

## A Bibliometric Review of a Study on Building Information Modelling (BIM)

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### Abstract

A prevailing technology in construction is called Building Information Modelling (BIM). This paper focuses on the current study of BIM and to give an overview of the BIM. In this review 8658 papers were published in Scopus index between the years of 2000-2022 were analysed for this article. This study employs methodical approach and makes use of bibliometric methods to better methodically categories. The relationship between the primary building information modelling is depicted in the co-citation and keyword co-occurrence maps. This study widely mentioned research papers, authors, keywords, organisations, and nations that have produced work in the area of BIM.

**Keywords:** Bibliometric Review, Building information modelling, VoSViewer, Scopus Database, Systematic Literature review, Network analysis.

### 1 Introduction

Building Information modelling (BIM) is advanced and widely adopted in collaborationist construction projects with multiple different parties providing facility and software applications. In recent years, BIM has enhanced one of the best and faster fastest-growing multidisciplinary data sharing in Architecture, Engineering, and Construction firms. Its success is largely attributable to a new design methodology that enables tracking of the project's entire life cycle, including additional information, which is very helpful to see every aspect in detail, including the schedule, the financial management, the calculations, and the simulations. (oktem, Etrgen & et al 2018)

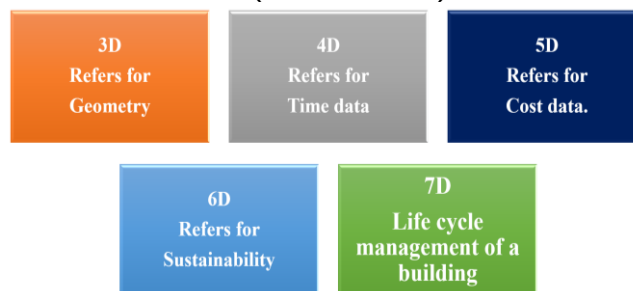
In comparison to 3D design CAD, the BIM is a model in which every entity has a specific role and information regarding the project. It also represents space in three dimensions. An architect's BIM model can be swiftly and readily transformed into an analytical model that a builder can utilize for structural analysis. A structural engineer can determine the stresses or deflections in a few easy steps then go on to thoroughly check the code requirements and do the cost estimation with easy steps. (Buet, Pathan & et al 2018)

BIM software is a tool for virtual reality and describes objects parametrically. When there are intricate calculations or a lot of repetitive tasks to be completed to obtain the most accurate estimations, applying BIM is quite advantageous. One of the untapped potential uses of BIM is that it can significantly reduce the time and effort required for cost estimation, allowing workers to focus on more beneficial tasks rather than manually counting the number of objects, such as value engineering, interference checking, constructability reviews, etc. (Sarkar, Modi & et al 2015)

### BIM SOFTWARES (Bhirud & Patil 2016):

Numerous software programs exist for building information modelling Examples of software used for architectural and engineering purposes include Autodesk Revit Advance, Graphisoft ArchiCAD, Bentley Architecture, Nemetschek Allplan Architecture, Gehry Technologies- Digital Project Designer, Nemetschek Vectorworks Architect, MSA IDEA Architectural Design (IntelliCAD), CADSoft Envisioneer, Softtech Spirit, and Rhino BIM (Beta). (Bhirud & Patil 2016) Additionally, the structural design software Autodesk Revit Structure, Bentley Structural Modeler, STAAD and Prosteel, Tekla Structures, CypeCAD, Bentley RAM, and Nemetschek Scia for structural purposes Autodesk Revit MEP (mechanical, electrical, engineers (electrical and plumbing) (Bhirud & Patil 2016)

**Different kinds of BIM dimensions are as follows: (Mahadevi 2018)**



**Fig No.1: Features of BIM**

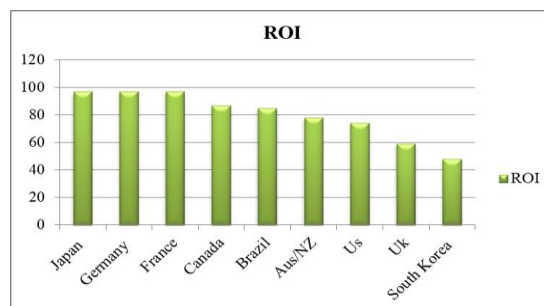
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### **BIM Across the globe: (Dodge data & analytics)**

Major business and public owners that seek to institutionalise BIM's advantages of quicker, more assured project delivery as well as more reliable quality and cost have sped up its adoption. Government mandates for BIM in the US, the UK, and other countries show how smart owners can set clear objectives and give design and construction firms the freedom to use BIM technology to achieve and surpass those targets while also advancing BIM throughout the larger project ecosystem. BIM usage as a result increased dramatically in North America from 28% to 71% between 2007 and 2012, and similar explosive growth is anticipated in the UK and other regions. In North America, adoption of contractors (74%) has surpassed that of architects (70%) and this group is increasingly taking the lead in advancing BIM innovation, metrics, and value. (Dodge data & analytics)

### **Return on investment (ROI) for BIM: (Dodge data & analytics)**

The majority of Firms estimate their ROI on their BIM investments to be between 10% and 25%, despite the lack of a common metric for calculating BIM ROI (unlike more common measurements for project ROI). The results show that each region has a distinct set of indicators that are valued highly and various variables that construction businesses believe would increase their return of all the regions, contractors in Japan, Germany, and France report the highest returns on their BIM investments, with South Korea, the UK, and the US trailing behind. (Dodge data & analytics)



**Fig No.2: Contractors Reporting a Positive Return on Investment (ROI) for BIM (By Country)**

(Source: Compile from Dodge data and analytics, 2013 by Author)

Metrics relating to the project delivery process, such as fewer RFI's, fewer unexpected changes, improved customer satisfaction, and less interruption in the project process, are widely regarded as the second most important category for determining ROI on BIM investments after financial metrics. Recognizing the collaborative nature of BIM projects, 60% of contractors across all regions stated that they thought that future BIM visualisation improvements would likely have the greatest positive influence on their BIM ROI. (Dodge data & analytics)

Furthermore, the research is organised as follows: Section 2 delves into bibliometric analysis, which includes, among other things, yearly publishing trends, author trends, journal statistics, geographical analysis, and handshakes between publications and citations. Section 3 provides a concluding overview. The final section of the paper represents the scope of future work/future research directions.

### **Research Methodology: -**

The Scopus database was used for this bibliometric investigation. Building information modelling, "building information modelling vs. traditional," and numerous other terms related to the berries and benefits of building information modelling have all been used by the author to retrieve the database. Out of the more than 9000 document details in that database, 8658 usable documents were found after the bifurcation. Following the bifurcation, additional

data analysis was done utilising the co-author, co-citation, co-occurrence, and co-documentation approaches using the tools VosViewer, Origin Pro, and Lucid Chart.

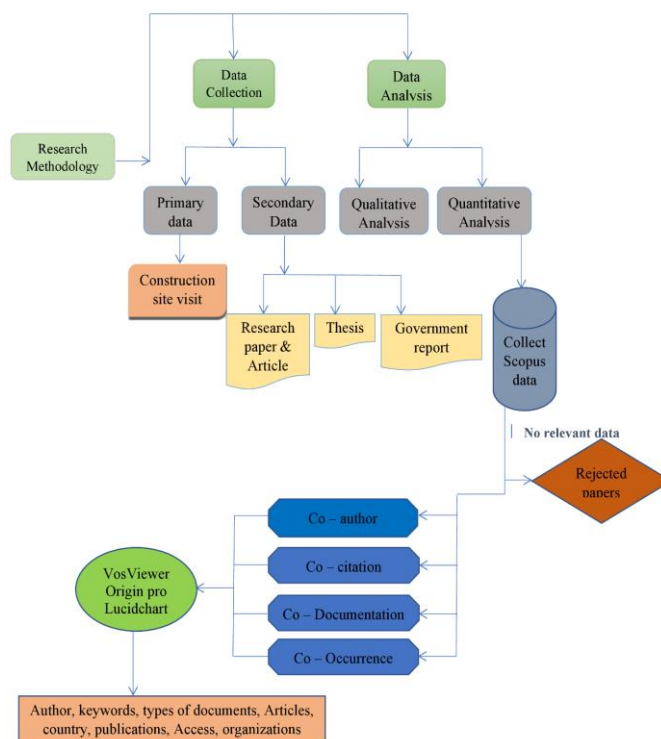


Fig No .3: Research stages

#### Finding from Bibliometric Analysis: -

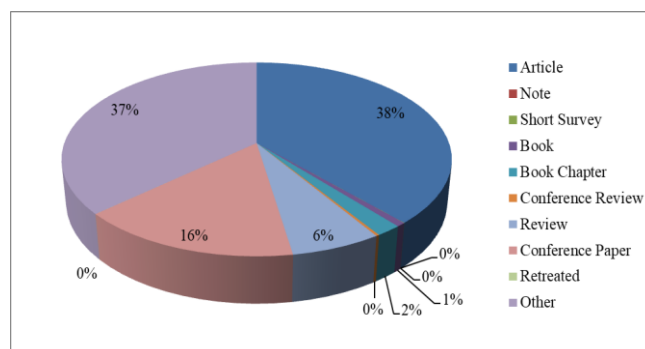
8658 documents or publications in total during the year of 2000 to 2022 were analysed for this bibliometric analysis. They are evaluated in light of their many traits, which are noted and identified in accordance with the use of a spread sheet created for their future investigation. Building information modelling and many other terms linked to it were used to find a preliminary sample of more than 9000 Scopus documents. After combining the samples from each keyword, eliminating duplicate articles, and applying the other suggested exclusion criteria, the author discovered 8658 documents that were thought to be pertinent to this study.

#### 1.Document Type

The Scopus database contains 38% articles, 16% conference papers, 6% reviews, 2% book chapters, and 37% other items. Which are displayed in Figure 4 and Table No. 1 The author came to the conclusion that 91% of the Scopus database's traffic comes from articles, conference papers, and other sources, and that most researchers choose these sources over blogs and other online publications for their research.

Table No. 1: Documents types published in Scopus from database

| Serial No. | Document Types    | Number of Documents |
|------------|-------------------|---------------------|
| 1.         | Article           | 5238                |
| 2.         | Note              | 0                   |
| 3.         | Short Survey      | 2                   |
| 4.         | Book              | 91                  |
| 5.         | Book Chapter      | 252                 |
| 6.         | Conference Review | 32                  |
| 7.         | Review            | 881                 |
| 8.         | Conference Paper  | 2169                |
| 9.         | Retreated         | 1                   |
| 10.        | Other             | 5016                |



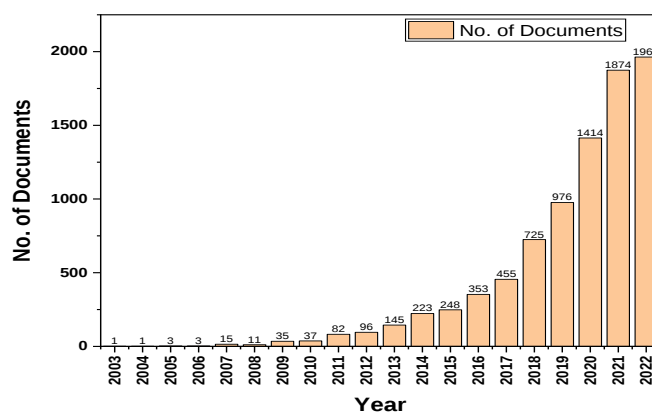
**Fig No. 4: Documents according to their type in Scopus database form 2000-2022**

## 2. Yearly number of research papers published (2003 - 2022)

In Table 2 and Figure No. 5 for the Scopus databases, respectively, the yearly publication trend in the bibliometric survey on clustering is displayed for the past 20 years. The year 2021 and 2022 saw the most publications in the current research study, and it has been discovered that publication patterns differ in kind.

**Table No. 2: The number of a document published annually during 2003-2022**

| Serial No. | Year | No. of Documents | Serial No.   | Year | No. of Documents |
|------------|------|------------------|--------------|------|------------------|
| 1.         | 2003 | 1                | 12.          | 2014 | 223              |
| 2.         | 2004 | 1                | 13.          | 2015 | 248              |
| 3.         | 2005 | 3                | 14.          | 2016 | 353              |
| 4.         | 2006 | 3                | 15.          | 2017 | 455              |
| 5.         | 2007 | 15               | 16.          | 2018 | 725              |
| 6.         | 2008 | 11               | 17.          | 2019 | 976              |
| 7.         | 2009 | 35               | 18.          | 2020 | 1414             |
| 8.         | 2010 | 37               | 19.          | 2021 | 1874             |
| 9.         | 2011 | 82               | 20.          | 2022 | 1963             |
| 10.        | 2012 | 96               | <b>Total</b> |      | <b>8660</b>      |
| 11.        | 2013 | 145              |              |      |                  |



**Fig No. 5: The number of a document published annually during 2003-2022.**

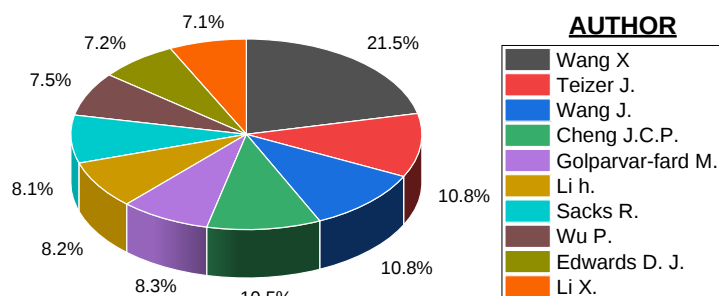
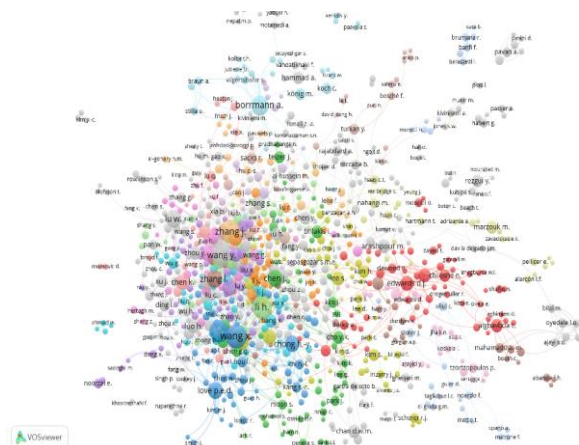
## 3. Authors' Research trend

The top 10 authors who contributed to the bibliometric study are shown in the clustering from Scopus along with their connections. Table 3 clearly identifies the key contributors to the study as being The citation analysis revealed that the Wang X , Teizer J ,Wang J and cheng J.C.P which are frequently cited by researchers worldwide, have 4120, 2079, 2077 and 2008 , This was further underlined by the Research Tool (VoSViewer) for Network analysis and author co-occurrence map.

**Table No. 3: A table showing the top 10 authors of Green Building studies in the clustering domain published in Scopus.**

| Serial No. | Author            | Citation |
|------------|-------------------|----------|
| 1.         | Wang X            | 4120     |
| 2.         | Teizer J.         | 2079     |
| 3.         | Wang J.           | 2077     |
| 4.         | Cheng J.C.P.      | 2008     |
| 5.         | Golparvar-fard M. | 1595     |
| 6.         | Li h.             | 1568     |
| 7.         | Sacks R.          | 1561     |
| 8.         | Wu P.             | 1430     |
| 9.         | Edwards D. J.     | 1374     |
| 10.        | Li X.             | 1370     |

In the Building information modelling research, the most often referenced author is displayed via hierarchy map in Figure 6. Because they are simple to understand and because their size, colour, and other percentage attributes shows the maximum research citation done by those authors.

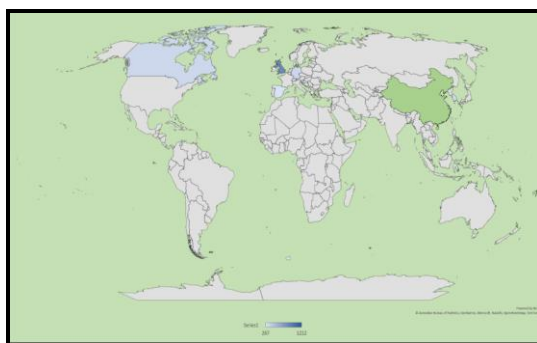
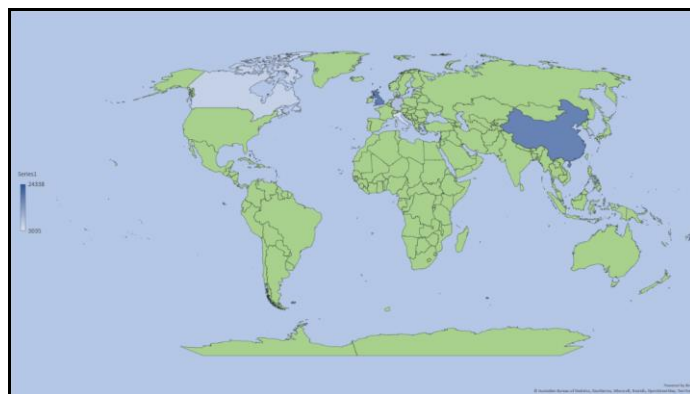
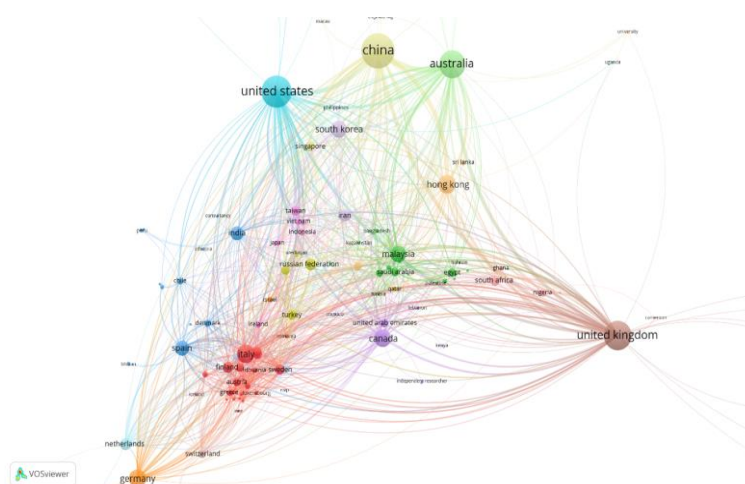
**Fig No. 6: A Sunburst hierarchy map of top 10 authors of building information modelling****Fig No. 7: Bibliometric map of Author co-repletion**

#### 4. Geographical Region Analysis

Using data from Scopus, countries containing documents in the topic of "Building information modelling research" are clustered in Figures 8 and 9. The country's bibliometric map is displayed in the research tool (VoSViewer). The map with the nodes and links illustrates the relationships between the various countries. China and the United States have contributed the most documents to the building information modelling study, 1212 and 1026, respectively. United States tops the list in terms of citations with 24338, followed by the United Kingdom with 18557.

**Table No. 4: countries currently involved in the building information modelling Study.**

| ial No. | Country        | Documents | Serial No. | Country        | Citation |
|---------|----------------|-----------|------------|----------------|----------|
| 1.      | China          | 1212      | 1.         | United State   | 24338    |
| 2.      | United State   | 1026      | 2.         | United Kingdom | 18557    |
| 3.      | United Kingdom | 862       | 3.         | Australia      | 17956    |
| 4.      | Australia      | 766       | 4.         | China          | 17384    |
| 5.      | Hong Kong      | 343       | 5.         | Hong Kong      | 9696     |
| 6.      | Germany        | 341       | 6.         | Germany        | 8066     |
| 7.      | Canada         | 339       | 7.         | South Korea    | 7460     |
| 8.      | South Korea    | 307       | 8.         | Canada         | 5757     |
| 9.      | Malaysia       | 293       | 9.         | Italy          | 4214     |
| 10.     | Spain          | 267       | 10.        | Singapore      | 3035     |

**Fig No. 8: world map showing the countries involved in building information modelling studies by Documents****Fig No. 9: A world map showing the showing the countries involved in building information modelling studies Citation****Fig No. 10: Bibliometric map of Country Co-Relation**

5. Organization Trend

This section looks at the number of building information modelling related publications that have been released by various organisations. The company's bibliometric map was created using the Research Tool (VoSViewer). On the map, the connections between the organisations are clearly visible. With the support of links and nodes, this map also depicts the organisational relationships. The school of built environment documents are primarily cited by the researcher. The school of built environment and Building received 1275 citations.

Table No. 5: A table showing the organization involved in building information modelling studies.

| Serial No. | Organization                                      | Citation |
|------------|---------------------------------------------------|----------|
| 1.         | School of built environment                       | 1275     |
| 2.         | School of architecture and built environment      | 1202     |
| 3.         | Institute for industrial production               | 769      |
| 4.         | Department of housing and interior design         | 641      |
| 5.         | Department of construction management             | 632      |
| 6.         | Department of computer science                    | 624      |
| 7.         | Department of civil and environmental engineering | 599      |
| 8.         | Department of building and real estate            | 587      |
| 9.         | Department of building and real estate hong kong  | 566      |
| 10.        | Deakin university                                 | 560      |

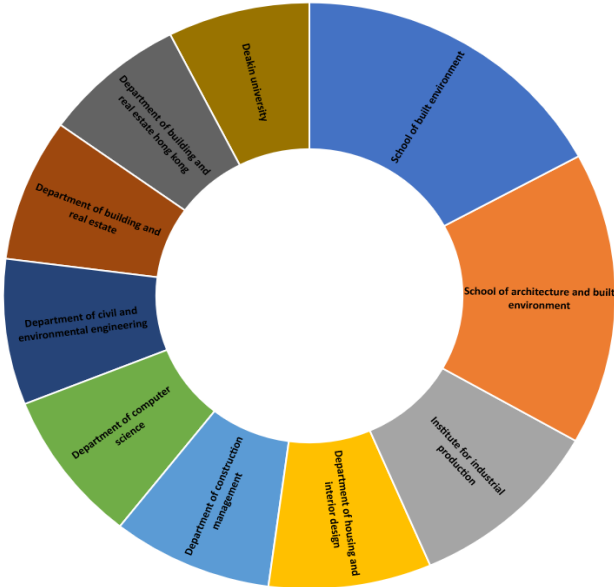


Fig No. 11: A sunburst hierarchy showing the organizations involved in building information modelling studies

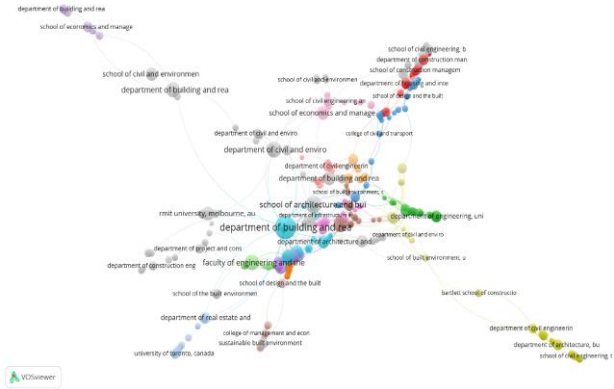


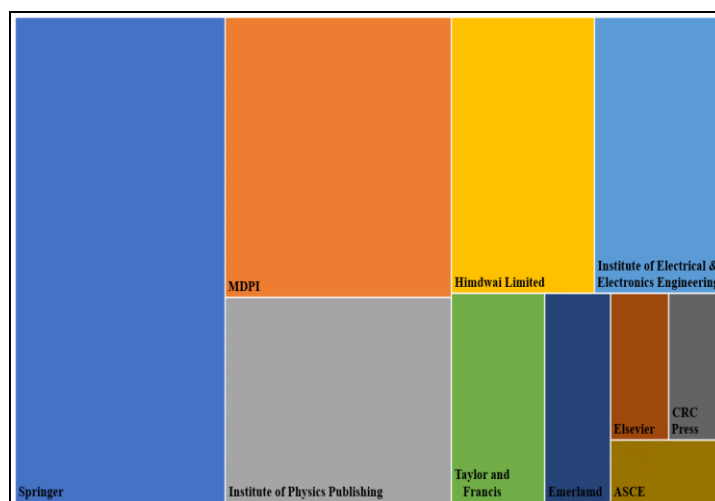
Fig No. 12: Bibliometric map of Organization Co-Relation

## 6. Publication Analysis

This section looks at the number of clustering-related publications that publish the most papers on building information modelling and how many papers building information modelling are linked to those publications. The top 10 publications are listed below the list. Springer has published the most documents (1721) pertaining to the building information modelling, as shown in Table 6.

**Table No. 6: Number of Documents published by Publication**

| Serial No. | Publication                                       | Documents |
|------------|---------------------------------------------------|-----------|
| 1.         | Springer                                          | 1721      |
| 2.         | MDPI                                              | 1070      |
| 3.         | Institute of Physics Publishing                   | 785       |
| 4.         | Hindwai Limited                                   | 668       |
| 5.         | Institute of Electrical & Electronics Engineering | 595       |
| 6.         | Taylor and Francis                                | 331       |
| 7.         | Emerland                                          | 232       |
| 8.         | Elsevier                                          | 144       |
| 9.         | CRC Press                                         | 132       |
| 10.        | ASCE                                              | 117       |



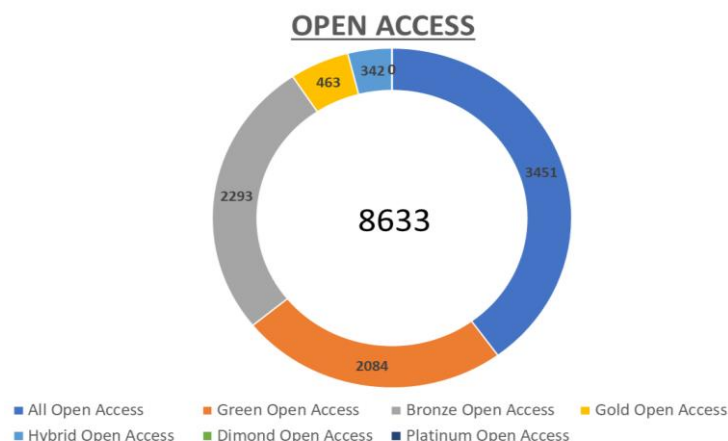
**Fig No. 13: Tree map hierarchy for publication who publish most Documents on building information modelling**

## 7. Open Access

Open-access journals offer a diverse range of types and accommodate different publishing methods. The document has a total of six different open-access types and 33 document not mentioned in Access. In the Scopus database from 2000 to 2022, there are All Open Access Gold Open Access, Hybrid Open Access, Diamond/Platinum Open Access, Bronze Open Access, and Green Open Access papers. In All open-access Categories, the maximum number of documents (3451) is available.

**Table No. 7: Different open access types Document published in Scopus database.**

| Serial No. | Types of Access      | Documents   |
|------------|----------------------|-------------|
| 1.         | All Open Access      | 3451        |
| 2.         | Green Open Access    | 2084        |
| 3.         | Bronze Open Access   | 2293        |
| 4.         | Gold Open Access     | 463         |
| 5.         | Hybrid Open Access   | 342         |
| 6.         | Dimond Open Access   | 0           |
| 7.         | Platinum Open Access | 0           |
| 8.         | <b>Total</b>         | <b>8633</b> |
| 9.         | <b>Not Mentioned</b> | <b>33</b>   |



**Fig No. 14: Different open access types Document published in Scopus database**

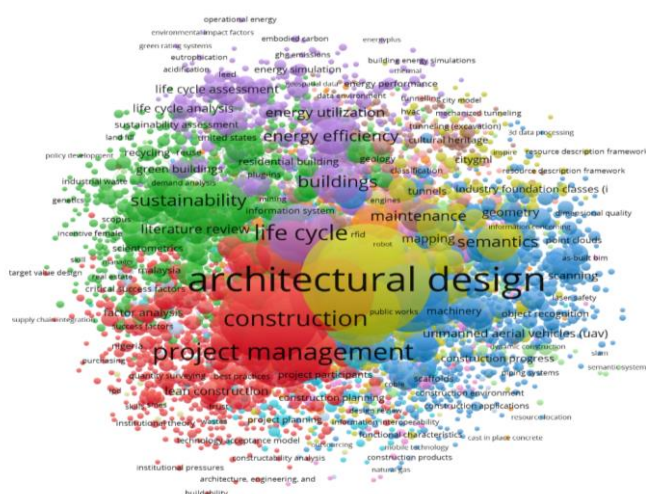
### 8.Key Words

The top 10 keywords for building information modelling are shown in the table below. The keywords were most frequently used. Architectural design, construction industry, and information theory are examples of related words. Below is a network map of keyword co-citations that we made using VosViewer. The size of the node shows how frequently a keyword occurs.

The most used keywords for building information modelling are listed in Table 8. Architectural Design (28466), construction industry (16210), and information theory (12024) are the top three most frequently used keywords in table no 8.

**Table 8: Top 10 keywords on building information modelling**

| Serial No. | Key Words                            | Link Strength |
|------------|--------------------------------------|---------------|
| 1.         | Architectural Design                 | 28466         |
| 2.         | Construction Industry                | 16210         |
| 3.         | Information Theory                   | 12024         |
| 4.         | Building Information Modelling       | 11642         |
| 5.         | Project Management                   | 11193         |
| 6.         | Building Information Modelling – BIM | 10946         |
| 7.         | Construction                         | 9020          |
| 8.         | Life Cycle                           | 8491          |
| 9.         | BIM                                  | 8346          |
| 10.        | Information Management               | 7702          |



**Fig No. 15: Keyword co-occurrence network map**



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