



Research Article

© 2024 Tiantian et al.  
This is an open access article licensed under the Creative Commons  
Attribution-NonCommercial 4.0 International License  
(<https://creativecommons.org/licenses/by-nc/4.0/>)

Received: 1 September 2023 / Accepted: 20 December 2023 / Published: 5 January 2024

## Areas of Study on Flexibility Housing for Sustainability: Bibliometric Analysis of Cross-regional Trends

Mu Tiantian<sup>1</sup>

Jestin Nordin<sup>1\*</sup>

Nor Fadzila Aziz<sup>1</sup>

Guangyu Zhu<sup>2</sup>

Xu Yang<sup>3</sup>

<sup>1</sup>School of Housing,  
Building and Planning,  
Universiti Sains Malaysia,  
Malaysia

<sup>2</sup>School of Design and Art,  
Communication University of Zhejiang,  
310018 Hangzhou,  
Zhejiang Province,  
China

<sup>3</sup>School of Arts,  
Universiti Sains Malaysia,  
Malaysia

\*Corresponding Author

DOI: <https://doi.org/10.36941/ajis-2024-0009>

### Abstract

Urbanization has led to an uneven distribution of adequate, safe, and affordable housing as the global population converges on cities. Many cities are faced with significant housing price disparities. Housing flexibility can reduce the cost of housing and meet the human need for comfort, health, safety, and a sense of community in housing, in line with the UN Sustainable Development Goals and Principles. As a result, experts and academics in the architectural design field are increasingly focusing their interest on this matter. This paper offers a bibliometric analysis of all Scopus database publications pertaining to housing flexibility from 2010 to 2021 and energy efficiency characterization. The status of research on housing flexibility in sustainability research is further discussed. The study uncovers yearly research publications, average citation rates, locally cited literature, prominent information sources, corresponding author countries, domestic scientific output, and a global representation of international collaborations. Overall, this research offers an in-depth description of the subjects and methodologies within the most frequently cited articles.

**Keywords:** Flexibility Housing, Sustainability, Bibliometric, Methods and Subjects, Energy Efficiency Characterization

## 1. Introduction

Architecture plays a very important role in shaping human lives. Humans spend most of their time, money, and effort on buildings, particularly constructing their own houses. Therefore, the housing industry is an essential part of overall regional and urban development and requires full cooperation from different institutions and agencies to provide the basic needs of its citizens. However, human perceptions have evolved over time, as have the forms, methods, and uses of housing, causing the study of housing to become an important architectural theme (Gad & Aly, 2020).

Energy efficiency investments are integrated into the conventional capital budgeting processes at the firm level. These investments in commercial, institutional, and governmental buildings typically encompass various aspects like lighting, heating, ventilation, air conditioning (HVAC), and components such as motors and reflective roofs (Jackson, 2010). Efficiency decisions are made at the building's initial design stage, during equipment replacement, or as part of efficiency enhancements that can be implemented at any point. Regarding energy efficiency investments in industrial companies, they come in two distinct categories. Substantial alterations in production technology and processes are relatively rare, happening once every ten years or longer, and are mainly influenced by choices related to technological advancements, market demands, and other strategic, longer-term considerations (Jackson, 2010).

Sustainability is a prevailing concern in contemporary social development. As per the Sustainable Development Goals pertaining to housing research, the objective is to guarantee that every individual has access to suitable, secure, and economically viable housing alongside essential services. Nowadays, with the concentration of today's world population in the cities, urbanization has led to an uneven distribution of proper, safer, and affordable housing. Many cities face huge differences in housing prices, which are always too costly, while most ordinary families lack the financial resources to move to a house better suited to their changing needs. As a result, households have had to meet their changing living needs by increasing the flexibility of their housing where possible (Borsos et al., 2019).

Bibliometrics can be used as an analytical method to measure progress in the discipline, and it facilitates a detailed analysis of the relevant literature (Elaish et al., 2019; Kalantari et al., 2017). To assess the research, various additional indicators are required. Using citation analysis and peer review has often enhanced evaluation quality (Das, 2015). According to Ellegaard & Wallin (2015), several handful tools (databases) significantly facilitate the creation of bibliometric outcomes. These databases comprise citation analysis and the Web of Science Core Collection (WoS), Google Scholar, and SCOPUS (Martin et al., 2018; Bergman, 2012). However, Google Scholar offers unrestricted access to all types of scholarly literature, which makes its coverage questionable (Mongeon & Paul-Hus, 2015). WoS and SCOPUS are the most common search databases used by all academics to search the literature in different scientific fields (Chadegani et al., 2013). Hence, this research undertakes a comparison of the inclusion of studies related to flexible housing within SCOPUS and WoS databases and identifies the database that best serves as the research platform. Current research aims include quantifying trends in housing flexibility research, characterizing global collaboration and authorship dynamics, and evaluating citation patterns with influential literature.

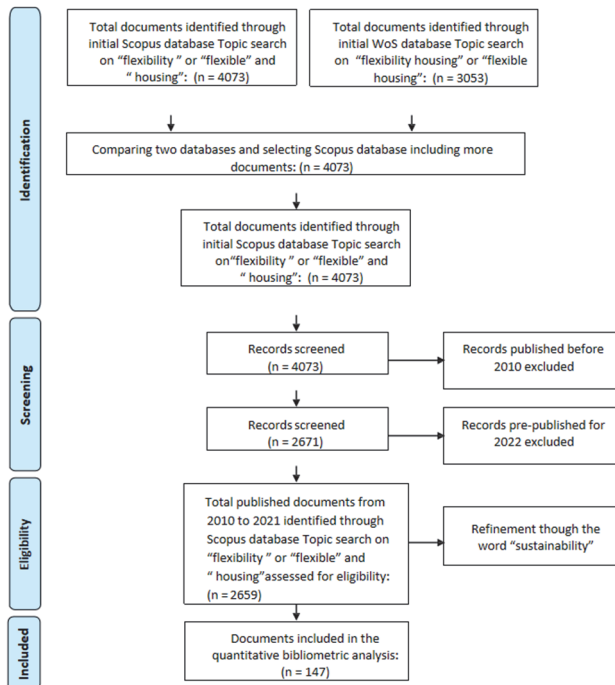
## 2. Methodology

The flexible housing subject served as the basis for this study. The search criteria were applied to Web of Science (WoS) and Scopus using the subject, title, abstract, and keywords, including "flexible housing," "flexible," and "housing." The results yielded 3053 publications in WoS and 4073 in Scopus, respectively. Although WoS is an extensive and reputable database for searching and analyzing literature, Scopus encompasses a significantly wider and comprehensive range of journals (Ghanbari et al., 2019; Chadegani et al., 2013). Title, abstract and keyword search for flexibility housing in Scopus on 19 November 2021 shows that there were total of 2659 articles. The total number of citations for these 2659 articles was 21,766, with approximately 8.18 citations per documents (**Figure 1**). Research shows that the number of publications in flexible housing field has increase dramatically during this time (2010-2021).

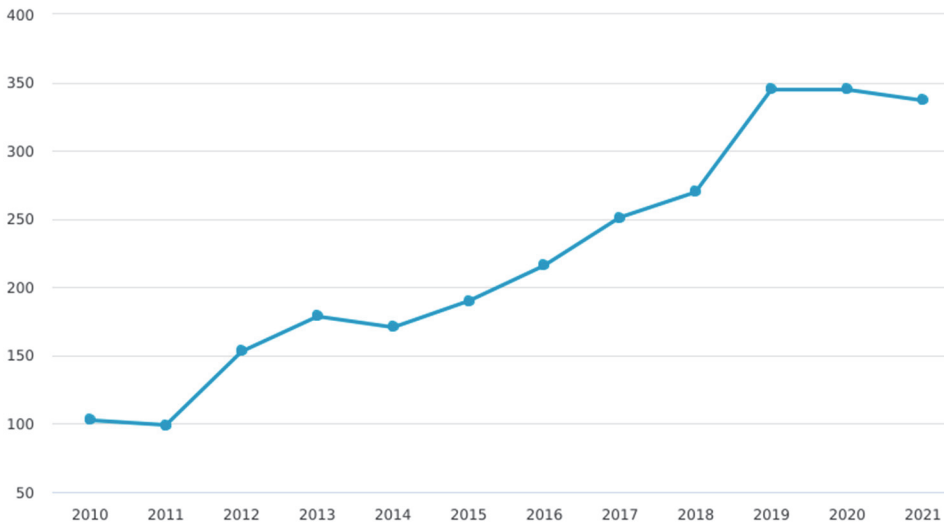
Description	Results
<b>MAIN INFORMATION ABOUT DATA</b>	
Timespan	2010:2021
Sources (Journals, Books, etc)	110
Documents	147
Average years from publication	4.14
Average citations per documents	8.245
Average citations per year per doc	1.731
References	6037
<b>DOCUMENT TYPES</b>	
article	119
book chapter	1
conference paper	21
review	6
<b>DOCUMENT CONTENTS</b>	
Keywords Plus (ID)	1015
Author's Keywords (DE)	556
<b>AUTHORS</b>	
Authors	416
Author Appearances	422
Authors of single-authored documents	30
Authors of multi-authored documents	386
<b>AUTHORS COLLABORATION</b>	
Single-authored documents	31
Documents per Author	0.353
Authors per Document	2.83
Co-Authors per Documents	2.87
Collaboration Index	3.33

**Figure 1:** Flexibility housing articles publications year 2010-2021

A thematic search using the keyword "sustainability" yielded 147 citations in Scopus database. The citation count per publication in its associated literature is around 8.245, surpassing the citation count for the keyword "flexible housing". The data collection process is shown as preferred R-reporting items for systematic reviews and meta-analyses (PRISMA) in **Figure 2**. R- Tool (BiBliometrix-package; <http://www.bibliometrix.org/>) was used to analyze the 147 papers, based on Aria & Cuccurullo (2017) method.



**Figure 2:** PRISMA diagram for bibliometric analysis in the sustainable flexible housing field

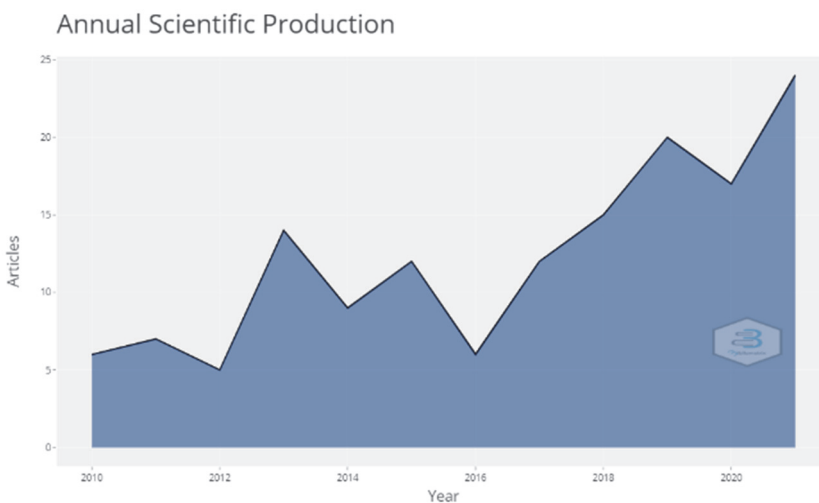


**Figure 3:** Synopsis of collected bibliometric data, 2010-2021

## 2.1 Quantitative Study

### 2.1.1 Examination of Publication Years

Figure 3 depicts the summary of key information from the bibliometric data. There were 119 articles, one book chapter, 21 conference papers and six reviews. Thus, to understand the latest sub-themes in the field of research on "flexible housing", particularly concerning sustainability, out of 119 articles, a qualitative analysis was conducted on the 10 most frequently cited publications. Both quantitative and qualitative outcomes were depicted in the subsequent section.



**Figure 4:** Annual scientific output for sustainability in flexibility housing research, 2010-2021

Figure 4 shows the annual scientific output of articles on "flexibility housing" and "sustainability" published between 2010 and 19 November 2021. One hundred forty-seven research articles were published, including 119 dissertations, 1 book chapter, 21 conference papers and 6 reviews. The total number of publications per year shows a generally upward trend, with a more fluctuating number of publications from 2010 to 2016, reaching its lowest output in 2012 and the highest, albeit only 14, in 2013. Starting in 2017, flexible housing began to receive renewed attention from researchers, and in the following years, the number of articles published climbed rapidly, reaching a peak of 24 in 2021.

### Average Article Citations per Year

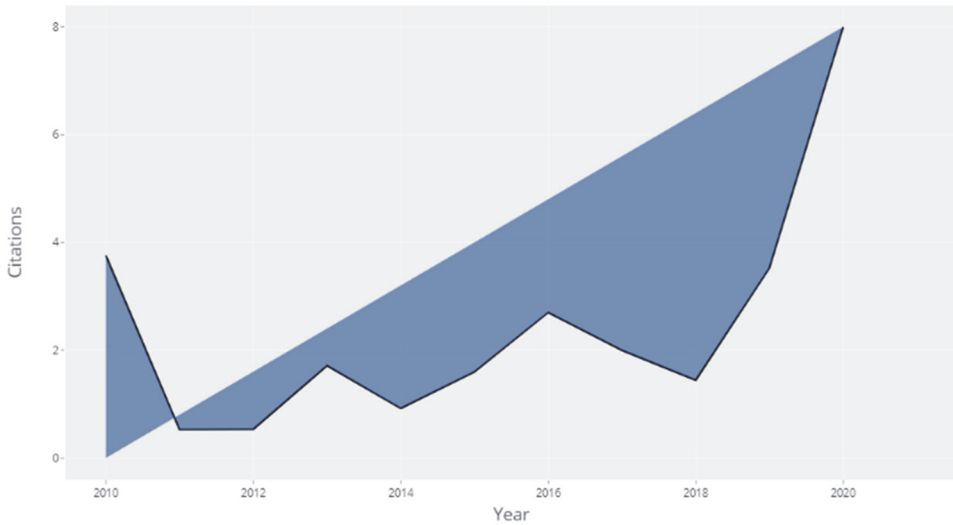


Figure 5: Average yearly citations for flexibility housing sustainability research, 2010-2021

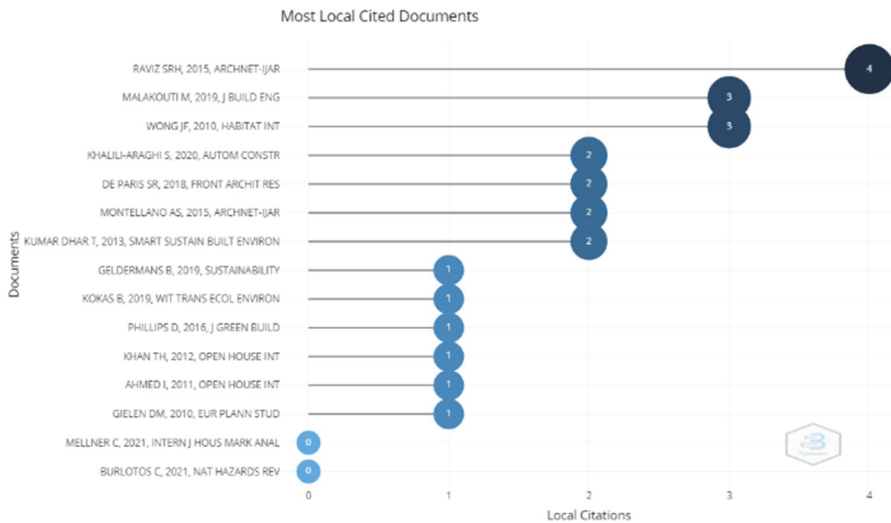


Figure 6: Top 15 locally cited flies published on flexibility housing for sustainability research area

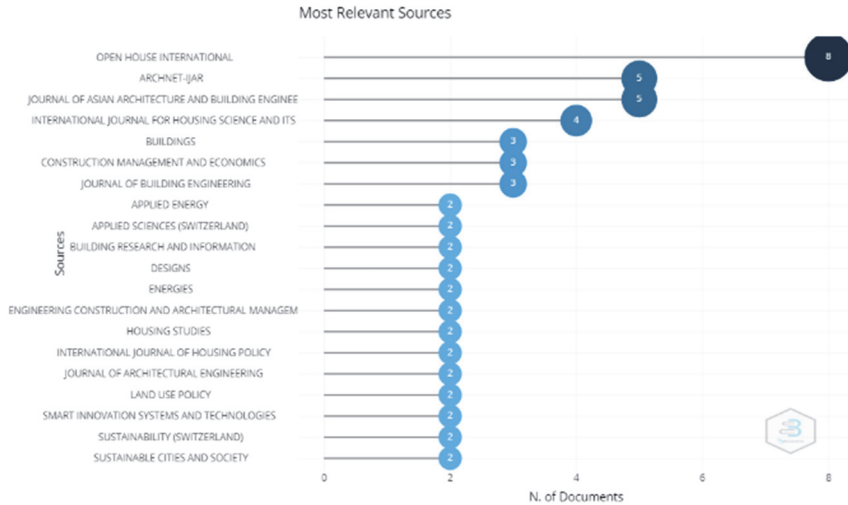
Figure 5 shows the yearly citations for articles published between 2010 and 2020. There has been an annual increase trend from 2018, with the highest yearly average citation value of 8.0. Most articles were published in 2020, followed by 2019. Figure 6 clearly shows the 15 highest local citations between 2010 and 2021. Local citations assess the citations received by papers within the dataset. As the graph shows, an article from 2015 has the highest citation rate, followed closely by 2019 & 2010, but it is the 2019 article that appears the most.



**Figure 7:** Top 10 utmost correlative author's output on flexibility housing for sustainability research areas during 2011 and 2021

## 2.2 Analysis of the Authors

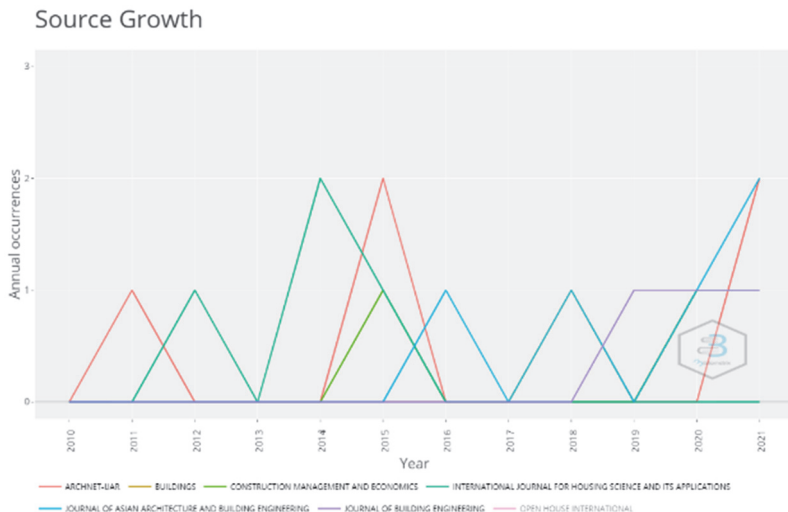
Figure 7 shows the production of the top 10 most correlative authors between 2011 and 2020. The red line indicates the authors' timeline. For example, CAPOLONGO S and REBECCHI A published two articles on sustainable flexible housing between 2017 and 2020, the two authors with the longest timeline. Moreover, the size of the circle is related to the quantity of papers published in the year, e.g., SCUDERIG published 2 articles in 2019 (Figure 7). In addition, the intensity of the circle color is also linked to the whole quantity of citations each year, e.g., CAPOLONGO S and REBECCHI A published papers with a higher citation rate than other authors. According to this graph, the number of publications and citations of articles on flexible housing in the sustainability field has significantly increased in 2020, indicating that more and more research scholars are interested in this field and are beginning to study it.



**Figure 8:** Top 20 utmost correlative sources by the number of papers published on flexibility housing for sustainability research area

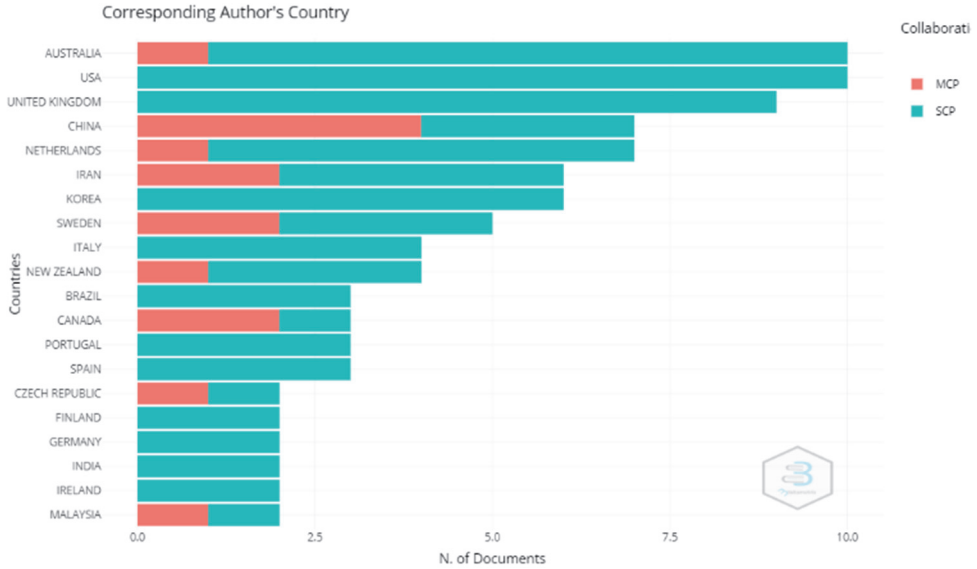
### 2.3 Source Analysis

Figure 8 reveals the top 20 publisher sources most relevant to sustainable flexible housing. Each source has two or more papers relevant to the field. Firstly, OPEN HOUSE INTERNATIONAL is the best key journal in this area, with 8 papers published between 2010 and 2021. ARCHNET-IJAR and JOURNAL OF ASIAN ARCHITECTURE AND BUILDING ENGINEERING come second, with five related articles. Therefore, the top three journals in the chart are important for everyone studying flexible housing when preparing a paper for submission.



**Figure 9:** Yearly incidence of the top 5 utmost correlative sources in flexibility housing for sustainability from 2010 to 2021

Figure 9 depicts the publication trends of the top 5 publications from 2010 to 2021, with 7 publications. These publications exhibit a consistent upward trend, particularly *ARCHNET-IJAR* and *JOURNAL OF ASIAN ARCHITECTURE AND BUILDING ENGINEERING*. The two journals with the most publications show a gradual increase from 2019 onward.

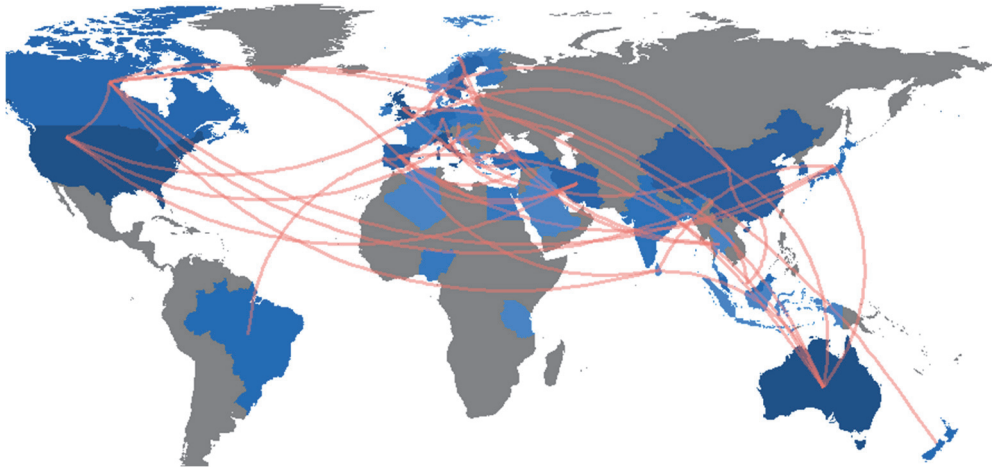


**Figure 10:** Top 20 corresponding author's nation. Note: red line: Multiple Countries Publication (MCP), Single Country Publication (SCP)

#### 2.4 Analysis of the State

A collection of 147 papers from 48 countries has been published in sustainable flexible housing. Figure 10 shows the top 20 nations arranged in the light of their scientific output. The red line shows the publication rate in the corresponding author's nation, encompassing collaborations with one or more international partners known as Multi-Country Publications (MCP). Meanwhile, the blue line indicates Single Country Publications (SCP), representing the number of dissertations published in the same countries. The graph shows that AUSTRALIA and the USA, the most relevant countries, have published 10 articles. After that, the sub-relevant countries are UNITED KINGDOM, CHINA, and NETHERLANDS. CHINA is involved in the largest number of international collaborations in these countries.





**Figure 11:** World Map: Nations' Contributions to Flexible Housing Sustainability Research.  
**Note:** Blue (dark/light): number of authors affiliated per nation; Gray: non-related country

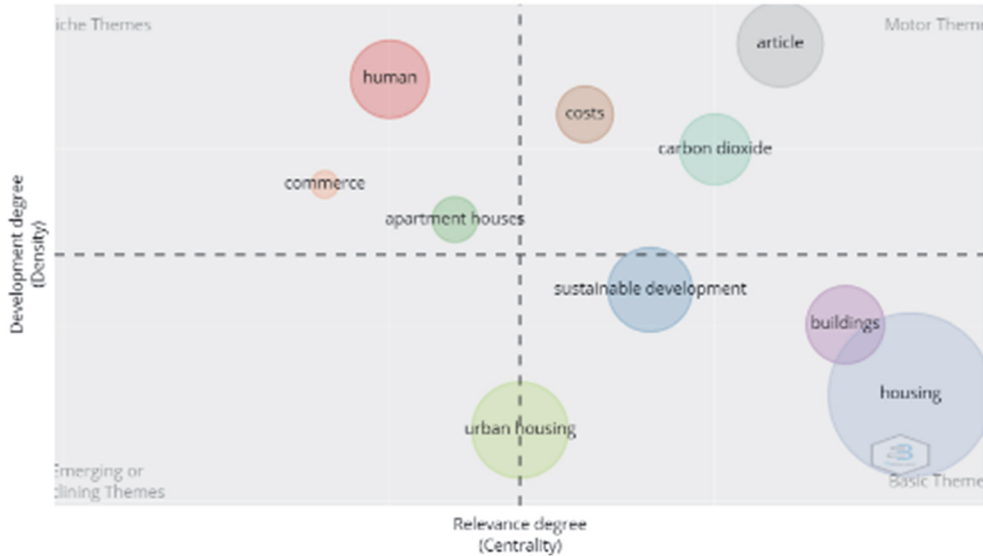
Figure 11 displays the top nations in terms of the number of joint papers published in sustainable and flexible housing. In both graphs, the depth of the blue hue corresponds to the number of contributing authors per country. Each variation of blue denotes a specific number of contributing authors, ranging from dark blue for AUSTRALIA with 30 authors to light blue for THAILAND with only one author. The shades of blue highlight that AUSTRALIA serves as a central research hub in sustainable flexible housing research, followed by the USA and ITALY, equally productive as the second most prolific contributors.

## Country Scientific Production



**Figure 12:** Nation cooperation world map of flexibility housing for sustainability research area.  
**Note:** red line width: the number of joint publications

Figure 12 demonstrates that the width of the red line corresponds to the number of collaborative publications between specific nations. Thicker the red line signifies a higher level of cooperation between the countries at either end of this line. As the graph shows, the width of the red line is consistent between countries, indicating a comparable number of collaborations between countries, with AUSTRALIA and SPAIN having the highest number of collaborations with other countries. It shows close scientific links between AUSTRALIA, SPAIN, and other countries.



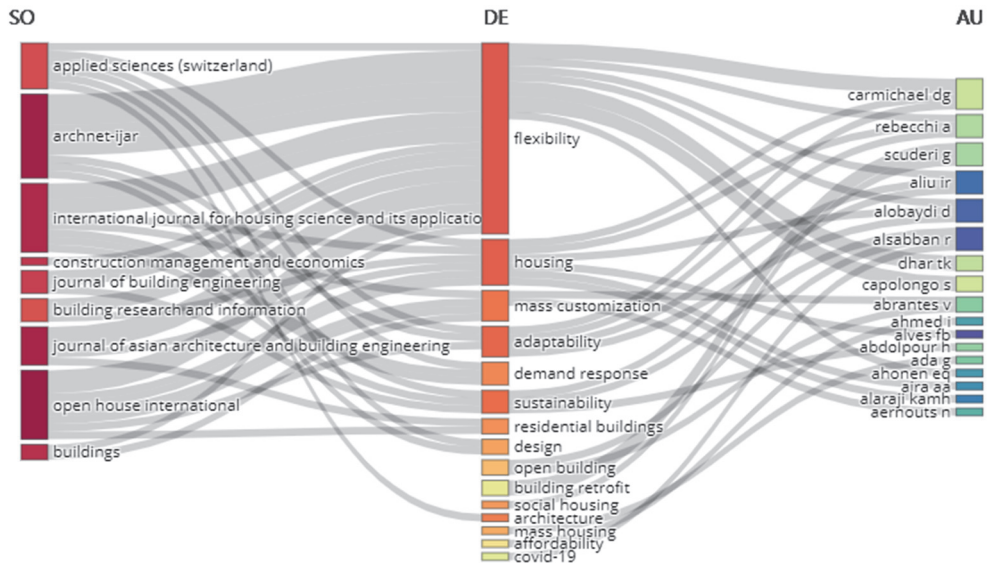
**Figure 13:** Mapping themes and networks of keyword clusters in the research area of sustainable flexible housing

### 2.5 Subject Analysis

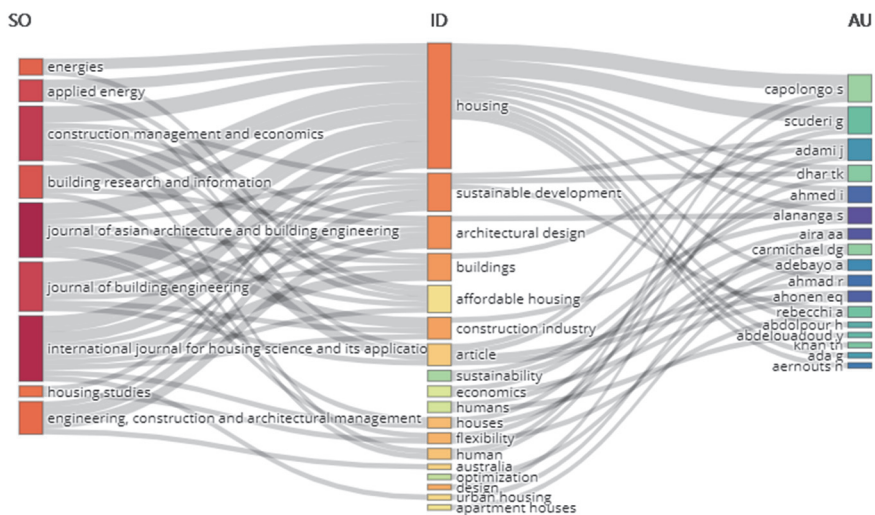
A network of keywords was used to analyze the main topics of the publication on sustainable and flexible housing. The keyword network represents the co-occurrence in the bibliographic dataset. The term network can be clustered to draw attention to themes of variation. Every keyword is part of one topic only. A theme map is a concrete diagram that represents each theme. Figure 13 displays the thematic areas in the theme map that pertain to the research field of sustainable flexible housing. Each bubble represents a cluster of keyword networks. The name presented by the cluster is the most frequently occurring word. Thus, the most relevant thematic indicators are human, commerce, apartment houses, costs, carbon dioxide, article, sustainable development, urban housing, building, and housing.

The bubble size in Figure 13 visually indicates the number of times the cluster word appears, while the bubble's position indicates the word's density and centrality. Centrality and density represent the importance and granularity of the studied themes, respectively. As shown in the figure, the position of each bubble represents the importance and refinement of the cluster terms in the flexible housing research area. Four spaces are segmented according to the two axes of centrality and density. These four spaces are introduced from the top left corner along the clockwise direction, and they signify the following themes: basic themes, moving themes, emerging and declining themes, and extremely developed and isolated themes. Keywords such as commerce apartment houses represent 2 clusters and appear very rarely. They are located in the upper left corner, indicating their importance

and difficulty in improving them. On the contrary, keywords including architecture, housing, and sustainability are located in the lower right corner and are referred to as basic themes. Among them, housing is the most important theme and shows supreme centrality.



**Figure 14:** Interrelationship between top keywords (middle), top authors (right), and top sources (left) in publications on sustainable flexible housing using Three-Field Plot



**Figure 15:** Visualization of interrelations between top keywords plus (middle), top authors (right), and top sources (left) in publications on sustainable housing flexibility using a Three-Field Plot

The setting of the three domain maps provides a common view of the use of sustainability in keywords in articles about flexible housing. Figures 14 and 15 reveal the three domains that highlight

the most significant keywords. Figure 14 shows the three main analysis conditions, from left to right: source, keyword, and author. It reveals the relevance between the most frequent keywords, the best-known authors, and the relevant sourcing. As shown in Figure 14, most of the keywords would be used by Carmichael dg, Rebecchi a, Scuderl g, Aliuir, Alobaydi d, Alsabban r, Dhartk, Capolongo s, Abrantes v, Ahmed i in their publications. The keywords most used are flexibility, housing, mass customization, adaptability, demand response, design, and open building renovation. The most common keywords used by the authors are flexibility, housing, adaptability, sustainability, open building, building retrofit, social housing, mass housing, and affordability. The most popular keywords for journals are flexible, housing, mass customization, adaptability, demand response, sustainability, residential buildings, and design. Sources include Applied Sciences (Switzerland), archnet-ijar, International Journal for Housing Science and its Applications, Construction Management and Economics, Journal of Building Engineering, Building Research and Information, Journal of Asian Architecture and Building Engineering, Open House International, building is the top journal publishing on flexible housing.

Figure 15 was created by changing the intermediate condition keyword for keyword plus. It shows the relationship between the top keyword and the other two conditions. The keyword plus sign is a word or phrase frequently appearing in the computer-generated title citation. The analysis of keyword-heated door research topics that represent the field of flexible housing research helps readers discover the latest research. Figure 15 shows that journals focusing on urban housing are only found in the *International Journal for Housing Science and Its Applications*. The journal also published many articles on housing, sustainable development, architectural design, buildings, affordable housing, and the construction industry. Keywords such as housing, sustainable development, buildings, affordable housing, construction industry, flexibility, houses, etc., are more likely to appear in the *Journal of Asian Architecture and Building Engineering*. The acceptance of the *housing* keyword is very high because every top author has used it in their journals, and most publishers have access to it. The top-level flexible housing authors are all involved in human research, and their papers are mainly published in construction management, economics, and building research and information. Author DharTk has published articles on flexibility in the Asian Journal of Architecture and Building Engineering and Housing Research. Therefore, Figure 15 is ideal for finding the top journals in the field of flexible housing research and guiding the submission of a manuscript to a specific journal.

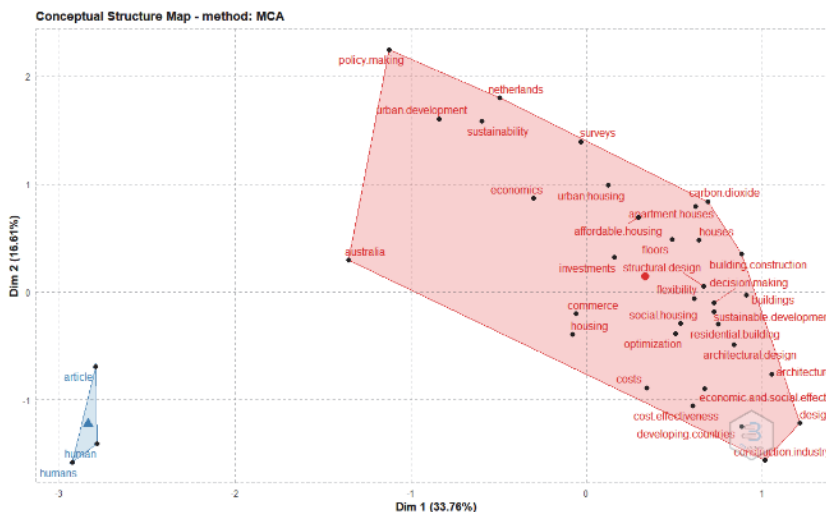
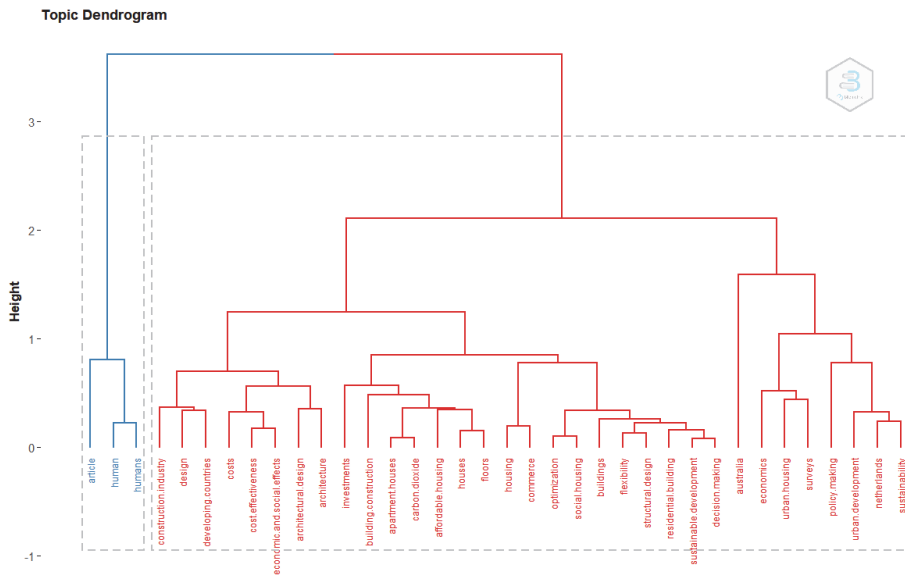


Figure 16: Conceptual framework diagram of keywords for flexible housing in sustainability publications

Figure 16 reveals the relationship between the keywords appearing in all publications through a conceptual structure diagram. The two shapes in the figure show the approximate location per keyword containing literature, while the center point shows the core of resilient housing used in sustainability research. Each document's words are related like a network in a conceptual framework. This co-word network aids readers in understanding research field themes and identifying research frontiers. Data simplification techniques allow the detection of sub-domains, separate from mesh analysis. As shown in Figure 16, there are two categories of colors. Each color implies a set of known words that pass the clustering. The blue clusters contain three keywords: article, humans, and human. In this group, the distance between almost all keywords is very long. Conversely, the red cluster clearly shows that it contains far more keywords than the blue cluster, with about 30. Apartment houses and carbon dioxide, houses and floors, housing and commerce, optimization and social housing, flexibility and structural design, sustainable development, and decision-making are very close.



**Figure 17:** Dendrogram of Topic Conceptual Structures for Keywords in Publications on Sustainable Housing Flexibility

Figure 17 shows another conceptual schematic of the "Topic Tree Diagram" keyword. This diagram is similar to Figure 17, but the viewing angle differs. In common, this theoretical framework tree appears in two groups of keywords. The closer the words or phrases are to each other, the lower the height of the connecting line. Conversely, the higher the height between the connecting words, the further the two are from each other. Each tree diagram represents a partition and is accurately positioned.



Figure 18: Top keywords plus in flexibility housing for sustainability publications



Figure 19: Top author's keywords in sustainable flexible housing publications



Figure 20: Top title words in sustainable flexible housing publications



Figure 19 reveals the authors' keywords, with occurrences ranging from 34 to 1: flexibility, housing, adaptability, sustainability, etc. Figure 20 reveals the most relevant keywords in the title: housing, residential, flexibility, study, design, and building. Figure 21 illustrates the prevalent terms within abstracts, with the most frequently occurring words being housing, flexibility, design, building, study, residential, paper, and social. These key terms are frequently encountered in "flexible housing" related publications. Essentially, it is worth noting that the keywords found in author names, titles, and abstracts demonstrate remarkably consistent patterns. Consequently, it is advisable to exercise caution and choose more pertinent words when writing titles and abstracts.

Figure 22 shows the top keywords on sustainable flexible housing from 2010 to 19 November, 2021. Since 2010, housing has been growing rapidly as a research topic. Keywords such as architectural design, construction industry, and articles frequently appear in recent publications. Since 2016, the 2 keywords design and building have gradually not received much attention from the academic community. More work on these topics is expected in flexible housing research due to the gradual increase in research frequency from 2010 to 2021.

## 2.6 Qualitative Analysis

Between 2010 and November 2021, 143 papers were published in the field of housing flexibility related to sustainability. There are 119 articles within this group, and in this section, a qualitative analysis is conducted based on 10 referenced articles.

## 3. Subjects

The most frequently cited topics used in articles on flexible housing include retrofitting the interior spaces of houses, assessing housing variability, and sustainability assessment of housing flexibility (Malakouti et al., 2019; Montellano, 2015). Each of the top articles discusses or uses flexibility in their case studies. More than half of the authors in this analysis cited interior space renovation as the topic of their articles (Aryani & Jen-Tu, 2021; Kumar et al., 2013). While design flexibility is a common authoring keyword and is included in the top keywords, the probability of appearing in the selected articles is around 25% (Aryani & Jen-Tu, 2021; Kumar et al., 2013). Study topics, including social housing, lifestyle, user adaptations, and residential segregation, were also popular with about 50% of the authors (Bettaieb & Alsabban, 2021; D' alessandro et al., 2020; Huuhka & Saarimaa, 2018; Kumar et al., 2013).

Only a few papers combined modularity, prefabrication, urban living, and eco-friendly topic keywords. Urban living and ecological environment is a rare title in this collection, as only a few titles focus on them, suggesting a potential area for increased exploration. Housing sustainability is one of the themes in all the cited articles, with a particular focus on the social dimension of sustainability development, i.e., meeting the changing needs of users for housing space. Less frequently, attention is paid to the environment and the economy, indicating a potential gap in future studies (Borsos et al., 2019). Conversely, housing designs such as flexible design, space transformation, and House of Quality (HoQ) are also highly cited (Malakouti et al., 2019).

About 80% of the cited articles explore design strategies to achieve flexibility in housing, and only 10% apply and evaluate the design in actual housing. This implies a potential need for more study to translate design concepts into practical applications and assess their effectiveness in real-world scenarios. Thirty percent of the papers focused on the assessment of the rate of flexibility in housing spaces (Elkady et al., 2018; Montellano, 2015). Hence, emphasizing on the assessments suggests a concern for ensuring that theoretical flexibility concepts are translated effectively into tangible benefits in housing. In addition, 20% of the papers explored culturally and structurally flexible design (Yang et al., 2021; Agha & Kamara, 2017). This highlights the recognition of the role of cultural and structural considerations in housing flexibility. Most of the papers cited cite flexible design as the best solution for increasing space utilization in housing. The way the building is



constructed is mentioned in almost every discussion of flexible design, indicating a close connection between flexible design and building construction. Also, this emphasized the importance of understanding the construction process influences and is influenced by flexible design concepts.

#### 4. Trend

The design trends for housing flexibility are divided into interior space planning and extended expansion of housing space. More than half of the authors of the cited articles preferred to study the space transformation within the existing housing area. While the design strategies are more consistent, they only differ in study geography and housing conditions. The first field survey measured the flexible and non-modifiable spaces in the housing. Secondly, targets are set for the actual needs of the households and possible future needs. It is worth noting that design orientation, in addition to focusing on the social dimension of sustainability in housing design, also considers environmental aspects of sustainability. However, this aspect is not assessed as a major research component. And 80% of the cited papers do not mention economic sustainability.

In addition, the characteristics of the housing cases in the article can be divided into singularity and extensiveness. Singularity refers to only one type of housing in one geographical area, and extensiveness refers to different housing types in the same geographical area or the same housing type in different geographical areas. The final 10 articles that received the highest citations in Scopus for flexible housing are reviewed. Space utilization is the most used question in flexible housing studies. Most of the analyzed literature points to the expansion of the housing space generic area to maximize space utilization. These implications provide insights into the nuances of design trends, sustainability considerations, and the characteristics of housing flexibility research. They also highlight areas where further research or attention is required, including the limited exploration of economic sustainability in the existing literature.

#### 5. Conclusion

This study provides an econometric analysis of the flexible housing research literature from 2010 to 2021 using Scopus data. The findings indicate that flexible housing has made strides towards sustainability in recent years. Annual publications in sustainability flexibility housing research have kept increasing since the turning point in 2017. Researchers from Australia, United States, Italy, United Kingdom, and China contributed the most to the publication. AUSTRALIA and USA ranked first and second, respectively, in article production. "OPEN HOUSE INTERNATIONAL", "ARCHNET-IJAR" and "JOURNAL OF ASIAN ARCHITECTURE AND BUILDING ENGINEERING" were regarded as the utmost relationship journals around flexible housing research. Essential keywords like construction, housing, and sustainable development exemplify the fundamental and cross-cutting themes of current bibliography studies. In recent years, the visibility of keywords such as housing, construction industry, and architecture design has increased, and design and buildings are gradually disappearing. In addition, the qualitative analysis points out that flexible design offers solutions for improving space utilization in homes and that housing flexibility is also consistent with sustainability principles. The aspiration is that the findings presented in this study will offer an expanded viewpoint for future research endeavors in the realm of sustainable flexible housing.

#### References

- Agha, R. H., & Kamara, J. M. (2017). Adaptations in traditional courtyard houses in Baghdad, Iraq. *International Journal of Building Pathology and Adaptation*, 35(4), 348-363.
- Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of informetrics*, 11(4), 959-975.

- Aryani, N. P., & Jen-Tu, K. (2021). Environmental behavior analysis of social housing units in Surabaya, Indonesia. *Journal of Asian Architecture and Building Engineering*, 20(4), 398-413.
- Bergman, E. M. L. (2012). Finding citations to social work literature: The relative benefits of using Web of Science, Scopus, or Google Scholar. *The journal of academic librarianship*, 38(6), 370-379.
- Bettaieb, D. M., & Alsabban, R. (2021). Emerging living styles post-COVID-19: housing flexibility as a fundamental requirement for apartments in Jeddah. *ArchNet-IJAR: International Journal of Architectural Research*, 15(1), 28-50.
- Borsos, Á., Balogh, J., Kokas, B., & Bachmann, B. (2019). An eco-approach to modularity in urban living. *International Journal of Design & Nature and Ecodynamics*, 14(2), 83-90.
- Chadegani, A. A., Salehi, H., Yunus, M. M., Farhadi, H., Fooladi, M., Farhadi, M., & Ebrahim, N. A. (2013). A comparison between two main academic literature collections: Web of Science and Scopus databases. *arXiv preprint arXiv:1305.0377*.
- D'alessandro, D., Gola, M., Appolloni, L., Dettori, M., Fara, G. M., Rebecchi, A., ... & Capolongo, S. (2020). COVID-19 and living space challenge. Well-being and public health recommendations for a healthy, safe, and sustainable housing. *Acta Bio Medica: Atenei Parmensis*, 91(9-S), 61.
- Das, A. K. (2015). Introduction to research evaluation metrics and related indicators. In *Open access for researchers, module 4: research evaluation metrics* (pp. 1-18). UNESCO, Paris.
- Elaish, M. M., Shuib, L., Ghani, N. A., Mujtaba, G., & Ebrahim, N. A. (2019). A bibliometric analysis of m-learning from topic inception to 2015. *International Journal of Mobile Learning and Organisation*, 13(1), 91-112.
- Elkady, A. A., Fikry, M. A., & Elsayad, Z. T. (2018). Developing an optimized strategy achieving design flexibility in small-area units: Case study of Egyptian economic housing. *Alexandria Engineering Journal*, 57(4), 4287-4297.
- Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact?. *Scientometrics*, 105, 1809-1831.
- Gad, M.M. and Aly, A.G.E.D., *Study the Social Needs for Proper Housing*. IOP Conference Series: Materials Science and Engineering, 2020. 974.
- Ghanbari Baghestan, A., Khaniki, H., Kalantari, A., Akhtari-Zavare, M., Farahmand, E., Tamam, E., ... & Danaee, M. (2019). A crisis in "open access": Should communication scholarly outputs take 77 years to become open access?. *SAGE Open*, 9(3), 2158244019871044.
- Huuhka, S., & Saarimaa, S. (2018). Adaptability of mass housing: size modification of flats as a response to segregation. *International Journal of Building Pathology and Adaptation*, 36(4), 408-426.
- Jackson, J. (2010). Promoting energy efficiency investments with risk management decision tools. *Energy Policy*, 38(8), 3865-3873.
- Kalantari, A., Kamsin, A., Kamaruddin, H. S., Ale Ebrahim, N., Gani, A., Ebrahimi, A., & Shamshirband, S. (2017). A bibliometric approach to tracking big data research trends. *Journal of Big Data*, 4(1), 1-18.
- Kumar Dhar, T., Sk. Maruf Hossain, M., & Rubayet Rahaman, K. (2013). How does flexible design promote resource efficiency for housing? A study of Khulna, Bangladesh. *Smart and Sustainable Built Environment*, 2(2), 140-157.
- Malakouti, M., Faizi, M., Hosseini, S. B., & Norouzian-Maleki, S. (2019). Evaluation of flexibility components for improving housing quality using fuzzy TOPSIS method. *Journal of Building Engineering*, 22, 154-160.
- Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & López-Cózar, E. D. (2018). Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. *Journal of informetrics*, 12(4), 1160-1177.
- Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: a comparative analysis. *Scientometrics*, 106, 213-228.
- Montellano, A. S. (2015). Housing flexibility by spatial indeterminacy: The case of the Casa de las Flores in Madrid. *ArchNet-IJAR: International Journal of Architectural Research*, 9(2), 4.
- Yang, X., Majid, A. Z. A., Tiantian, M., & Guangyu, Z. (2021). Ten Decades Of Research On Sustainability Of Product Design: A Bibliometric Analysis Of Trends A Cross Regions. *International Journal of Entrepreneurship*, 25, 1-18.