional architecture would be one approach to further that development from the point where it is important to take into account the values of vernacular architecture as the foundation. Also, to assure the evaluation of energy-efficient systems regional guidelines should be developed.

This experience must be recovered- not as an antimicrobial experimental investigation, but rather through its updated application and active implementation- to realise the benefits of the renewable energy sources, such as the solar energy that is readily available in our country and to help to preserve our cultural and environmental settings.

Current architectural techniques can be created to make the best use of local resources, to employ construction methods based on local knowledge, use sustainable conceptual models, and take into consideration regional climate changes throughout time.

According to this study's research, the fundamental

issue is that it is unclear how modern buildings will adapt to climate change and the present technologies. Additionally, there is no way to distinguish between the sustainability of an old and a modern building construction in architecture. The neglect of the study of traditional architecture in particular, which fits into the framework of social and environmental sustainability to achieve balance in the current structures, moves towards greater sustainability. The lack of in-depth understanding of the qualities of traditional architecture including the beneficial elements that enhance sustainability in the existing structures give to the notion that traditional architecture is of low quality. Furthermore, there is no sustainability index for traditional architectural history that would facilitate the process of developing sustainable structures while maintaining the location's character and cultural context.

PERSPECTIVES FOR FUTURE RESEARCH

The local expertise possessed, however, should be used in future residential design. It is necessary to perform more studies in lighting of comparisons with related fields and the diversity of the data resource. Increasing the awareness of severe weather conditions is also required to create successful strategies. Correspondingly, a suitable policy can subsequently be developed on the subject of environmental issues.

Future studies should concentrate on the procedures for building a new structure while taking the lessons that have been discovered o conventional architecture into account. However, because of the climatic differences across different places, where people build according to their local conditions and experiences, those sustainability teachings may also be found in numerous cultures.

In the future, sustainable building technology will be developed in a more intellectual, humanized, and individualized way, supplying more comfortable, safe, and efficient smart services for new houses and encouraging sustainable living. A more pleasant and welcoming environment for users' human-computer interactions can only be achieved through technical and unplanned contact between people and computers.

Finally, from a critical standpoint, the findings of this article provide a starting point for more thorough research that considers the potential uses and advantages of technology in the future.

ACKNOWLEDGEMENT

This work supported by the Ministry of Higher Education Malaysia that had funded this research through the Fundamental Research Grant Scheme (FRGS/1/2019/TK10/UKM/02/4 - Adaptation of An Architectonic Traditional Building: A Systematic Review).

DECLARATION OF COMPETING INTEREST

None

REFERENCES

A. Abbas. 2017. Erbil citadel revitalization and the presence of its emergence history. *3rd International Conference on Preservation, Maintenance and Rehabilitation of Historic Buildings and Structures*, Braga.

A. Abbas & Khaznadar, B. 2019. Using adaptive reuse as a strategy for the renovation of traditional vernacular architecture in Erbil city.

Asma Ahmed Mustafa Al Jaff, Mohammed Sabah Al Shabander & Havva Alkan Bala. 2017. Modernity and tradition in the context of Erbil old town. *American Journal of Civil Engineering and Architecture* 5(6): 217–224. DOI:10.12691/ajcea-5-6-1.

Al-Jubouri, I.H.K., Al-Hilali, B.M.I. & Jasim, A.A. 2022. Iraq (heritage houses as a model). DOI:10.1007/978-3-030-99480-8.

Alabsi, A.A.N., Song, D.X. & Garfield, W.H. 2016. Sustainable adaptation climate of traditional buildings technologies in the hot dry regions. *Procedia Engineering* 169: 150–157. DOI:10.1016/j.proeng.2016.10.018.

Alabsi, A.A.N., Wu, Y., Koko, A.F., Alshareem, K.M. & Hamed, R. 2021. Towards climate adaptation in cities: Indicators of the sustainable climate-adaptive urban fabric of traditional cities in West Asia. *Applied Sciences (Switzerland)* 11(21). DOI:10.3390/app112110428.

Alobailan, L. & Alawad, A. 2022. Architectural values behind the formation of heritage houses as a tool for promoting cultural identity in Saudi Arabia. *Islamic Heritage Architecture* 4(1): 29–50. DOI:10.2495/iha220031.

Alyami, S.H. & Alreshidi, E.J. 2019. Holistic IoT architecture for smart sustainable cities: Current

perspective and future directions. *Proceedings of the 2019 6th International Conference on Computing for Sustainable Global Development, INDIACom 2019* 312–317.

Amrutha, V.N. & Geetha, S.N. 2020. A systematic review on green human resource management: Implications for social sustainability. *Journal of Cleaner Production* 247: 119–131. DOI:10.1016/j.jclepro.2019.119131.

Baper, S.Y. 2018. The role of heritage buildings in constructing the continuity of architectural identity in Erbil city. Heritage buildings as a physical reference. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologie*s (1): 1–12.

Carlos, G.D., Correia, M.R. & Rocha, S. 2015. Vernacular architecture? DOI:10.1201/b18856-4

Cheng, C. 2021. Adaptation of buildings for climate change: A literature review.

Costantini, M. 2017. Adaptable architecture: Theory and practice. *International Journal of Building Pathology and Adaptation* 35(4): 434–435. DOI:10.1108/IJBPA-09-2017-0044.

Edition, F. T. H. (n.d.). Cambridge Learner's Dictionary.

Ellegaard, O. 2018. The application of bibliometric analysis: Disciplinary and user aspects. *Scientometrics* 116(1): 181–202. DOI:10.1007/s11192-018-2765-z

Farah Wisssam Al-hashimi. 2016. The hidden face of Erbil change and persistence in the urban core. 395. Retrieved from http://irep.ntu.ac.uk/id/eprint/31613/.

Flexibility_in_building_use_the_technica.pdf. (n.d.).

Geraedts, R.P. 2008. Design for change; flexibility key performance indicators. *1st International Conference on Industrialised, Integrated, Intelligent Construction (I3CON)* (May): 11.

Grandjean, P., Eriksen, M.L., Ellegaard, O. & Wallin, J.A. 2011. The Matthew effect in environmental science publication: A bibliometric analysis of chemical substances in journal articles. *Environmental Health: A Global Access Science Source* 10(1): 1–8. DOI:10.1186/1476-069X-10-96.

Guerrero B.L.F. & Soria L.F.J. 2018. Traditional architecture and sustainable conservation. *Journal of Cultural Heritage Management and Sustainable Development* 8(2): 194–206. DOI:10.1108/JCHMSD-06-2017-0036.

Harvey, L. 2008. Rankings of higher education institutions: A critical review. *Quality in Higher Education* 14(3): 187–207. DOI:10.1080/13538320802507711.

Hawar Himdad J. Sektani, Mahmood Khayat, Masi Mohammadi & Roders, A.P. 2021. Erbil city built heritage and wellbeing: An assessment of local perceptions using the semantic differential scale. *Sustainability (Switzerland)* 13(7): 1–19. DOI:10.3390/su13073763.

Karimi, F., Valibeig, N., Memarian, G. & Kamari, A. 2022. Sustainability rating systems for historic buildings: A systematic review. *Sustainability* 14(19): 12448. DOI:10.3390/su141912448.

Kaur, J., Radicchi, F. & Menczer, F. 2013. Universality of scholarly impact metrics. *Journal of Informetrics* 7(4): 924–932. DOI:10.1016/j.joi.2013.09.002.

Kendall, S., Coordinator, J. & Ando, M. 2005. Executive summary of the session theory and methods in support of adaptable building. *The 2005 World Sustainable Building Conference*, 27–29, Tokyo.

Khan, A., Jhanjhi, N.Z. & Humayun, M. 2022. The role of cybersecurity in smart cities. *Cyber Security Applications for Industry 4.0,* 195–208. DOI:10.1201/9781003203087-9.

Khoshnaw, R. & Kissfazekas, K. 2019. Urban form and sustainability in historic cities: A case study of two neighbourhoods in Erbil city, Iraq. *Epites-Epiteszettudomany* 47(1–2): 189–215. DOI:10.1556/096.2018.014.

Mileto, C., Vegas, F., Llatas, C. & Soust-Verdaguer, B. 2021. A sustainable approach for the refurbishment process of vernacular heritage: The sesga house case study (Valencia, Spain). *Sustainability (Switzerland)* 13(17): 1–19. DOI:10.3390/su13179800.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., Altman, D., Antes, G., Atkins, D. et al. 2009. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine* 6(7). DOI:10.1371/journal.pmed.1000097

Mohson, Z.H., Ismael, Z.A. & Shalal, S.S. 2021. Comparison between smart and traditional building materials to achieve sustainability. *Periodicals of Engineering and Natural Sciences* 9(3): 808–822. DOI:10.21533/pen.v9i3.2283.

Mostafa, I. & Demery, E. 2010. Sustainable architectural design: Reviving traditional design and adapting modern solutions. *International Journal of Architectural Research: Archnet-IJAR* 4(1).

Murata, K., Wakabayashi, K. & Watanabe, A. 2014. Study on and instrument to assess knowledge supply chain systems using advanced kaizen activity in SMEs. *Supply Chain Forum* 15(2): 20–32. DOI:10.1080/16258312.2014.11517339.

M. Rahim. 2022. Bioclimatic and sustainable features on vernacular architecture in Ternate. *IOP Conference Series: Materials Science and Engineering* 1212(1): 012006. DOI:10.1088/1757-899x/1212/1/012006.

Mustamin Rahim, Maulana Ibrahim & Firdawati Marasabessy. 2021. Construction system and environment adaptation of traditional architecture in Moluccas Island. *Civil Engineering and Architecture* 9(5): 1530–1545. DOI:10.13189/CEA.2021.090524.

Minhaz Nishan. 2019. Urban expansion of Erbil and the effects of environmental during the period 1947-2017 (A study in the geography of cities). *The Journal of The University of Duhok* 22(1): 452–468. DOI:10.26682/hjuod.2019.22.1.26.

N. Fakriah & M.H.A. Edytia. 2021. Sustainability concept as climate change adaptation in the vernacular house in Aceh. *IOP Conference Series: Earth and Environmental Science* 881(1).
DOI:10.1088/1755-1315/881/1/012026

Philokyprou, M. & Michael, A. 2021. Environmental sustainability in the conservation of vernacular architecture. the case of rural and urban traditional settlements in Cyprus. *International Journal of Architectural Heritage* 15(11): 1741–1763. DOI:10 .1080/15583058.2020.1719235.

Rajković, I., Bojović, M., Tomanović, D. & Akšamija, L.C. 2022. Sustainable development of vernacular residential architecture: A case study of the Karuč settlement in the Skadar lake region of Montenegro. *Sustainability (Switzerland)* 14(16). DOI:10.3390/ su14169956.

Sahebzadeh, S., Heidari, A., Kamelnia, H. & Baghbani, A. 2022. Sustainability features of Iran's vernacular architecture: A comparative study between the architecture of hot–arid and hot–arid–windy regions. *Sustainability* 9(5): 749.

Shireen, P., Illyani, J.K., Zalina, I.N. & Kamaruddin, H.K. 2018. Ecological urbanism in the tropics studies on the sustainable dimensions of Malay traditional urban centers. *International Journal of Engineering and Technology(UAE)* 7(3): 93–99. DOI:10.14419/ ijet.v7i3.9.15285.

Sholihah, A.B., Agustiananda, P.A., Junanah & Setiawan, W. 2019. Traditional architecture: The role of traditional festival in Islamic historic district to achieve local community wellbeing. *Journal of Design and Built Environment* 19(3): 13–23. DOI:10.22452/jdbe.vol19no3.2.

Slaughter, E.S. 2001. Design strategies to increase building flexibility. *Building Research and Information* 29(3): 208–217. DOI:10.1080/09613210010027693.

Sokienah, Y. 2020. Aspects of sustainability in the design elements of traditional Jordanian houses. *Civil Engineering and Architecture* 8(6): 1194–1201. DOI:10.13189/cea.2020.080604.

Soleymanpour, R., Parsaee, N. & Banaei, M. 2015. Climate comfort comparison of vernacular and contemporary houses of Iran. *Procedia - Social and Behavioral Sciences* 201: 49–61. DOI:10.1016/j. sbspro.2015.08.118.

Stefano, A., Endayani, S. & Sadono, R. 2021. Combining the traditional and modern architecture in Taman Samarendah Plan, Samarinda City, East Kalimantan Province, Indonesia. *International Journal on Advanced Science, Engineering and Information Technology* 11(2): 705–711. DOI:10.18517/ ijaseit.11.2.8341.

Teknologi, U., Uitm, M. & Alam, P. 2018. Aspects of sustainable architecture: Centre for innovative architecture and build environment (SERAMBI). Faculty of Engineering and Built Environment, Center of Studies for Architecture, Faculty of Architecture Planning and Surveying 11: 2–11.

Thi, H.L.V. & Nguyen, T.Q. 2021. Adaptive reuse of local buildings in Sapa, Vietnam for cultural tourism development towards sustainability. *IOP Conference Series: Earth and Environmental Science* 878(1). DOI:10.1088/1755-1315/878/1/012032.

van Eck, N.J. & Waltman, L. 2013. *VOSviewer Manual*. Leiden: Univeristeit Leiden. http://www.vosviewer.com/documentation/Manual_VOSviewer_1.6.1.pdf (accessed September).

Wicaksana, A. 2016. Building Adaptation. https://medium.com/@arifwicaksanaa/pengertian-use-case-a7e576e1b6bf (accessed n.d.)

Zeynab Mohammadian & Majid Shahbazi. 2018. Study of the effect of sustainable architecture on the design of residential buildings (Case study: Qazvin Pardis complex). *Civil and Environmental Engineering* 14(2): 91–98. DOI:10.2478/cee-2018-0012.