Restoration in the Discipline of Architecture: A Bibliometric Analysis of Research Trends Since 2000

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Article Info	Abstract
	The preservation of architectural heritage and its transfer to next generations have been important subjects worldwide from past to present. In this context, the concept of architectural restoration plays an important role. Numerous studies have been conducted in the field of architectural restoration, but there are not enough bibliometric analysis studies on these studies. In this study, it is aimed to determine the research trends that have changed over the years by systematically analyzing the relevant literature with the help of bibliometric analysis and to provide ideas for future studies. In the study, 1415 articles published in the Web of Science (WoS) database under the title of architectural restoration between 2000–2021 were analyzed bibliometrically with the help of VOSviewer and WoS software. The data obtained at each stage were evaluated separately and it was revealed in which direction the data of the studies published in 21 years on a global scale evolved. The results show that the most published journal in the field of architectural restoration is Archistor Architecture History Restoration while the most cited articles were published in International Journal of Architectural Heritage. On the other hand, although the published studies are mostly gathered under the keywords of restoration, conservation and cultural heritage, the current studies published in this field are summarized under the titles of sustainable design and building modeling.

1. INTRODUCTION

It is of great importance to protect and sustain historical structures and environments since they have the characteristics and values of the period and the society in which the architectural cultural heritage is found. Many countries with different cultural and historical heritage on a global scale have been negatively affected in terms of sociocultural and economic aspects for each heritage that cannot be protected and maintained [1]. Structures or groups of buildings, which have been damaged and/or lost partially in time, are subjected to protection and repair under the title of architectural restoration. Architectural restoration is all the practices that often require interdisciplinary work considering scientific techniques and methods [2, 3].

In Article of the Law No. 2863 on the Protection of Cultural and Natural Assets, 'Conservation' and 'Protection' are defined as "the preservation, maintenance, repair, restoration, function change works in immovable cultural and natural assets; and preservation, maintenance, repair and restoration works in movable cultural assets." [4]. Here, there are 9 basic concepts under the title of protection, which are listed as maintenance, repair, completion, renovation, improvement, restoration, reconstruction, transportation and reuse. Within the scope of this study, the concept of restoration in its most general definition is considered the process of restoring a culturally important and damaged structure or group of buildings. With the least intervention, in line with reliable documents and transferring them to the future in this direction. Restoration is one of the most general and basic building blocks of the concept of conservation [5, 6].

Numerous studies have been conducted in the field of architectural restoration [7-11] but there are not enough bibliometric analysis studies on these studies to determine the research trends that have changed over the years by systematically analyzing the relevant literature with the help of bibliometric analysis and to provide ideas for future studies. Bibliometric analysis is central to understanding the development and change of these studies from different perspectives, as well as making determinations that will contribute to the future.

1.1. Background Studies

Several studies on bibliometric analysis have been conducted in the field of architecture worldwide, some of which can be summarized in the following. In the study conducted by Makabate, Musonda, Okoro and Chileshe [12], researches on the adoption of BIM (Building Information Modeling) in the construction sector were analyzed. In the study published by Palabıyık and Demircan [13], the current status of architecture in different disciplines (such as economics, social psychology, technology and management) was investigated. In the study of Pramesti, Hasan and Ramandhika [14], analyzes were made within the scope of sustainable architecture between 1976-2020. In the study conducted by Zhao and Pan [15], bibliographic records related to the 'business model' for green buildings between 1998-2020 were analyzed in the Web of Science Core Collection. Aydın, İsmailoğlu, Akkan and Şanlı [16], analyzed master's theses in the field of building and building physics in the department of architecture in universities in Turkey between 2000-2018. Doğruer [17], searched for the articles on the subject of conservation published between 1952-2021 in the journal of Studies in conservation. Gan, Xie, Liu, Rameezdeen and Wen [18], conducted analyses in the context of the policy tools used by the Chinese Government in order to reveal the development of prefabricated construction and to explore the focus of prefabricated construction. Zami and Rahaman [19], conducted analyses in order to discover the results of scientific research in the field of architecture and to determine the research productivity in Gulf Cooperation Council (GCC) countries in 1976-2020 period. In the study conducted by Zhang and Zou [20], 372 documents of high interest to HBIM were analyzed using the CiteSpace scientific measurement analysis tool for the progress, hot spots and trends in the field of HBIM (Heritage Building Information Modeling) since 2010. The aforementioned studies have come to the fore in the literature, but as can be seen, no study has been conducted on the field of architectural restoration on a global scale. This study aims to contribute to the literature by closing this gap in this field.

1.2. Bibliometric Analysis

Bibliometrics is the mathematical and statistical expression of publications in a research field. Bibliometric analysis is the process of quantitatively and visually evaluating studies in any field and obtaining concrete data. In this context, the data of academic studies are interpreted by bringing them together and classifying them. The data of these publications are standardized, classified and interpreted by making analysis for research. For this purpose, the development of the field within the scope of the research can be revealed numerically [21-23]. Bibliometrics is formed by the combination of the words "biblion"; "book" and "metron"; "measurement" [24-26]. According to Çiçek and Kozak [27], bibliometrics is defined as "the method used in the examination of scientific information sharing tools such as published journals, books, etc. with mathematical and statistical techniques".

The number of publications, number of citations, author relations, sources, institutions and keywords can be analyzed within the scope of bibliometric analysis [28, 29]. In this study, VOSwiever software, which is a bibliometric analysis tool, can analyze the studies under 5 main headings. Co-authorship, co-existence, citation, bibliographic coupling, and co-citation. Co-authorship is the analysis option used in authorship and co-authorship relationships [30]. In this context, the authors and countries and institutions they are involved in can be evaluated together. The keywords selected in the studies provide information about the content of the study. Keywords are analyzed with co-existence. This option refers to the coexistence and common use of similar keywords [31]. In this context, the numerical density of the keywords used jointly in the scientific study shows that those studies have similar thematic features. This refers to the intensity of the relationship between words. The main themes that can change over the years can be determined with the help of keyword analysis [28, 32].

Citation is an element reflecting the effects of a study. This refers to the number of citations in a scientific study [33]. Studies can be analyzed separately as sources, authors, institutions and countries according to the number of citations [30]. Bibliographic coupling is defined as two different studies referring to the same source. The high number of bibliometric matches means a high number of common references of two different sources [34, 35]. This section can be analyzed separately as studies, sources, authors, institutions and countries. Co-citation is performed by looking at the number of common uses of two different studies in another study. Thanks to this analysis, the sources of studies that are related to each other but do not refer to each other can be determined [29].

The Web of Science (WoS) database was preferred in this study. The reason for choosing this database is that the resource range is excessive, it is reliable for bibliometric analysis and it provides high-quality data. Additionally, screening can be done with filtering and searching in different research areas [28, 36]. In the WoS database, many data available in the study content can be obtained visually and comparisons can be made between the data [37]. In this study, Sankey diagrams obtained from SankeyMATIC software and found in keyword analysis provide a better view of the data and data flow. It can visualize different data with different colors and arrows [38].

With VOSviewer software, analyzes can be made under 5 different main headings: co-authorship analysis, common word analysis, citation analysis, bibliographic matching and common citation analysis [39, 40]. In this study, the concept of restoration was evaluated for the discipline of architecture, and 1415 articles published in the WoS database in this field were subjected to bibliometric analysis. Bibliometric analysis is discussed under 9 headings as research areas analysis, publication type analysis, publication distribution by years and number of citations analysis, publication language of the studies, numerical distribution of the publications by countries, most cited studies, journals and publishing houses where the studies are most published, distribution of the studies by institutions and keyword analysis. The data obtained at each stage were evaluated separately, and the data of the studies published in the field of architectural restoration over 21 years on a global scale were completed with a comprehensive evaluation considering the orientation and changes.

2. MATERIAL AND METHOD

The bibliometric analysis method, one of the quantitative research method [41] was used in this study. The academic studies published in the field of architectural restoration worldwide wre analyzed. Firstly, the database to be used was decided. The WoS database, which is a reliable and widely used data network in bibliometric analysis studies, was preferred. On the WoS search page, a search was made by typing 'Restoration' in the search section. In the study, the search was filtered by selecting 'article' for document types section, 'architecture' in the WoS categories section, and finally the period covering 21 years between '2000–2021' in the publication years section. 1415 articles listed because of filtering were subjected to bibliometric analysis (Figure 1). Bibliometric analysis was performed using the WoS database, VOSviewer and SankeyMATIC software. Analysis results and findings were evaluated and discussed and presented in the following sections.
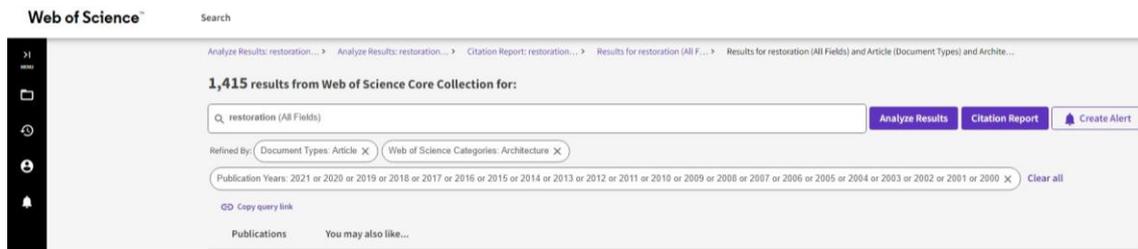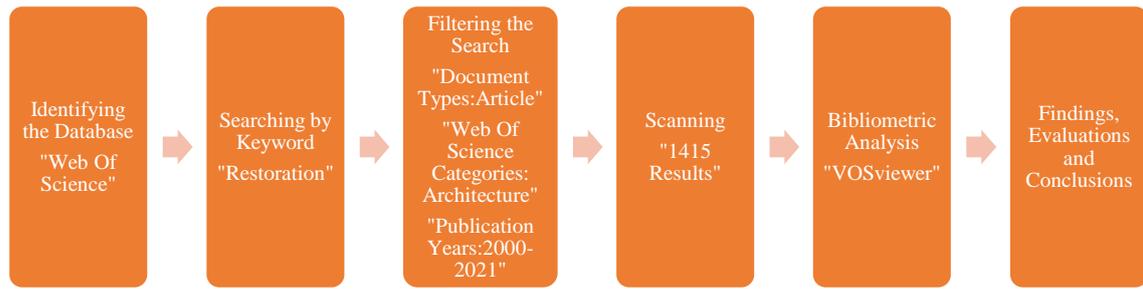

Figure 1. *Web of Science Search Screen*

Figure 2. *Analysis Flow Diagram*

3. FINDINGS AND DISCUSSION

3.1. Analysis of Research Areas

The concept of restoration, which is within the scope of this study, has been the subject of research not only in the field of architecture, but also in different fields. Restoration was written in the search section of the WoS database, and the period covering 21 years between 2000–2021 was selected and filtered in the publication years section. In this context, the studies conducted in the field of restoration were analyzed according to their fields, and the first 53 areas with the most publications were determined. The number of studies in these areas is given in Figure 3, and environmental sciences with 12,37% rate and 21.597 publications, ecology with 11,27% rate and 19.677 publications, dentistry and oral surgery with 9,807% rate and 17.112 publications were determined as the most intense areas of studies. The architectural restoration area within the scope of the study was ranked 53rd with a rate of 0,81% and 1.415 publications. At this point, it is seen that the scope of the restoration title is quite wide, it offers an upper umbrella as a field of study for many disciplines, and it is less used in the field of architecture than other disciplines.
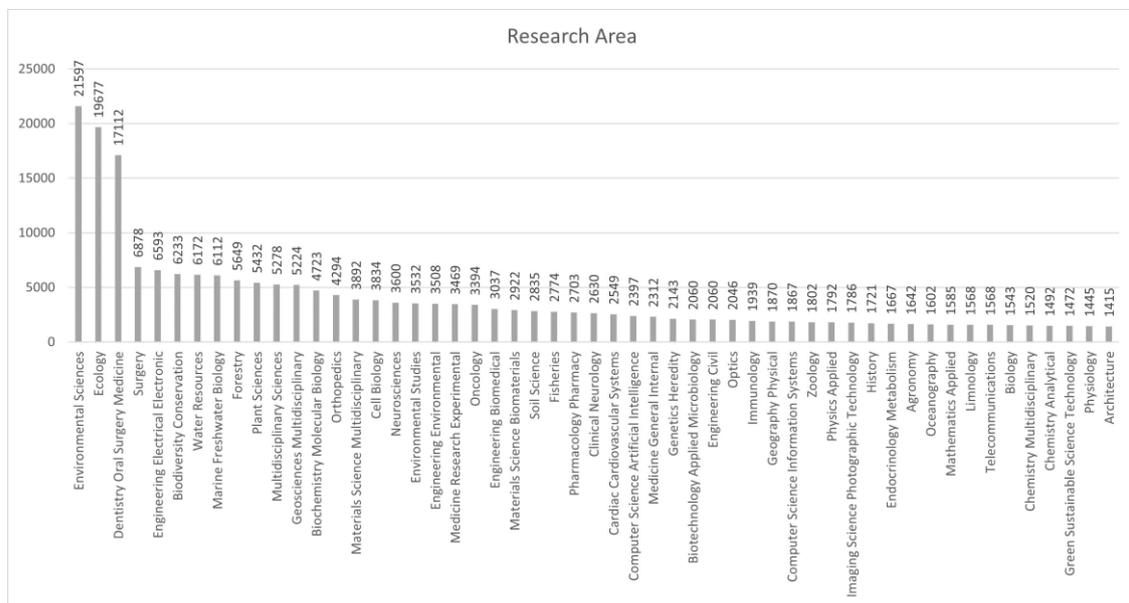

Figure 3. *Research Areas of Publications* [42]

3.2. Publication Type Analysis

When restoration is written in the search section of the WoS database, the period covering 21 years between 2000–2021 is selected in the publication years section and the architecture is selected and filtered in the categories section, 2.617 results are obtained. When Table 1 is examined, the publication types of 2.617 results published are examined under 13 headings as articles, procedure papers, book review, editorial materials, book chapters, news items, early access, letter, review article, book, art exhibit reviews, corrections, retracted publication. The articles, which constitute most 2.617 publications within

the scope of the study, rank first with 54% rate and 1.415 number. The numbers and ratios of other publication types are given in Table 1. It is seen that the most published type in the field of architectural restoration is the article, followed by proceeding papers (35%; 925 pieces). Although there are many books in the market in the field of architectural restoration, notably there are very few book chapters (1,87%; 49 pieces) scanned by WoS. Similarly, notably there are only 5 review articles (0.19%) in the field of architectural restoration.

Table 1. *Numerical and Proportional Distributions of Publication Types* [42]

Field: Document Types	Record Count	% of 2.617
Article	1.415	54,070%
Proceeding Paper	925	35,346%
Book Review	132	5,044%
Editorial Material	94	3,592%
Book Chapters	49	1,872%
News Item	44	1,681%
Early Access	8	0,306%
Letter	6	0,229%
Review Article	5	0,191%
Book	3	0,115%

3.3. Distribution of Publications by Years and Analysis of Citation Numbers

The publications and citations of 1.415 articles within the scope of the study between 2000–2021 are given in the graphic in Figure 4. According to the graph, the most published year with 190 publications is 2020, and the least published year with 15 publications are 2002 and 2004. In the graph, the increase and decrease in the number of publications between 2000–2018 varied. Considering the rate of increase in the number of publications, it was observed that the number of articles in 2018 peaked from 114 to 179 in 2019. It was observed that the rate of decrease in the number of publications peaked from 2020 (190 publications) to 2021 (122 publications). According to the graph, the year with the highest number of citations is 2021 with 427 citations, and the years with the lowest number of citations are 2000, 2001 and 2003 with 0 citations. The number of citations in the graph decreased between 2002-2003 and 2006–2007, and there was no increase or decrease between 2000-2001 and 2013–2014. Although there was an increase in the number of citations among the remaining years, it was observed that the highest increase occurred from 2018 (177 citations) to 2019 (268 citations).
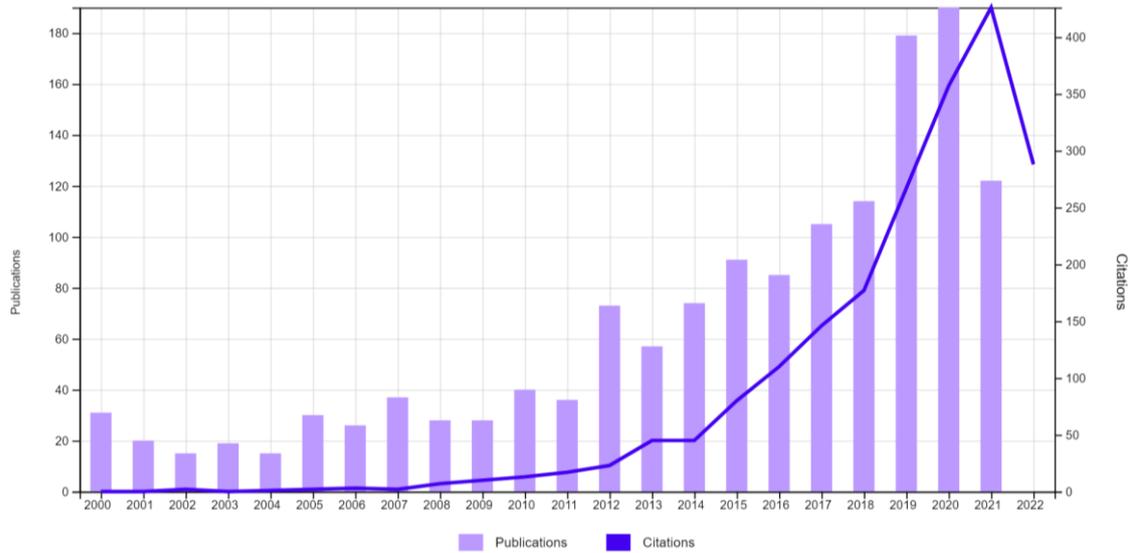
Figure 4. *Distribution of Publications and Number of Citations by Years* [42]

3.4. Publication Language of the Studies

The publication language distribution of 1.415 articles within the scope of this study is given in Table 2. According to the table, the first three languages with the highest number of publications are English with 50,6% and 716 numbers, Italian with 25,5% and 361 numbers, and Spanish with 9,6% and 136 numbers, respectively. The table also shows that Dutch, French, German and Turkish languages are used following these languages.

Table 2. *Publication Language of the Studies* [42]

Field: Languages	Record Count	% of 1.415
English	716	50,601%
Italian	361	25,512%
Spanish	136	9,611%
Dutch	52	3,675%
French	46	3,251%
German	46	3,251%
Turkish	716	1,625%

3.5. Numerical Distribution of Publications by Countries

The top 10 countries that published the most in 1.415 articles within the scope of this study are given in the graphic in Figure 5. According to the graph, the top 10 countries were Italy with 22,83% rate and 323 numbers, Spain with 6,9% rate and 97 numbers, USA with 6,6% rate and 93 numbers, Turkey with 4,5% rate and 64 numbers, Peoples R China with 4% rate and 58 numbers, Netherlands with 2,8% rate and 39 numbers, England with 2,7% rate and 38 numbers, Germany with 2,4% rate and 34 numbers, France with 1,4% rate and 20 numbers, and Japan with 1,3% rate and 19 numbers, respectively.
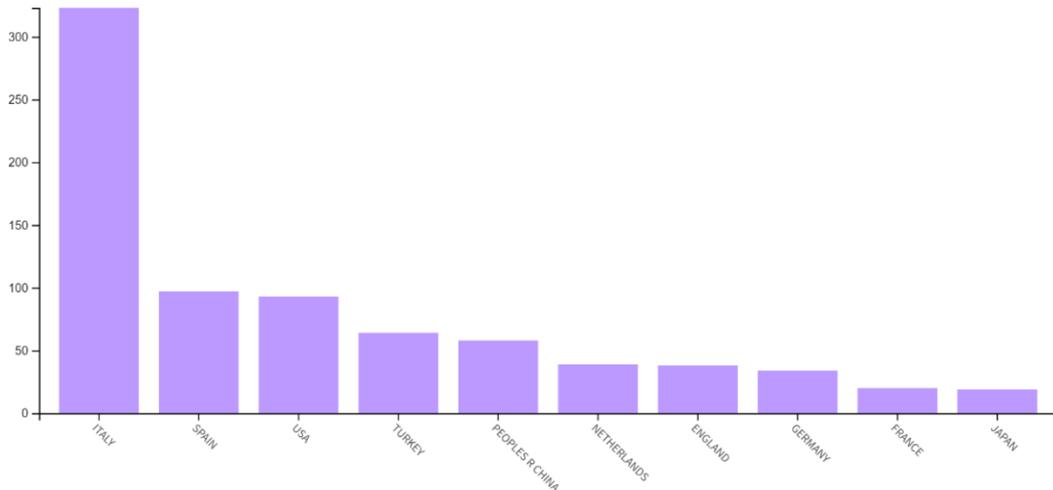
Figure 5. *Distribution of the Number of Studies by Countries* [42]

In order to determine cooperation between countries, a network of countries was created with VOSviewer software. Countries were filtered to a minimum number of publications of 10, and as a result of the filtering, a connection and cooperation map was created among 17 countries. In the map center are Italy, Spain and USA, which have the highest number of publications, respectively. Clusters have been formed between countries with a high number of connections between them. On the network map, countries within the same cluster are shown with the same color.
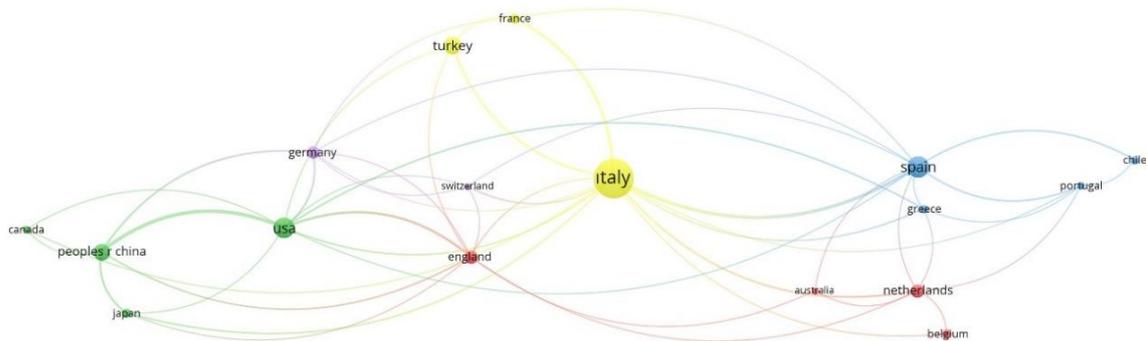

Figure 6. *Network of relations between countries*

3.6. Most Cited Works

The 10 most cited studies of 1.415 articles within the scope of the study are given in Table 3. Although the research covered the years 2000–2021, there were 1 study in 2008, 2011, 2014, 2016, 2017, 2 studies in 2013 and 3 studies in 2015. When the journals in which the studies were published were analyzed, it was seen that all 10 studies were published in the International Journal of Architectural Heritage. The three studies with the highest number of citations were determined to Guidelines for On-Site Assessment of Historic Timber Structures with 105 citations, Ammonium Phosphates as Consolidating Agents for Carbonatic Stone Materials Used in Architecture and Cultural Heritage: Preliminary Research with 74 citations, and Vulnerability Index: A New Approach for Preventive Conservation of Monuments with 50 citations, respectively (Table 3).

Table 3. *The 10 Most Cited Studies* [42]

Articles	Number of Citations
Guidelines for On-Site Assessment of Historic Timber Structures Cruz, H; Yeomans, D; (...); Lourenco, PB 2015 | International Journal of Architectural Heritage 9 (3), pp.277-289	105
Ammonium Phosphates as Consolidating Agents for Carbonatic Stone Materials Used in Architecture and Cultural Heritage: Preliminary Research Matteini, M; Rescic, S; (...); Botticelli, G 2011 | International Journal 2of Architectural Heritage 5 (6), pp.717-736	74
Vulnerability Index: A New Approach for Preventive Conservation of Monuments Ortiz, R and Ortiz, P 2016 | International Journal of Architectural Heritage 10 (8), pp.1078-1100	50
Shape Memory Alloy Devices for the Structural Improvement of Masonry Heritage Structures Indirli, M and Castellano, MG 2008 | International Journal of Architectural Heritage 2 (2), pp.93-119	40
Overview of the Pathology, Repair and Strengthening of Adobe Structures Illampas, R; Ioannou, I and Charmpis, DC 2013 | International Journal of Architectural Heritage 7 (2), pp.165-188	31
How Our Homes Impact Our Health: Using a COVID-19 Informed Approach to Examine Urban Apartment Housing Peters, T and Halleran, A 2021 | ARCHNET-IJAR International Journal of Architectural Research 15 (1), pp.10-27	30
A Framework for Using Point Cloud Data of Heritage Buildings Toward Geometry Modeling in A BIM Context: A Case Study on Santa Maria La Real De Mave Church Lopez, FJ; Lerones, PM; (...); Zalama, E 2017 | International Journal of Architectural Heritage 11 (7), pp.965-986	30
Santa Maria di Collemaggio Church (L'Aquila, Italy): Historical Reconstruction by Non-Destructive Testing Techniques Sfarra, S; Bendada, A; (...); Maldague, X 2015 | International Journal of Architectural Heritage 9 (4), pp.367-390	25
Refurbishment of a Traditional Timber Floor with A Reversible Technique: Importance of the Investigation Campaign For Design and Control of the Intervention Riggio, M; Tomasi, R and Piazza, M 2014 | International Journal of Architectural Heritage 8 (1), pp.74-93	24
Archaeological Consolidation of Unesco Masonry Structures in Oman: The Sumhuram Citadel of Khor Rori and the Al Balid Fortress Sassu, M; Andreini, M; (...); De Falco, A 2013 | International Journal of Architectural Heritage 7 (4), pp.339-374	24

3.7. Most Preferred Journals and Publishing Houses

The top 10 journals in which the studies in the field of architectural restoration are published the most are given in Table 4. According to this table, the top 3 journals with the highest number of publications were Archistor Architecture History Restoration with 23% rate and 328 publications, International Journal of Architectural Heritage with 9,7% rate and 137 publications, and Loggia Arquitectura Restauración with 5,9% rate and 83 publications, respectively.

Table 4. *The 10 Most Published Journals* [42]

Field: Publication Titles	Record Count	% of 1.415
Archistor Architecture History Restoration	328	23,180%
International Journal of Architectural Heritage	137	9,682%
Loggia Arquitectura & Restauración	83	5,866%
Landscape Architecture Frontiers	61	4,311%
Disegnarecon	53	3,746%
Bulletin Knob	52	3,675%
Bulletin Monumental	44	3,110%
Denkmalpflege	43	3,039%
Journal of Architectural Conservation	35	2,473%
Landscape Architecture	25	1,767%

The number of citations received by the journals is important in terms of the impact rate they provide. When 10 journals with the highest number of publications were evaluated in this context, the top three journals with the highest number of citations were determined to International Journal of Architectural Heritage with 1.127 citations, Journal of Architectural Conservation with 59 citations and Landscape Architecture Frontiers with 55 citations, respectively. Archistor Architecture History Restoration journal, which has the highest number of publications, ranked fourth with 33 citations.

The 10 publishing houses where the articles in the field of architectural restoration are published the most are given in Table 5. According to this table, 3 publishing houses with the highest number of publications were identified as Univ Mediterranea Reggio Calabria with 23% rate and 328 publications, Taylor & Francis with 14% rate and 201 publications, and Univ Politecnica Valencia, Editorial Upv with 6,7% rate and 9 publications, respectively. Archistor Architecture History Restoration, which has the highest number of publications, publishes under the publishing house Univ Mediterranea Reggio Calabria. The International Journal of Architectural Heritage, which has the highest number of citations, publishes under the Taylor & Francis publishing house.

Table 5. *The 10 Publishing Houses with the Highest Number of Publications* [42]

Field: Publishers	Record Count	% of 1.415
Univ Mediterranea Reggio Calabria	328	23,180%
Taylor & Francis	201	14,205%
Univ Politecnica Valancia, Editorial Upv	95	6,714%
Higher Education Press	61	4,311%
Koninklijke Nederlandse Oudheidkundige Bond-Knob	52	3,675%
Deutscher Kunstverlag Gmph	48	3,392%
Soc Fr Archeologie Musee Monument Francais	44	3,110%
Univ L'Aquila	43	3,039%
Univ Studi Bologna	32	2,261%
Amer Soc Landscape Architects	28	1,979%

3.8. Distribution of Studies by Institutions

The top 20 institutions where the studies were published the most are given in the graphic in Figure 7. According to the graph, the 3 institutions with the highest number of publications were determined as Polytechnic University of Milan with 2,19% rate and 31 publications, Sapienza University Rome with 1,83% rate and 26 publications, University of Bologna and University of Florence with 1,48% rate and 21 publications, respectively.

Figure 7. *Distribution of Publications by Institutions* [42]

3.9. Keyword Analysis

Keywords are evaluated according to their frequency in the article and the relationship between them. In this study, when 1.415 articles on architectural restoration obtained from the WoS database were analyzed with the help of VOSviewer software, 2.655 keywords emerged. The minimum number of repetitions of 2.655 keywords was filtered as 3. When 149 words that emerged because of filtering were evaluated in the context of relationship with each other, they were analyzed as 148 words. With the help of VOSviewer software, 148 keywords were divided into 14 different clusters in the context of their relationship with each other.

Figure 8. *Keyword Network Diagram*

In Figure 8, the keywords are shown in different colors considering the abovementioned clusters.

Cluster 1 is shown in red and summarized as Urban Identity cluster. Keywords within the scope of Cluster 1 are listed as Adaptive Reuse, Architecture, Art, Contemporary Architecture, Heritage Conservation, Hictoric Center, Historical Heritage, Identity, Innovation, Memory, Public Space, Time, Typology, Urban Devolopment, Urban Landspace, Urban Planning, Urban Regeneration, Urban Space, Vernacular Architecture.

Cluster 2 is shown in green and summarized as Structural Properties cluster. Keywords within the scope of Cluster 2; Authenticity, Compatibility, Dating, Dendrochronology, Deterioration, Diagnostics, Durability, Environment, Evolution, Heritage, Historic Buildings, Hydraulic Lime), Image, Lime Mortar, Mechanical Properties, Mortars, Venice Charter, Wood, XRD.

Cluster 3 is shown in navy blue and summarized as Ecological Restoration cluster. Keywords within the scope of Cluster 3 are listed as Biodiversity, Ecological Restoration, Ecosystem Services, Habitat Restoration, Landscape Architecture, Landscape Design, Management, Nature-Based Solutions, Nostalgia, Ruin, Stormwater Management, Stream Restoration, Sustainability, Urban Wilderness.

Cluster 4 is shown in yellow and summarized as Structure cluster. The keywords within the scope of Cluster 4 are listed as Consolidation, Criteria, Earthen Architecture, Foundation, History, Monitoring, Rammend Earth, Rehabilitation, Reintegration, Repair, Stratigraphy, Strengthening, Structure, Tower.

Cluster 5 is shown in purple and summarized as Building Modeling cluster. Keywords within the scope of Cluster 5 are listed as 3D Model, 3D Modeling, 3D Modeling, Bim, Built Heritage, Cultural Heritage, Digital Survey, Laser Scanning, Photogrammetry, Venice, Verona, Virtual Reconstruction.

Cluster 6 is shown in blue and summarized as Restoration cluster. Keywords within the scope of Cluster 6 are listed as Damage, Earthquake, Enhancement, Fire, HBIM, Istanbul, Landscape, Multidisciplinary Approach, Project, Restoration, Project, Restoration, Sandstone, Stone.

Cluster 7 is shown in orange and summarized as Sustainable Architecture cluster. Keywords within the scope of Cluster 7 are listed as Climate Change, Daylight, Design, Ecology, Facade, Health, Modern Achitecture, Northern Europe, Perception, Resilience, Thermal Comfort.

Cluster 8 is shown in brown and summarized as Architectural Heritage cluster. Keywords within the scope of Cluster 8 are listed as Architectural Heritage, Architectural Preservation, Architectural Survey, Augmented Reality, Finite Element Method, Hictoric City, History of Architecture, Knowledge, Monuments, Seismic Vulnerability.

Cluster 9 is shown in pink and summarized as Peservation cluster. Keywords within the scope of Cluster 9 are listed as Architectural Conservation, Construction History, Historical Structures, Industrial Heritage, Preservation, Refurbishment, Reinforced Concrete, Reuse, Reversibility.

Cluster 10 is shown in light pink and summarized as Structural Assessment cluster. Keywords within the scope of Cluster 10 are listed as Architectural Restoration, Cathedral, Limit Analysis, Masonry, Masonry Structures, Reconstruction, Structural Assessment, Vaults, Vulnerability.

Cluster 11 is shown in light green and summarized as Building Materials cluster. The keywords within the scope of Cluster 11 are listed as Assessment, Brick, Concrete, Diagnosis, Lime, Mortar, Protection, Timber Structures.

Cluster 12 is shown in dark blue and summarized as Survey cluster. Keywords within the scope of Cluster 12 are listed as Documentation, Drawing, Methodology, Modernism, Museum, Representation, Restitution, Survey.

Cluster 13 is shown in a cream color and summarized as Conservation cluster. The keywords within the scope of Cluster 13 are listed as Community, Conservation.

Cluster 14 is shown in light purple and summarized as Renaissance cluster.

Figure 9 shows the numerical distribution of keyword sets. The words were analyzed according to their number of repetitions and it was found that 148 words were repeated 915 times. According to the number of repetitions, the top 5 clusters were Restoration with 193 repetitions, Structural Properties with 94 repetitions, Urban Identity with 86 repetitions, Ecological Restoration and Building Modeling with 79 repetitions, respectively. The 5 clusters with the highest number of repetitions were also visualized and detailed (Figures 10-14).
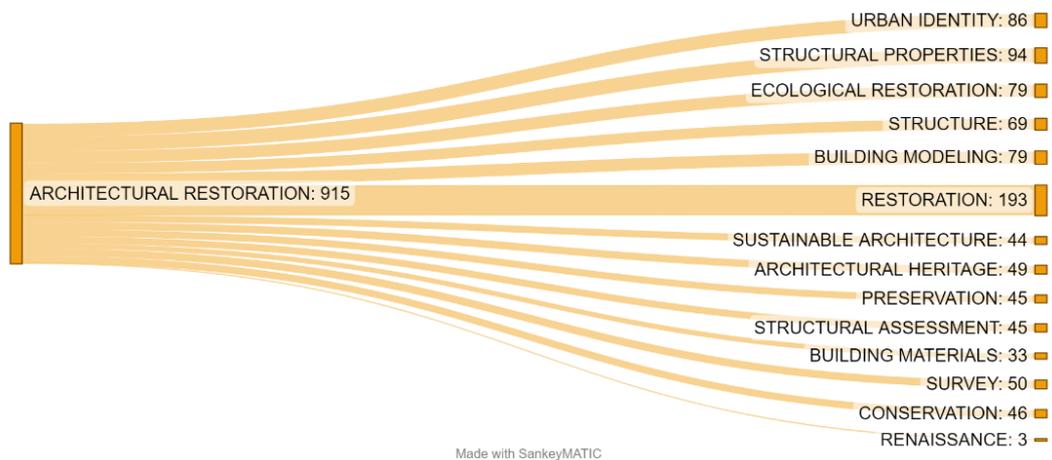
Figure 9. Number of Repetitions of Keywords by Clusters
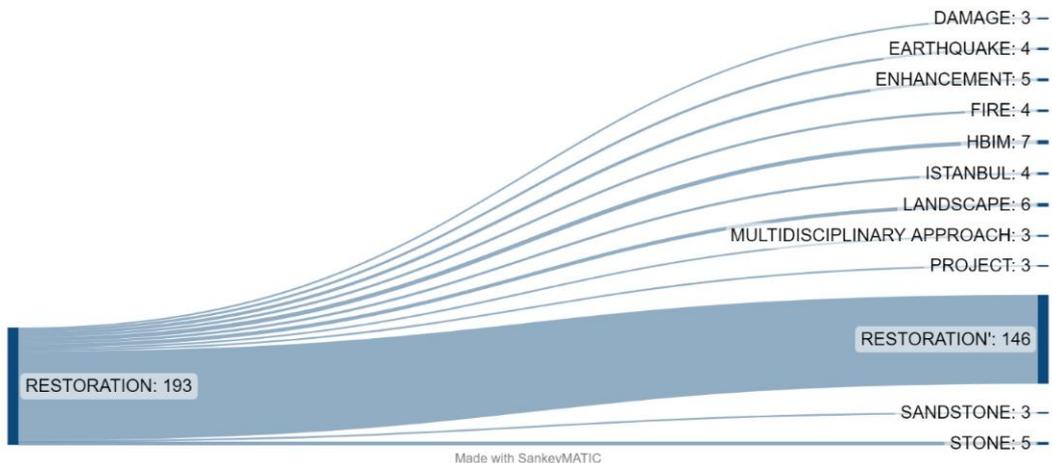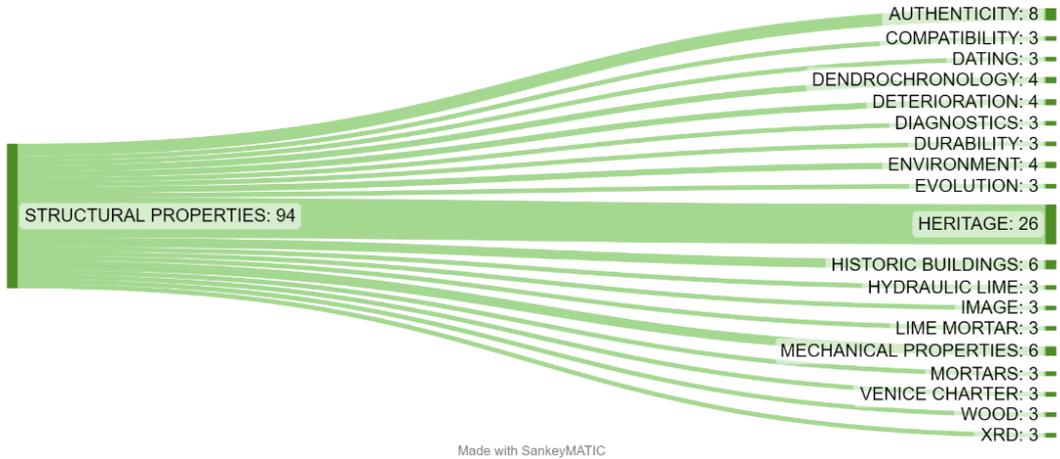

Figure 10. Restoration Cluster

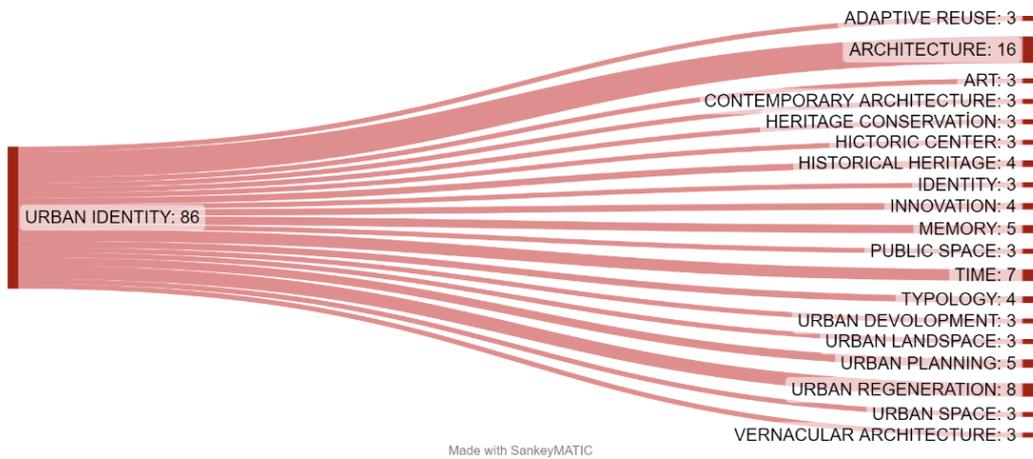***Figure 11.** Structural Properties Cluster*
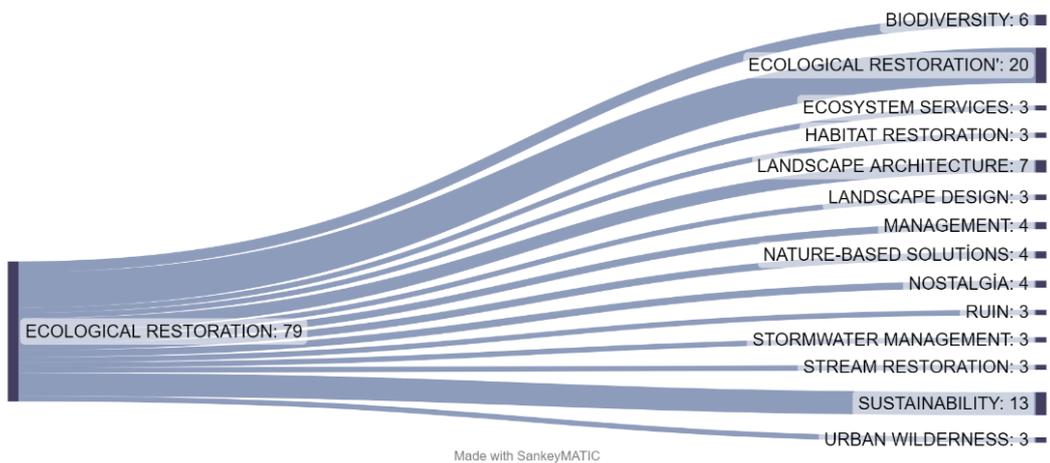

***Figure 12.** Urban Identity Cluster*

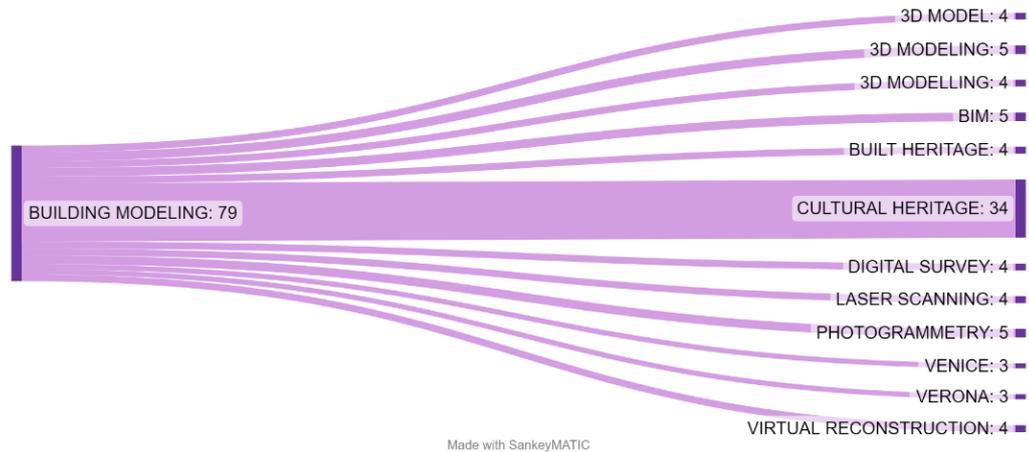***Figure 13.** Ecological Restoration Cluster*

Figure 14. Building Modeling Cluster

The keywords used in the studies were categorized by years. It was determined that the years in which keywords were used extensively were between 2014 and 2020. In Figure 15, purple and yellow colors were used to show the word intensity between these years, and the color scale varied depending on the intensity in this range (purple-blue-green-yellow).
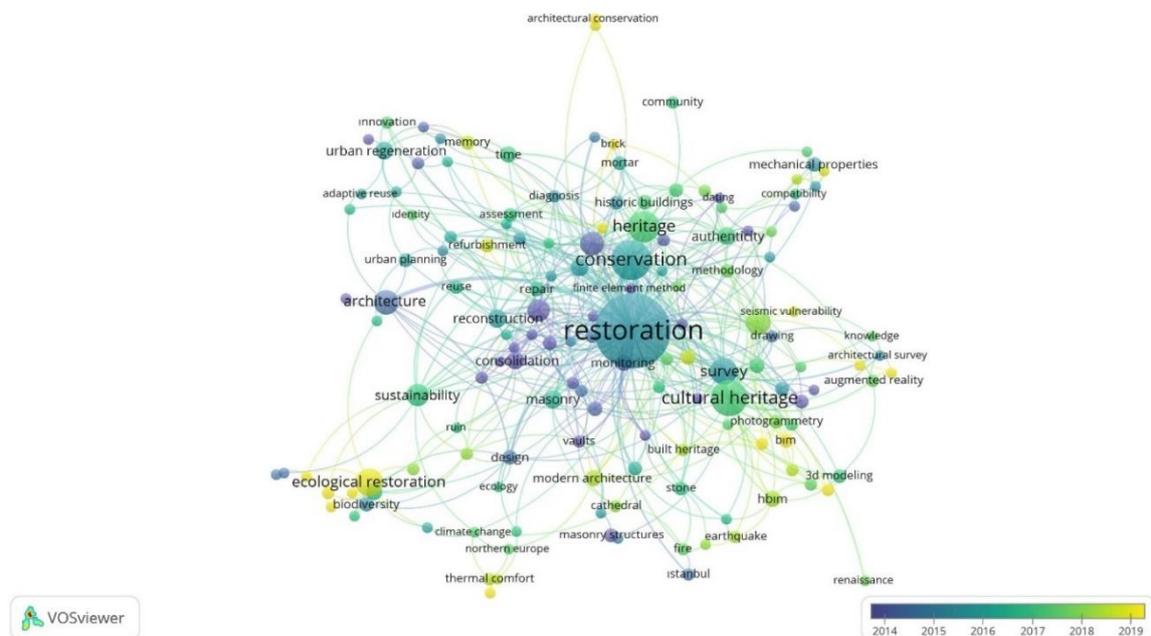

Figure 15. Distribution of Keywords by Years

- The common words, which are shown in purple and cover the period between 2014 and 2015, were determined as Evolution, Diagnostics, Dating, Construction History, Preservation, Image, Museum, Documentation, Venice, Monitoring, Sandstone, Facade, Vaults, Vulnerability, Strengthening, Rehabilitation, Tower, Rammed Earth, Consolidation, Criteria, Historical Heritage, Vernacular, Heritage, Public Space, Finite Element Method.
- The common words shown in blue and covering the period between 2015 and 2016 were determined as Architecture, Istanbul, Architectural Restoration, Architectural Survey, Drawing, Modernism, Survey, Mechanical Properties, Hydraulic Lime, Concrete, Reconstruction, Biodiversity, Design, Conservation, Restoration, Monuments, Limit Analysis, Enhancement, Typogly, Adaptive Reuse.
- Common words that are shown in green and cover the period between 2016 and 2018 are mainly Renaissance, 3D Modeling, Digital Survey, Fire, Multidisciplinary Approach, Stone, Perception, Northern Europe, Climate Change, Ecology, Landscape Architecture, Habitat Restoration,

Sustainability, Ruin, Modern Architecture, Repair, Reuse, Urban Space, Innovation, Time, Earthquake, Assessment, Timber Structures, Heritage, Architectural Heritage, Cultural Heritage, Historic Buildings, Protection, Authenticity, Hictoric City, Representation, Restitution, Photogrammetry, Laser Scanning, Augmented Reality, Knowledge, Lime Mortar, Compatibility, Reversibility, Heritage Conservation, HBIM, Damage, Thermal Comfort, Health, Cathedral, Memory.

- Common words shown in yellow and covering the period between 2018 and 2020 are mainly defined as Ecological Restoration, Landscape Design, Urban Wilderness, Nature-Based Solutions, Ecosystem Services, Daylight, 3D Model, BIM, Virtual Reconstruction, History of Architecture, Architectural Preservation, Seismic Vulnerability, XRD, Brick, Project, Refurbishment, Landscape.

4. RESULTS AND DISCUSSION

Buildings and building groups with historical and cultural importance can be repaired, preserved and transferred to future generations. In this context, restoration discipline plays an important role on a global scale. Scientific studies published in the field of architectural restoration provide much data on the development of this field [1, 3, 5]. Bibliometric analysis is a tool that helps interpret these data [22, 23]. Because of bibliometric analyses carried out with the help of these tools, it was aimed to give researchers working in the field of architectural restoration an idea for their future studies and to contribute to the literature in this context and to obtain data that will take this field to further levels. In this context, the findings obtained within the scope of this study are summarized below.

- According to the analysis of the research areas, the architectural restoration area ranks 53rd globally.
- In the type of publication analysis, most studies published in the field of architectural restoration consist of articles with 54% and 1.415 issues.
- Although the number of publications varies in the analysis of the number of publications and citations by year, the year in which the most studies were conducted in 2020 was determined as the year with the highest number of citations in 2021 according to the number of citations.
- Considering the publication language of the studies, it was determined that the most commonly used language is English.
- In the numerical distribution of publications by country and the analysis of collaborations, it was seen that Italy was the country with the highest number of publications, followed by Spain, USA and Turkey, respectively. The countries with the widest networks in terms of number of publications and collaboration were determined as Italy, Spain and America.
- In the analysis of the most cited studies, the first 3 studies were determined as 'Guidelines for On-Site Assessment of Historic Timber Structures', 'Ammonium Phosphates as Consolidating Agents for Carbonatic Stone Materials Used in Architecture and Cultural Heritage: Preliminary Research', 'Vulnerability Index: A New Approach for Preventive Conservation of Monuments'.
- When the journals where the studies were published the most were analyzed, it was seen that the journal that published the most was Archistor Architecture History Restoration. The International Journal of Architectural Heritage, which has the highest number of citations, has been determined as the journal with the highest impact rate.
- When the distribution of the studies by institutions is analyzed, among the institutions publishing the most, Polytechnic University of Milan, Sapienza University Rome, University of Bologna and University of Florence are in the first places, respectively.
- In the keyword analysis, restoration, conservation and cultural heritage were determined as the 3 most repeated keywords according to their number of repetitions. In this field, words are categorized in the context of being together and being used in current studies. Ecological Restoration, Landscape Design, Urban Space, Nature-Based Solutions, Ecosystem Services, Daylight, 3D Model, BIM, Virtual Reconstruction, History of Architecture, Heritage Conservation, Seismic Vulnerability, XRD, Project, Refurbishment and Landscape are the prominent words.

5. CONCLUSIONS

Science is a cumulative structure that grows in itself, including previous studies. At this point, the complete transfer of data belonging to a scientific study is a necessity of the scientificity of information. Published studies reveal field-specific data [43, 44]. Bibliometric analysis of the data of studies published in a field is of great importance in terms of transferring, developing and contributing to the future of information. Bibliometric analysis is an ongoing quantitative tool with the help of science maps on which direction publication trends are evolving [45, 46]. By gathering and evaluating data from publications, developments and deficiencies in the field are revealed. This serves as a guide for problem solving in future research in the light of the existing literature [47].

The concept of architectural restoration within the scope of this study is extremely important in terms of protecting the buildings and building groups that are of cultural heritage and transferring them to the future. Bibliometric analysis of previous studies published in this field will reveal the development of field and provide scientific and statistical data for new studies to be conducted [48-49]. Researchers are recommended to review these data and start their research and publication preparation process in the context of the visibility and effectiveness of their studies and publications. In this context, the results and suggestions developed for researchers working in this field are as follows.

- Studies were taken from the most preferred web of science database. Thus, limited number of data have been analyzed on this subject.
- The research results may change over time in the database, and there is a possibility that the data may not be accurate enough.
- The fact that the concept of 'restoration' is a wide field of research and in this context, scanning only with the term of 'restoration' in the literature searches to be made within the scope of 'architectural restoration' will not provide a meaningful data. A secondary word limitation defining the studies to be obtained in this field is important in terms of obtaining the right studies.
- Most of the studies published in the field of architectural restoration consist of articles. Conducting research in this field, especially through articles, will provide access to more and up-to-date data.
- Considering the distribution of the studies by years, it was seen that the most studies were in 2020, however, the most cited studies were in 2021. With the low number of publications but high number of citations in 2021, it can be said that the works published this year have developed a new perspective with a high impact on architecture. More research is needed into this perspective.
- Publishing publications in the field of architectural restoration in English will increase the effectiveness of the studies and their accessibility to more people.
- Italy has a high number of publications in the field of restoration. In studies published in Italy, there is accessibility to more resources with higher impact rates in this field. On the cooperation map, it is seen that there is a grouping between different countries and Italy is in the central position. However, in the globalizing world, cooperation between different countries should be strengthened. Producing collaborative and strategic solutions to problems will enable the emergence of new and practical methods while preserving historical and cultural values.
- Examining the studies published in the top journals in the field of restoration will provide an advantage in terms of accessing more resources.
- Although the published studies are mostly gathered under the keywords of restoration, conservation and cultural heritage, the current studies published in this field are summarized under the titles of sustainable design and building modeling. In this context, current research trends are on these topics, and it is important for the studies to be published today to focus on this in terms of impact rate. These topics are open to development and there is strong interest.

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