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A Bibliometric Analysis Of Sick Building Syndrome Research

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Abstract

Introduction: Sick-building syndrome (SBS) is a common but neglectedhealth issue in the world. Thus the study was to assess and analyze theanuualscientific output of SBS and evaluate the pertinent publication from the past decades.

Methods: A comprehensive list of citation classics in SBS was generated by searching the Scopus databases using keywords; Title (sick and building and syndrome) title (building and syndrome) during the period 1975 to march 2020. The main bibliometric indicators including, year of publications, country of origin, initiations, article type, productive journals, prolific authors, and funding sources.A statistical software package called R (Biblioshiny) and VOSviewer were used for data analysis and visualization.

Results: A total of 587 documents were retrieved from Scopus , with an average of 18.63 citations per documents, an average of 2.3 authors per documents. The United States was a leading country with the highest research documents(114), followed by Sweden (62) and United Kingdom(50). Geographical distribution of publications showed Asiancountries such as Japan(34),China(28), Malaysia(17) are the most active one among others. Chiba and Uppsala University (n =15) were the most active institution. The top-cited documents focused on the impact of SBSoutcome and its related symptoms.

Conclusions: The annual number of publications are slowly increasing fromthe past decades. There are not many Asian countries involved in SBS research, and very few numbers of paper are published in journal with good impact factor.Thus , this study highlights that a growing of documents in SBS research collaboration in this field needs to be strengthened to improve the global attention to SBS issue and others SBS factors need to be addressed.

Keywords: A Bibliometric. Building Syndrome. Sick Building Syndrome and Scopus

1 Introduction

Sick Building Syndrome (SBS) is a medical condition that has been the subject of health-related severe symptoms or illness with no apparent cause. It usually describes the situation of symptoms which increase according to the time people spend indoors, and it typically subsides over time when people are away. According to the National Health Service (NHS), most of the cases of the building syndrome are mostly reported in office buildings, particularly those with open floor plans, and it is also reported in homes, libraries, schools, and museums From last 20 years, there is a growing concern of people health in issues with an increasing number of complaint about building-related discomfort and its effect towards health with the relation between a period of stay in a closed area like residences or non-industrial workplace Issues related to the energy-efficient procedures in the form of tightening of buildings and reduction of the ventilation, and with the increasing industrialization of the building trade, involving the use of new building materials These causes are mainly due to energy-efficient procedure in the form of very tightening of buildings and reduction of the ventilation system . Mainly observed symptoms are headache, eye, nose, and throat irritation, fatigue, and dizziness and nausea among others [1-5].

In 1984 World Health Organization (WHO) report proposed thatworldwide,30% of renovated or new buildings are maybe the subject which is related topoor indoor air quality (IAQ) Ithas been suggested that sick building syndrome could be a cause of inadequate ventilation, buildings mainly located in a polluted urban area, fibreglass duct liners, chemical contaminants from indoor or outdoor sources, biological contaminants, air recycled using fan coils, traffic noise andinadequate lighting among others. These building-related symptoms may seemsimple and common at first sight, but together with all, they can be aimportant problem Though the cause and effect relation of building syndrome are unclear, many evidence shows that measured medication should be ruled out at an early stage to solve the problem .Bibliometric methods are the quantitative analysis of written publications. This method is a statistical interpretation of literature in aspects related to the topic of interest in a certain time frame which utilizes different practices in order to study the progress of, and trends in, a research topic as well as measuring the qualified importance of publications in a specific research field. Previously, it mainly consists of scientific production of highly cited publications; later it deep went into subdivided topic of author productions, national or subject bibliographies.Recent analysis measures focus on not only quantitative aspects but also the impact and implication of bibliometric analysis in research evaluation. There is nobibliometric studies have been carried out on SBS till the date. Therefore,the current study aims toanalyze the annual trends of worldwide publications on for SBS during the period 1975 up to March 2nd, 2020 using bibliometric analysis method from documents indexced in Scopus database [6-11].

2. Material And Methods

2.1. Sources Of The Data :

We conducted a bibliographic analysis using Scopus databases (https://www.scopus.com/) during the period 1975 until 2nd march 2020. was used to retrieve sample data for the bibliometric analysis. keywords including; Title (sick and building and syndrome), and title (building and syndrome) were used toretrieved the relevant documents.

2.2 Inclusion And Exclusion Criteria

The overall document of SBS were included in our analysis. The inclusion criteriaincluding all type of reported documents such as; full research papers, review papers, books, conference paper, editorial materials and letter to the editor. There is no language restriction, and a total of 17 different languages were included, and the majority of documents were written in English,German, French, Japanese, and Italy etc.

2.3 Data Extraction:

The two authors (UG) and Professor (ZJ), were extracted the related publications by using the Scopus databases. Data was downloaded as Bib TeX. File format and Excel 2019 for further analysis. Overall all data was extracted within a single day (March 2, 2020) to avoid daily updating bias since the database is still open, and the average of citation can increase per day.

2.4. Statistical Methods:

Data were analyzed using Excel 2019, Originpro 2018, to analyze the distribution of the most productive journals, annual trend, productive countries, institutions, and prolific authors. Furthermore, A statistical software package called R (Biblioshiny) and VOSviewer. (Van Eck &Waltman, Leiden University, The Netherlands) were used for data visualization.

3.Results

3.1 Type of the documents

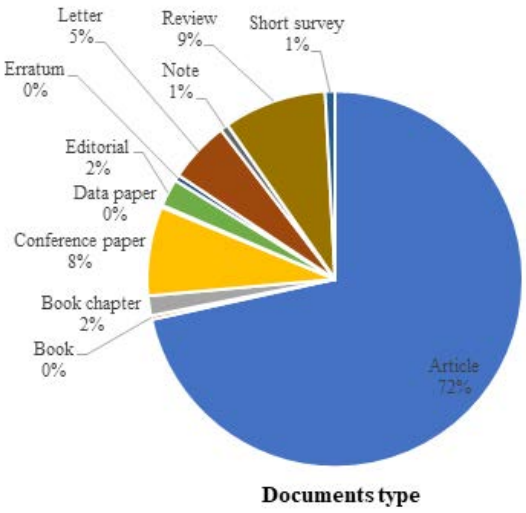

Figure 1: Document Types Of Scientific Papers Onsbs

3.2 Document Type

Approximately 587 of documents related to SBS were identified. The majority of published documents were full research articles (420;72%), and review paper (52; 9%), among others, as shown in (Figure 1).

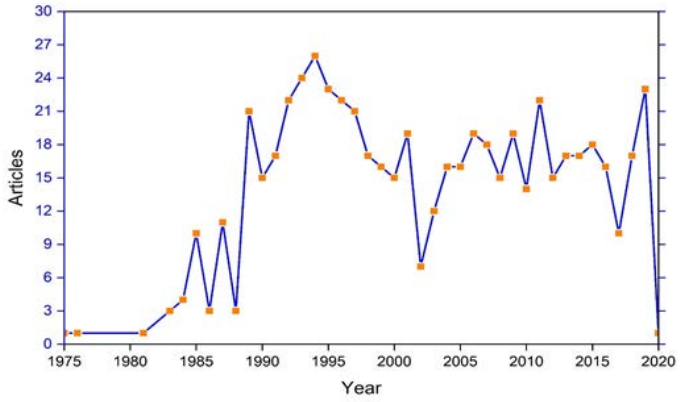

Figure 2: Annual Growth Of Sbs Publications During 1975 To 2020

3.3 Annual Growth Of Sbs Publications

Figure 2 shows the annual growth of publications. The graph shows that the number of publications remained low until early 1975 up to 1989, followed by a steady phase in 1990 until 2019. There was a noticeable sharp increase in 1995 (Figure. 2)

3.4 Annual Growth Of Average Mean Of Cited Documents

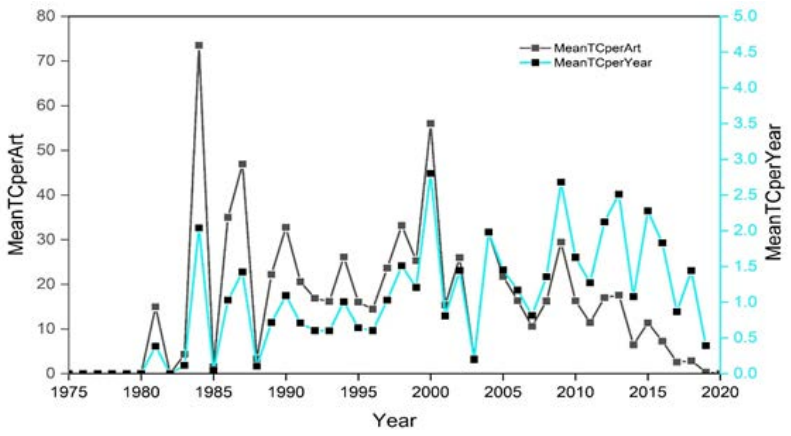

Figure 3: Annual Growth Of Average Cited Documents Per Article And Year During The Period 1975 To 2020.

3.4 Annual Growth Of Average Cited Documents

The retrieved documents received 587 citations, an average of 81.3 per document. The h-index of the retrieved documents with collaboration was 2.96. The range of citations was from 0 to 377. The article that received the highest citations was published in 1984, which coversmore above 70 of mean total citation per articles (Figure .3).

Table 1: The Top 10 Most Active Journals of Sbs During 1975 To 2020.

Rank	Source	h_index	TC	NP	PY_start	(IF:2018)
1st	Indoor air	19	1800	25	1991	4.71
2nd	Indoor and Built Environment	9	155	15	1992	1.36
3rd	Environment International	7	503	12	1987	7.94
4th	Occupational and Environmental Medicine	11	847	12	1994	3.56
5th	International archives of occupational and Environmental Health	10	396	10	1993	5.73
6th	Building and Environment	6	166	8	1991	4.82
7th	Science of the Total environment	8	293	8	2009	5.59
TC: Total Ciations						

3.5 The Top 10 Most Active Journals Of Sick Building Syndrome

The most top ten productive journals included "Indoor air" with h_index:19 and TC=1800), "Indoor and Built Environment" with h_index 9 and TC=155), "Environment International" with h_index:7 and TC=503), in the first which are top three among others(Table1).

Table 2: Most Active Countries And International Collaboration On Sbs (1975-2020).

Rank	Country (587)	Articles	Freq	SCP	MCP	MCP_Ratio	GDP(2019)
1st	USA	93	0.23	86	7	0.08	65,111.6
2nd	United Kingdom	44	0.11	37	7	0.16	41,030.2
3rd	Sweden	42	0.10	39	3	0.07	51,241.9
4th	Germany	37	0.09	35	2	0.05	46,564.0
5th	Japan	28	0.07	23	5	0.18	40,846.8
6th	Denmark	20	0.05	18	2	0.10	59,795.3
7th	China	15	0.04	10	5	0.33	10,098.9
8th	France	12	0.03	12	0	0.00	41,760.6
9th	Malaysia	11	0.03	10	1	0.09	11,136.8
10th	Canada	10	0.02	10	0	0.00	46,212.8

3.6 Top 10 Most Active Countries And Their International Collaborations

The international collaboration analysis shows the top producing countries for research in SBSpublications. Among the top ten countries that contributed countries in SBS research is United Sate (USA) with (93) articleswhich are highest in GDP 2019 among other countries(Outlook 2020), followed by United Kingdom (44) articles, and Sweden occupied the third rank (42) articles, respectively. Among the Asian countries, Japan, China and Malaysia are reported in the top 10 countries in SBS research with the frequency of (28,15 and 11) publications, respectively. The analysis of the multi-country papers (MCP) shows that the USA (MCP=7), UK(MPC=7) are still had the highest number of publications. Where in single country papers analysis (SCP=86), followed by Sweden (SCP39), United Kingdom (SCP=37) and Germany (35). Some Asian countries also had SCP for example; Japan (SCP=23), China (SCP=10), and Malaysia (SCP=10).

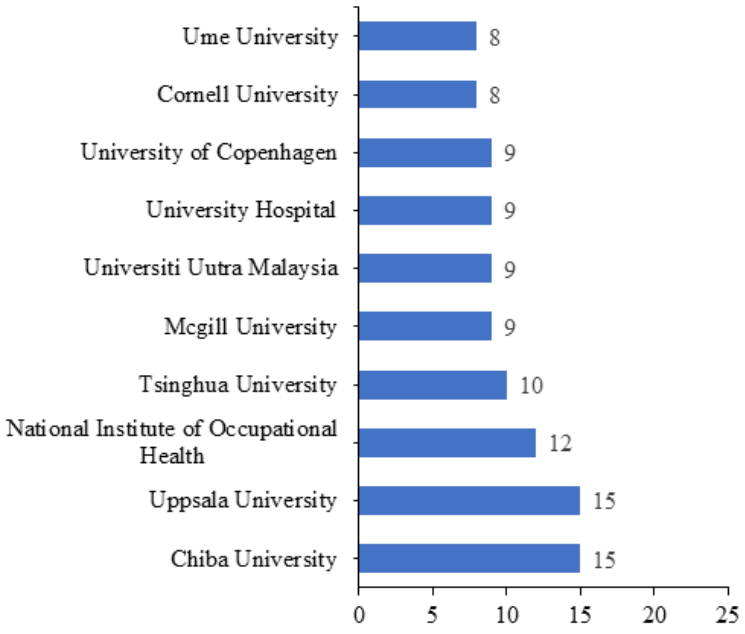

Figure 4: The Top 10 Most Relevant Affiliation on Sbs During the Period 1975 to 2020.

Among the top 10 Affiliation Chiba and Uppsala university are in highest rank with a 15 number of documents followed by the National Institute of Occupational Health (12) which are shown in Figure 4.

Table 3: Top 10 Cited Articles Sbs During The Period 1975 To 2020

Rank	Author,	Journal,	Articles	Year	TC
1st	Wargocki P, 2000.	Indoor Air	The Effects of Outdoor Air Supply Rate in an Office on Perceived Air Quality, Sick Building Syndrome (SBS) Symptoms and Productivity	2000	377
2nd	Finnegan MJ, 1984.	BR MED J	Sick building syndrome	1984	274
3rd	Wargocki P, 1999.	INDOOR AIR	Perceived Air Quality, Sick Building Syndrome (SBS) Symptoms and Productivity in an Office with Two Different Pollution Loads	1999	272
4th	Burge S, 1987.	ANN OCCUP HYG	Sick Building Syndrome: A Stud Y oF 437 3 Office Workers	1987	269
5th	Redlich CA, 1997.	LANCET	Sick-building syndrome	1997	262
6th	Cooley JD, 1998.	OCCUP ENVIRON MED	Correlation between the prevalence of certain fungi and sick building syndrome	1998	239
7th	Skov P, 1987.	ENVIRON INT	The "Sick" Building Syndrome Office Environment: The Danish Town Hall Study in the	1987	193
8th	karmiloff-smith A, 2004.	J Child Psychol Psychiatry ALLIED DISCIP	Exploring the Williams syndrome face-processing debate: the importance of building developmental trajectories	2004	186
9th	Skov P, 1989.	SCAND J WORK ENVIRON HEALTH	Influence of personal characteristics, job-related factors and psychosocial factors on the sick building syndrome. Danish Indoor Climate Study Group.	1989	176
10th	Apte MG, 2000.	indoor air	Associations Between Indoor CO2 Concentrations and Sick Building Syndrome Symptoms in U.S. Office Buildings: An Analysis of the 1994–1996 BASE Study Data	2000	173

3.7 Top 10 Cited Articles

Table 3 shows the top 10 highly cites articles in SBS. The highest number of total citations obtained was 377 which belongs to Wargocki P et al., and the article was published in "International Journal of Indoor Environment and Health" in 2000(Wargocki et al. 2000)This was followed by an M J Finnegan et al. published in the "British Medical Journal" in 1984(Finnegan, Pickering, and Burge 1984). The top 10 cited articles were all research articles about sick building syndrome. Out of most cited articles, major was published under the journal named "International Journal of Indoor Environment and Health" (Indoor air).

3.8 Top 10 Authors Working On Sick Building Syndrome

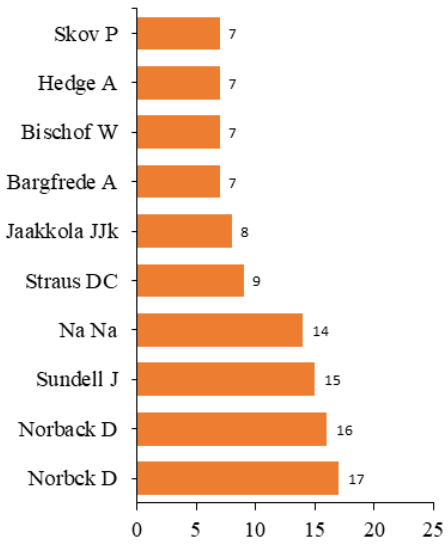

Figure 5: Top 10 Author Working On Sbs

Figure 5 presented the top 10 authors working on sick building syndrome. Norbck D and NorbackD frompublished an highest number of document 17 and 16 respectively followed by sundell J (15) and Na Na (14) among others.

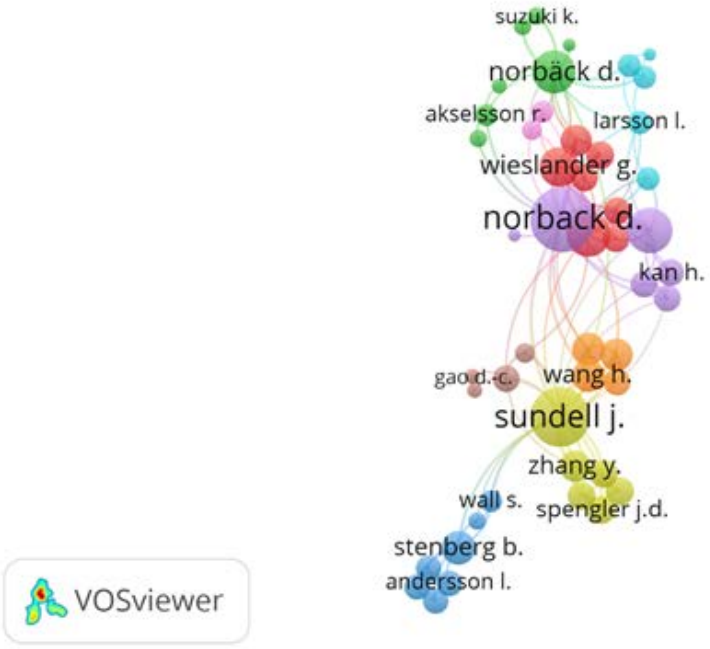

Figure 6: Co-authorship Analysis and Reported Authors on Sbs During the Period 1975 to 2020.

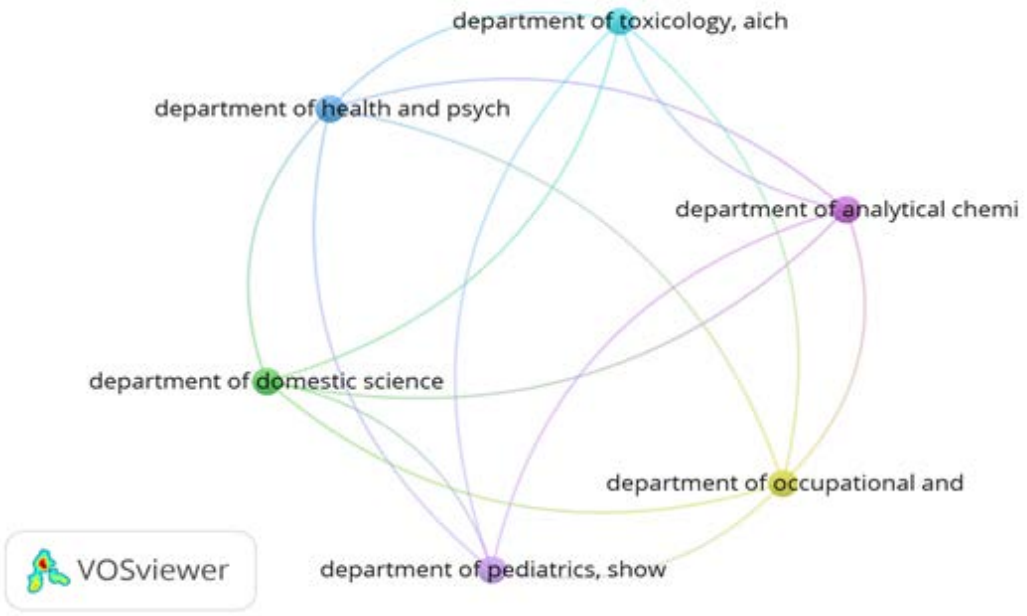

Figure 7: Vos Viewer Visualization of Organizational Colloboration (1975 to 2020)

Colloboration of Organizations.

Of 981 organization, a minimum 2 document of authors were selected, which is resulted in 46 organizations meet the threshold. In total, 6 items are shown in the visualization analysis distributed in 6 clusters The overall 6 departments have an equal number of documents, Citations and Total length strength (n=2 documents, TC=13 citations)(Figure:6).

Figure 8: Visualization Of Co-Cited References On Sbs During 1975 To 2020.

Figure 9: WordCloud of Author Keywords on Sbs During 1975 to 2020.

the frequency of the most top 100 authors keywords out of 795 authors.We notice that the “sick building syndrome” were frequently reported (186;23.3%), followed by “indoor air quality” (38;4.8%), “sbs” (19;2.4%), “indoor air pollution” (14;1.7%), “indoor environment” (12;1.5%), “ventilation” (12;1.5%), “building related illness” (11;0.1%) and “epidemiology” (11;0.1%) among others.

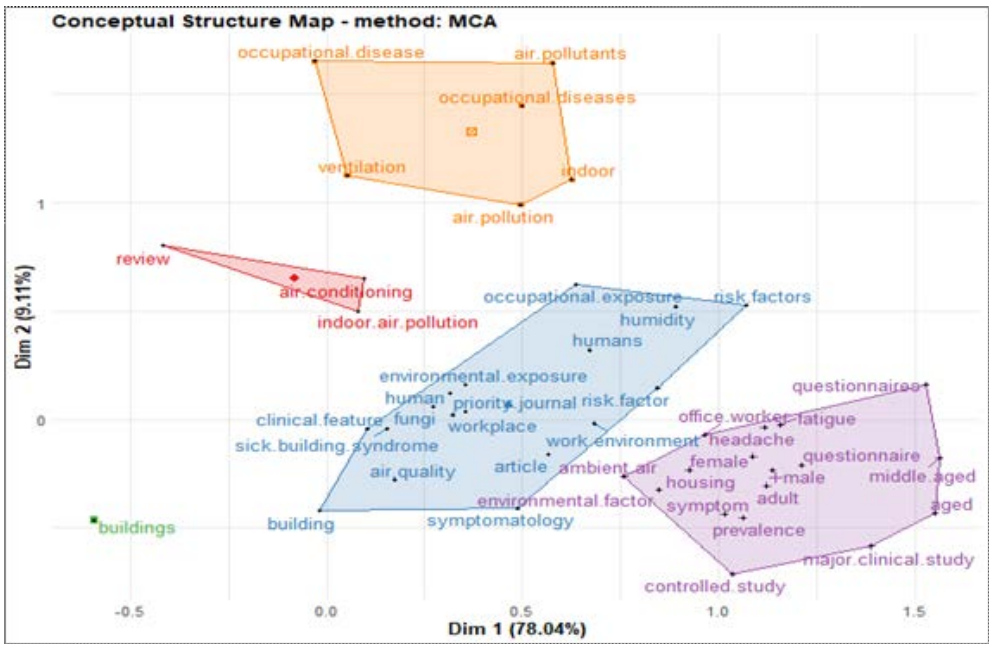

Figure 10: Factorial Analysis Of Conceptual Structure Map Of Multi-Corresponding Authors (Mca) Analysis.

The Factorial Analysis of MCA using authors keyword Plus for the top 100 keywords Plus were visualized into 4 clusters as; red cluster is the smallest one which includes (review, air condition, and air pollution),the orange cluster includes (air pollution, occupational diseases, ventilation) and so on.Blue cluster contains the highest number of keywords and research, which is in the middle of the framework. Workplace, Human's occupational exposure is commonly used terms in the frame (Figure 9).

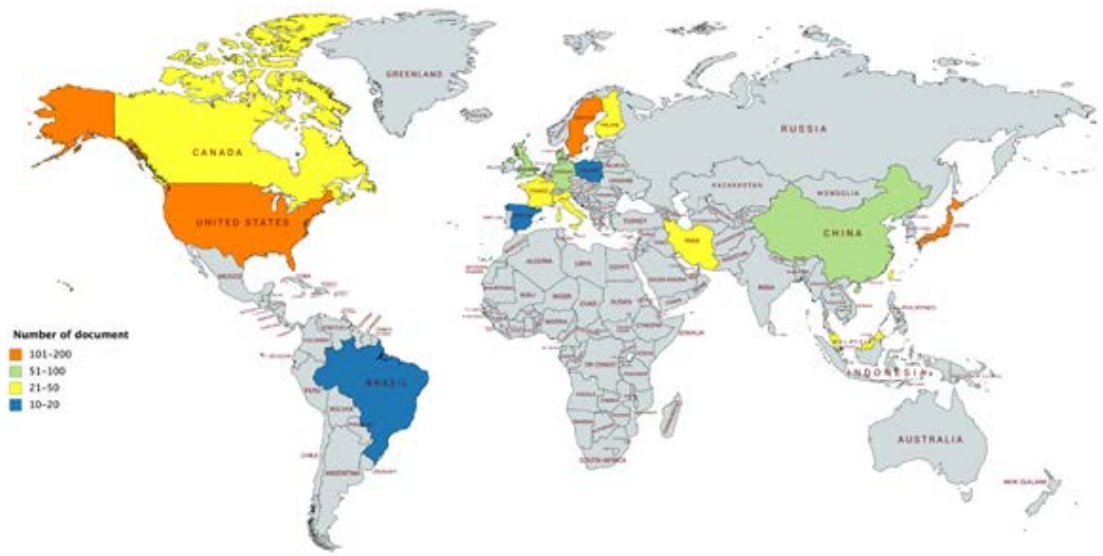

Figure 10: Factorial Analysis Of Conceptual Structure Map Of Multi-Corresponding Authors (Mca) Analysis.

4. Discussion

Our bibliometric analysis presented an overview of the trend and development of research from past 19th century to till now.The initial search revealed that 489(84%) of the publications were in English, implying that English is the broadest language used in most official and international communications followed by others. Trend and development of scientific output in SBSaregradually growing. Thus,it may lead to the question that SBS are still health issues in the globe.The USA still held an executiveposition. However, several Asian countries also significantly contributed, for example, Japan, China and Malaysia. The identification of SBS as its related illness differs from country to country. However, the symptoms occur in various kinds of buildings like offices, apartment, houses, among others. A recent enquiry among 10,000 people living in Stockholm, Sweden,

revealed that 13% of those living in apartment complain about health problems which weredirectly related due to indoor environment. SBS is a problem which can be prevented or detached(WHO 2014). It is an unnecessary cause of ill-health with considerable loss of productivity and quality of life for those who affected. For people affected by SBS, the symptoms can cause significantinterruption to both their work performance as well as personal relationships. There will be a straight affect on the productivity in the work area which will result in increased staff turnover. British approximations from different studies show that up to 8% of the working population repeatedly experience SBS symptoms to theextent that their productivity and health are entirely affected .There is important to remember, yet, that the symptoms of SBS can be considered as slight since recovery is quite rapid as soon asthe problem is recognized and remedial measures should beaddressed quickly(Quality 1994). It is often measured that SBS symptom has a minimum prevalence report about 15 to 20% for 2 weeks SBS symptoms informed by 30% or more of workers are symbolic of conditions in the building environment that demand attention. Though the single cause is not responsible, combinations of factors are responsible for contributing Sick Building Syndrome like inadequate ventilation, presence of long term sources of contaminations, close space working environment etc. This study gives an overview of growing research in SBSresearch like published articles (420;72%), with an international collaboration by a different country, authors and are mostly published in Indoor Air which h_index is 19 and total citation(TC) is 1800. Besides,United State some Asian countries are also involved in SBS research like Japan, China and Malaysia with the frequency (28,15 and 11) of publications. Word cloud of key words gives an overview of most frequently used keywords by authors in their research like sick building syndrome 186(23.3%), indoor air quality 38(4.8%),sbs 19(2.4%),indoor air pollution 14(1.7%), indoor environment 12(1.5%)and ventilation 12(1.5%) are topmost among others.we can notice thatthere is an increasing issue globally so as authors are focusing on it.It is usually due to indoor air quality andpoor ventilation system . The most vulenerable groups highlighted by authors are like office workers, school children and some occupational exposure, which not only affect physical health but also psychologically if not managed early. To addressed this issue we need to be awareness about sick building related symptoms and educate to those risk people who spend their maximum number of time indoor specially children , elderly sick and womens who usually cook [12-22].

Country scientific productions elasticities an overview of the involved country around the world. Although there issome actively involved country in research, there is a still gap of knowledge about research in some developing and most of the Asian countries which need to be addressed. Health and well beingisa vitally important aspect of people, and Sick building syndrome is a collection of factors which directly or indirectly affect not only physical but psychological well being due to human biological interactive system.we need to have wellknowledge about building-related symptoms for further prevent from building-related illness [22-24].

The current study, to the best of the author's knowledge, is the first bibliometric study to analyze the health-related issue and trend in SBS. Previously therearenopublished bibliometric studies on Sick Building Syndrome. The health aspect of building syndrome is an emerging and important health component which need tobe addressed. The current study also has some limitationsfundamental in bibliometric methodology. In bibliometric analyses, only one database can be used because data from more than one database cannot be combined and analyze .Besides, the authors did the best use of keywords that represent the topic and also did a manual check for retrieved articles;however, a limited number of false-positive or negative remain possibility. Concerning the ranking, the authors extracted the information as it is from the Scopus. However,due to the different spelling of authors or institutions, it is possible that may some authors have multiple affiliations that the authors were not aware of, so the ranking might not be 100% correct. Lastly, in VOSviewer, we mostly used a limited number or threshold to visualize the maps and tables. Thereforeall the items are not being shown in the map and chart does not mean that those itemsarenot essential or that the authors were biased toward any particular item. The authors were aware of all these limitations and did their finest to minimize it to an acceptable level [24-31].

5. Conclusion

This study measured the health-related literature onSBS, with providing baseline information for future research. The retrieved literature focused mainly on the effect and outcome of a building-related syndrome. Thus, there is a serious need to study more aboutthe health aspectsofthe building-related syndrome. The current study showed inadequate international collaboration in this field. Establishing global research networks which include low and middle-income countries is very important for the future to get more knowledge about it. Such networks will help developingcountries to improve their research and knowledge in response tobuilding-related symptoms. Such collaboration will also create a global platform for experts to exchange information and health lessons from previous and experiences to be used for early identification, prevention and control the SBS issue in the coming future.

Availability of data and materials

All research data used to support the findings of this studyare included in the article, and the analyzed data used can be freely accessed from the Scopus data collection.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Authors' Contributions:

UG and ZJconceptualized and designed the study, interpreted the data, and wrote the manuscript. The author read and approved the final manuscript.

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Consent for publication
Not applicable.

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