Winter 2-4-2020

Construction Labor Productivity Modeling and Use of Neural Networks: A Bibliometric Survey

Shalaka Hire
Symbiosis Institute of Technology, Symbiosis International (Deemed University),
shalaka.hire@sitpune.edu.in

Sayali Sandbhor
Symbiosis Institute of Technology, Symbiosis International (Deemed University),
sayali.sandbhor@sitpune.edu.in

Construction Labor Productivity Modeling and Use of Neural Networks: A Bibliometric Survey

Shalaka Hire, Sayali Sandbhor
Research Scholar, Civil Engineering Department, Symbiosis Institute of Technology, SIU, Pune, India.
Assistant Professor, Civil Engineering Department, Symbiosis Institute of Technology, SIU, Pune, India.

Abstract: Productivity of a project has a major impact on its cost and profitability. In spite of construction being labor intensive field with labor cost adding up to 30% to 50% of overall project cost, the productivity of labor is one of the least studied areas in the construction industry. It requires to be given due attention to the issues affecting labor productivity and design solution using soft computing techniques to improve the overall performance of the industry. This research paper aims to conduct a bibliographic survey of the literature available in the domain of Labor Productivity (LP) as well as the application of Neural Network (NN) for the prediction of labor productivity in the construction sector. Time span considered for the survey is from the year 1996 to 2020. This bibliographic survey mainly focuses on literature from Scopus database. It provides statistics of publications by journals, countries, authors, and citations till date. The study intends to highlight the quantum of research in the selected domains and compare the two to derive a suitable conclusion. The outcome of this survey not only emphasizes the need for research in labor productivity assessment using NN but also throws light on the urge to promote and conducting research by Indian researchers. The study is a first of its kind bibliometric analysis for labor productivity in construction projects. It explores the particulars of previous studies carried out in the selected domain and is helpful in designing methodology for carrying out further research in the domain.

Keywords: Labor productivity, neural network, construction, prediction, bibliometric survey, scopus database

1. INTRODUCTION

As per the Planning Commission of India, in the last five years, the contribution of the construction industry to the nation's GDP is about 8 % [1]. The industry employs a large number of skilled, semi-skilled, and unskilled workers [2]. The construction industry is defined as a labor-intensive industry [3]. The cost spent on labor is 30% to 50% of the total project costs [4]. Construction productivity is one of the crucial issues that must be considered as productivity is a measure of the efficiency of a construction project. Generally, productivity is the ratio of output produced per unit input. It can also be defined as shown below in equation 1.

$$\text{Productivity} = \frac{\text{Output}}{\text{Resource}} \qquad \ldots\ldots\ldots\ldots(1)$$

Resources comprise of labor, capital, time, energy, raw material, etc. that translates directly into cost savings and profitability [5]. Despite economic support in developing countries, the construction industry still faces problems with low productivity, limited mechanism, inexperienced, and unprofessional labor. Ample research is conducted to describe the factors affecting the efficiency of construction work with

methods such as work-study, regression analysis, statistical methods including principal component analysis, total interpretive structural modeling, neural networks, etc. A neural network is the most widely used method of analyzing productivity these days. It is an artificial intelligence technique used to understand data relationships through a mechanism that mimics how the human brain functions. The following subsection explains the background and needs of the present study.

1.1 Background

Productivity-enhancing issues have long been a concern of researchers. Many researchers have studied critical factors affecting labor productivity with various techniques. It includes the use of fuzzy expert systems for prediction of industrial construction labor productivity [6]. Identification of factors relating to labor productivity and its effect on project schedule performance studied in [7] where, critical factors such as lag of material, labor strikes, delay in the material are determined. A relative importance index is used for analysis. Regression analysis is adopted for comparison of labor productivity in the United States and China [8]. Critical factors such as material shortage, lack of labor experience, lack of labor surveillance, misunderstandings between labor and superintendent, and drawings and specification alteration during execution are identified in [9] with importance index for a building project. Most of the researchers have used techniques such as relative importance index, regression analysis, work-study, fuzzy-AHP for the identification of critical factors. The majority of the researches was limited to quantitative analysis. Very few researchers used NNs in civil engineering for decision making, prediction, and optimization. Some of the previously studied areas include modeling techniques for quantitative evaluation for the impact of multiple factors on productivity in which neural network productivity models for concrete pouring, formwork, and concrete finishing tasks, using data compiled from eight building projects were prepared [10]. The estimation of labor productivity using a probability inference neural network is showcased in [11]. The research identified factors contributing to the adverse effect of change orders on labor productivity by using neural networks [12]. A study [13] computed labor output level using the neural network by direct observation for the formwork of beams in different high concrete structures. Simulation for the productivity of the masonry crew using two NN techniques was conducted in a study by [14] in which the efficiency of the feed-forward neural network was compared to the radial base neural network. Recently, the impact of environmental and operational variables is estimated by the application of NN in predicting formwork labor productivity. Literature shows use of various NN models have been used including the General Regression Neural Network (GRNN), the Back Neural Network (BNN), Radial Basis Function Neural Network (RBFNN), and the Adaptive Neuro-Fuzzy Inference System (ANFIS) [15] as shown in Table 1.

Table 1: Types of NN adopted for measuring labor productivity for various activities in construction

ANN Types	Author	Activity	Year
General Regression Neural Network Back propagation Neural Network Radial Base Function Neural Network Adaptive Neuro-Fuzzy Inference System	Golnaraghi et al.[15]	Formwork	2019
Feed-forward Neural Network	Gerek et al.[14]	Masonry crews	2015
Artificial Neural network and even discrete simulation	Song et al.[16]	Steel drafting	2008
Artificial Neural network with fuzzy logic	Portas et al.[17]	Concrete formwork tasks	1997

1.2 Need for the study

Bibliometry is a branch of scientific study that deals with systematic analysis of available literature from various aspects. It includes geographic analysis, author analysis, journal analysis, etc. Based on observations from literature, it is commented that the field of labor productivity in construction lacks a systematic bibliographic survey. It is essential to conduct a bibliometric analysis of the search result for the field of LP assessment. It would throw light on the important research gaps and need of carrying out research in the said domain. From 1996 onwards, a large number of research efforts have been put in assessing construction labor productivity with specific attention to improvement in the on-site processes. The study not only assimilates the bibliographic information using certain keywords but also analyzes the quantum of work conducted in the area of labor productivity in general and labor productivity assessment or prediction using a neural network in particular. It is needed to compare the results of two, to emphasize the amount of research done and the need for research in the domain which is new to the community and upcoming. The following sections describe the survey sequence, details, and observations based on relevant literature.

2. BIBLIOMETRIC SURVEY

There are numerous sources for gathering data from previous studies. The databases available for data collection include and not limited to Scopus, Web of science, research gate, Science Direct, Google Scholar, etc. However, this survey is limited to the Scopus databases; it is comparatively easier to navigate as compared to other databases. Scopus is the platform where the publications of the latest researches and advancements are available. Scopus is Elsevier's abstract and citation database launched in 2004 that covers peer-reviewed journals, open access journals, conference reports, trade papers, book series, academic databases, etc. Some of them are open access, and some are paid access. This study presents bibliographic analysis and a comparison of two sets of keywords. This study explores the researches in the selected area with its publication statistics such as year, author, country, affiliation, sources, and citations. Following is the flow chart of the methodology (figure 1) developed for carrying out this bibliographic survey.

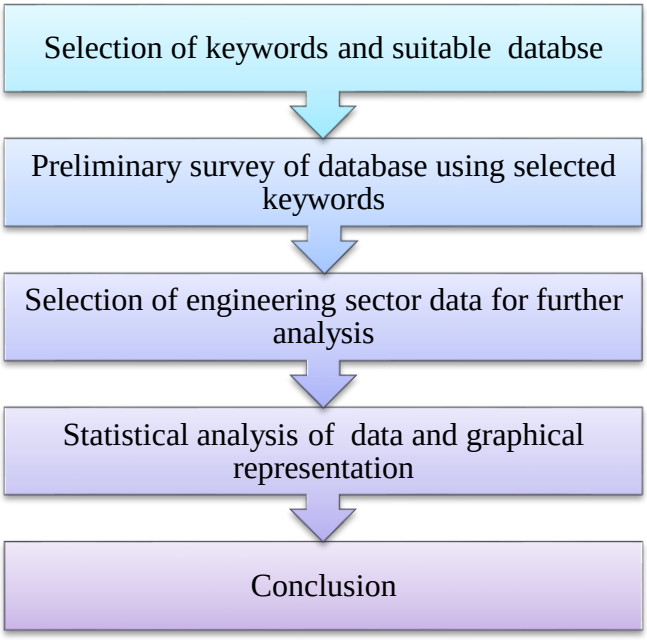

Figure 1: Flow chart of the bibliographic survey

The bibliographic survey is initiated with a selection of keywords and a suitable database. Keywords play a vital role in the analysis of the database. Two sets of keywords are selected for the survey. Both set I and set II of the keyword to provide different groups of documents by subject area. The information in the form of document groups is further analyzed separately for keywords set I and keywords set II for obtaining preliminary results. The next step is to select the subject area from the data obtained from the preliminary survey. To converge the information, engineering sector data is selected for further analysis. Followed by Statistical analysis of the data and its graphical representation. It includes all yearly published research data comprising of various journals, country of publication, publication author, citation records. Followed by an interpretation of results and conclusion. Sub-sections 2.1 to 2.3 describe the further steps of methodology in detail.

2.1 Selection of keywords

Data collection is one of the important steps in conducting research. This survey is carried out with specific keywords that best describe the proposed search area.

Keyword's selection plays a significant role in bibliometric studies as results vary with the use of a different set of keywords. The use of the conjunctions "AND" and "OR" also varies with the use of keywords. According to the scopus database, AND should be used when research is required to include all terms, and the terms may be far apart. "OR" conjunction should be used when the expected search results must include one or more terms (synonyms), and as a result, any document with the fed term would be found. For the present study, two sets of keywords are selected. Set I includes, labor productivity, construction, prediction, forecasting. Set II consists of labor productivity neural network, construction, prediction, and forecasting. Conjunctions used to input the keywords in the database for beginning the search are mentioned in table 2

below. The purpose of selecting the two sets is to examine a number of papers published in the area of LP as well as in the area of NN application in LP. It would help in revealing the need for conducting research in the area of NN for LP.

Table 2: Keywords for bibliographic survey

Keywords Set I	**Keywords Set II**	**Conjunction**
Labor productivity, construction, prediction	Labor productivity, neural network, construction, prediction	AND
prediction, forecasting	prediction, forecasting.	OR

In the search tab of scopus GUI, keywords set I is added in the format as 'labor productivity and construction and prediction or forecasting.' Keywords set II is added as 'labor productivity and neural network and construction and prediction or forecasting.'

2.2 Preliminary survey of a database using selected sets of keywords

Keywords set I search has revealed the result of having a total of 919 documents. These results are refined for identifying the most relevant documents in this area. The refined search identifies 523 most relevant documents out of 919 documents originally obtained. For set II, the refined result gives a total of of26 most relevant documents out of 29 documents. These identified documents are categorized by subject areas. Figure 2 exhibits a bar chart representing a number of documents according to their subject area for a set I and set II. The top six subject areas are shown in the bar chart.

2.2.1. Documents by subject area

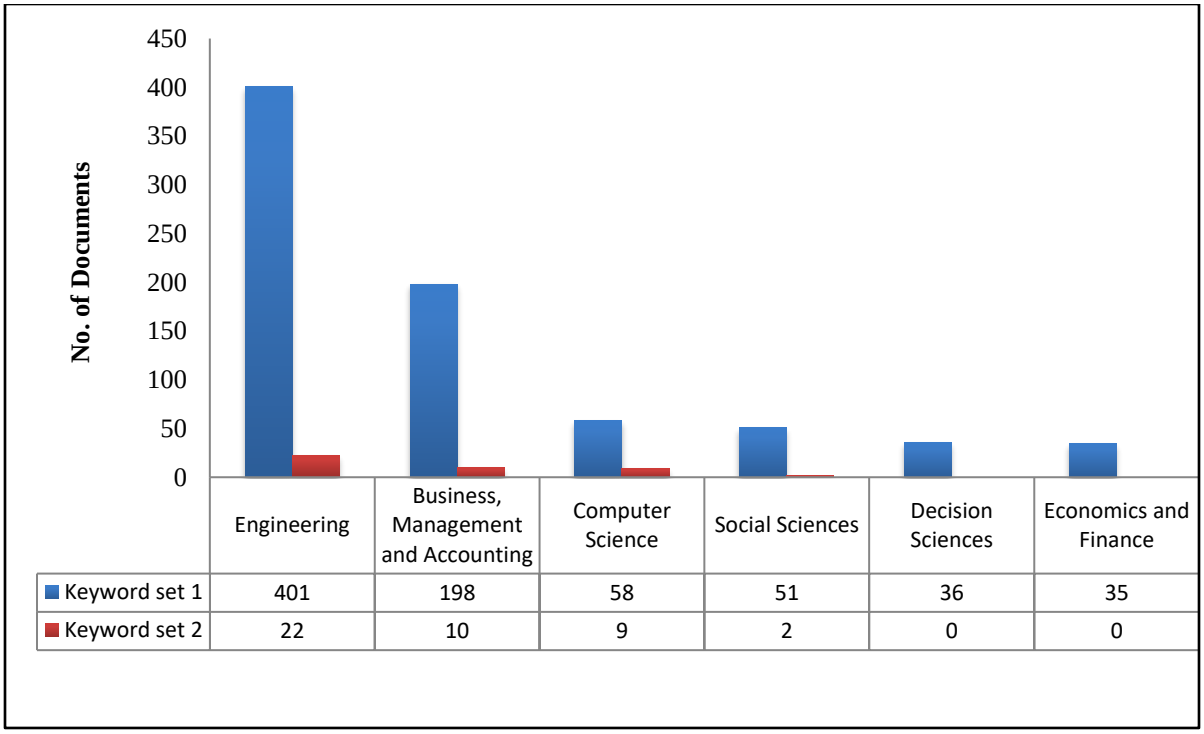

Figure 2: Bar chart showing documents by subject area (Information Source - www.scopus.com)

Figure 2 exhibits a bar chart of two keyword sets. Information of documents in a set I is represented by blue coloured bars and set II with red coloured bars. The total count of documents for a set I is 523 and for set II is 26. However, in the bar chart, it appears to be more because some documents are overlapping in two or more subject areas. It is observed that the highest number of documents are from the engineering sector for both the sets with 76.67 % of documents from the set I and 84 % of documents from set II. Next to engineering is 'business management and accounting' stream with 37.85 % and 34.61 % of the total documents from the set I and II, respectively. Further study is confined to documents from the engineering sector alone.

2.3 Analyzing engineering Sector data

As observed from the bar graph, the engineering sector has the highest number of documents accounting to 401 documents in a set I and 22 in set II. For further bibliographic analysis, the engineering sector's data is represented in table 3 below, that shows the statistics of documents in varied sources of publication.

Table 3: Documents by sources for the engineering sector (Source-http://www.scopus.com)

Source	Keywords set I	Keywords set II
Articles	237	16
Conference paper	145	4
Review	10	1
Book Chapter	6	1
Note	2	-
Short survey	1	-
Total	401	22

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It is observed from table 3 that maximum documents are published in the form of articles for both the sets followed by conference papers. These documents are further categorized as per their year of publication, publication country, author of the publication, type of publication, and citations. Statistical analysis is conducted and represented in graphical format in the next section.

3. STATISTICAL ANALYSIS AND GRAPHICAL REPRESENTATION

The systematic bibliographic study is conducted to know the various types of sources, recent advances in research in the selected domain, and influential authors in labor productivity prediction. It includes the geographical focus of the sample, documents published per year, author contributions, journals, citations analysis, and collaborative studies. Following section explains about the year wise publications observed for a set I and set II.

3.1 Year-wise publication details

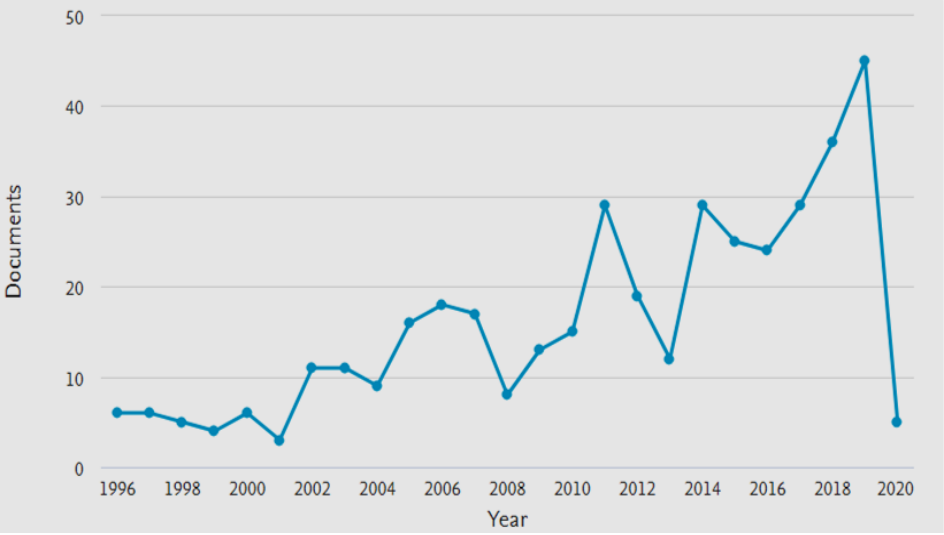

Figure 3:Year-wise number of publications for Set I (Source-http://www.scopus.com)

The line graph in figure 3 and figure 4 show the year wise publications for both the sets of keywords. The survey is carried out for a span of 14 years, starting from 1996 till date. For the set I, the domain has witnessed a rise in a number of publications from 6 in the year 1996 to 45 in the

year 2019.

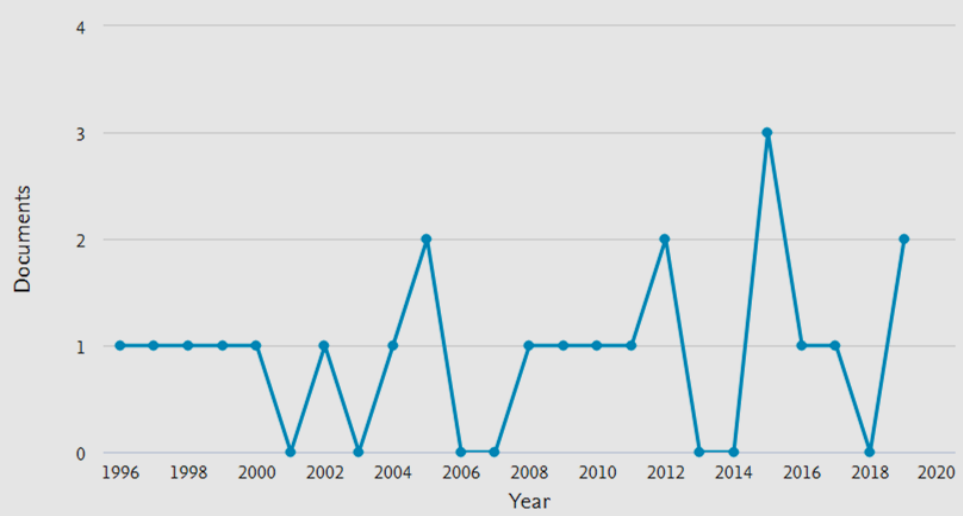

Figure 4: Year-wise number of publications for Set II(Source-http://www.scopus.com)

For set II (Figure. 4), for a span of 8 years between 1996 and 2004, only one document is published per year except in 2001 and 2003, when no publications are witnessed. Two documents are published in the year 2005, 2012 and 2019. In the year 2016,3 documents are observed to be published, marking the highest publications in any particular year.

It is observed from both the figures that general publications of labor productivity prediction are greater than prediction using neural networks. The least number of papers are published in the area of labor productivity and NN. It states that there is a need for more research in this area.

3.2 Country wise publication details

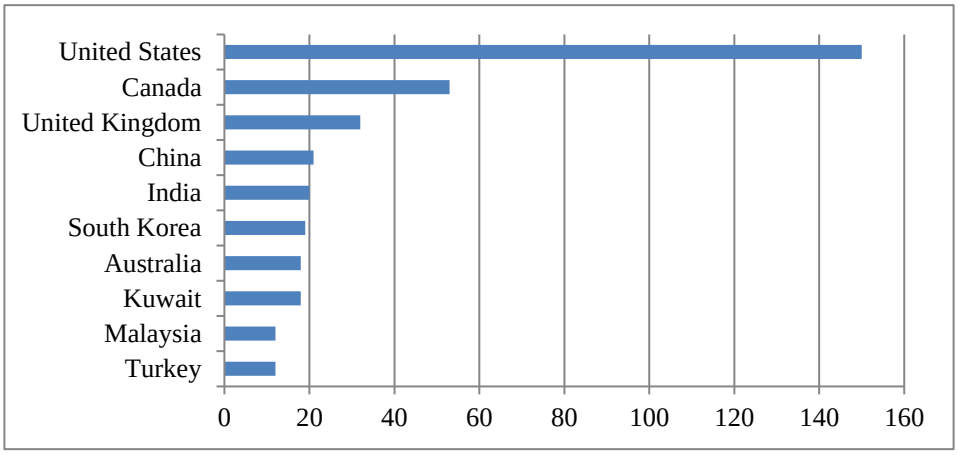

Figure 5: Country-wise number of documents for set I (Source-http://www.scopus.com)

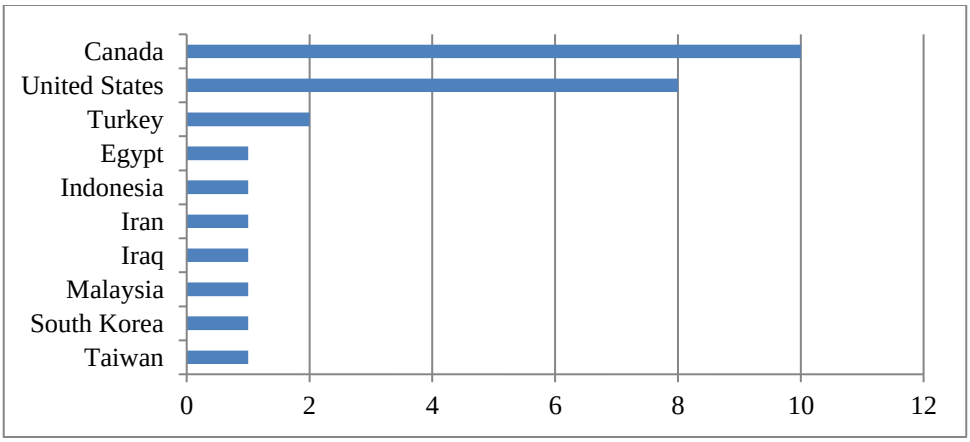

Figure 6: Country-wise number of documents for set II (Source-http://www.scopus.com)

Figures 5 and 6 show country-wise publications for a set I and 2. It is observed that in both cases, The United States and Canada are at the topmost position with maximum publications. In the set I, US has 165 whereas Canada has 59 documents. For set II, Canada has 12, and US has 8 documents. The geographic regional analysis of the documents identified for the study are analyzed using 'iMapBuilder' online software for a better understanding of the spread of the research work on the world map. Maps in Fig. 7 and Fig. 8 show the geographical attentiveness of publications in various countries for a set I and set II, respectively.

Figure 7: Geographic regional analysis (I) Figure 8: Geographic regional analysis (II)

3.3 Document analysis based on author details

Study of the top 10 productive authors, their country of publications, and h -index is elaborated in Table 5 and Table 6. Goodrum P.M. has 26 publications accounting to a maximum number of publications as compared with other authors active in the said domain of research (Table 5). For set II, Moselhi O. has four publications accounting for maximum number of publications against other researchers.

Table 5: Top 10 productive authors for set I (Information source-http://www.scopus.com)

Publications	No of publication	Country	h - index
Goodrum, P.M.	26	US	20
Hanna, A.S.	21	US	25
Jarkas, A.M.	17	Kuwait	10
Fayek, A.R.	16	Canada	20
Haas, C.T.	13	Canada	37
Thomas, H.R.	12	Sweden	57
Caldas, C.H.	11	US	27
Liu, M.	10	China	78
Sullivan, K.T.	8	US	11
Chang, C.K.	7	South Korea	40

Table 6: Top 10 productive authors for set II (Information source- http://www.scopus.com)

Author Name	No of publication	Country	h- index
Moselhi, O.	4	Canada	29
Abourizk, S.M.	2	Canada	36
Fayek, A.R.	2	Canada	20
Hanna, A.S.	2	US	25
Khan, Z.	2	Canada	4
Lee, M.J.	2	South Korea	5
Lu, M.	2	Canada	21
Rowings, J.E.	2	US	8
Sonmez, R.	2	Turkey	11
Abdel-Khalek, H.A.	1	Egypt	2

3.4 Journal statistics

Journals are the most important sources for researchers to collect and read the various papers as well as it is a platform for a researcher to publish their work worldwide. Articles published in peer-reviewed journals are likely to remain a very important means of distributing research findings for the foreseeable future. Following are the top five productive journals for set I and set II, respectively (Table 7).

Table 7: Productive journals for set I and set II (Source-http://www.scopus.com)

Keywords Set	Journal Name	No. of documents	Country	h-index	Quartile
SET I	Journal of Construction Engineering and Management	71	USA	95	Q 1
	Construction Management and Economics	16	UK	81	Q 2
	Canadian Journal of Civil Engineering	14	Canada	53	Q 3
	Journal of Management in Engineering	13	USA	55	Q 1
	Automation in construction	11	Netherlands	95	Q 1
SET II	Journal of Construction Engineering and Management	6	USA	95	Q 1
	Construction Innovation	3	UK	32	Q 2
	Journal of Computing in Civil Engineering	3	USA	64	Q 1
	Journal of Civil Engineering and Management	2	USA	95	Q 1
	AACE International Transactions of the Annual Meeting	1	USA	10	-

For both the sets, Journal of Construction Engineering and Management (JCEM)is observed to have the highest number of publications with a total of 71 papers for set I and 6 papers for the set II. JCEM is followed by Construction Management and Economics with 16 publications in set I. Next is Canadian Journal of Civil Engineering with 14 publications. For set II, on the second position are two publishers, namely, Construction Innovation and Journal of Computing in Civil Engineering, with three publications each.

4. CITATION ANALYSIS USING CLUSTERING

A citation is a reference to the source of information used in the research. Citations to sources help readers expand their knowledge on a topic. For the bibliographic survey, citation analysis is carried out in two parts, with Part A for keyword set I and Part B for the keyword set II, using VOSviewer tool version1.6.13. VOSviewer is a software tool for constructing and visualizing

bibliometric networks. Networks may consist of several thousands of nodes. A cluster is a set of closely related nodes. Each node in a network is assigned to exactly one cluster. It uses colors to indicate the cluster to which a node has been assigned. It has terms like link strength and total link strength. Link strength indicates the number of items cited to the selected node, whereas total link strength represents a number of times a document is cited by links strengths. Following is the citation analysis for part A showing citations of set I.

4.1 Part A- Citation Analysis of keyword set I data

This section includes a detailed analysis of citations using cluster diagrams for citation statistics as per sources of publications, authors of publications, and countries applicable for keywords set I.

4.1.1 Citations by sources

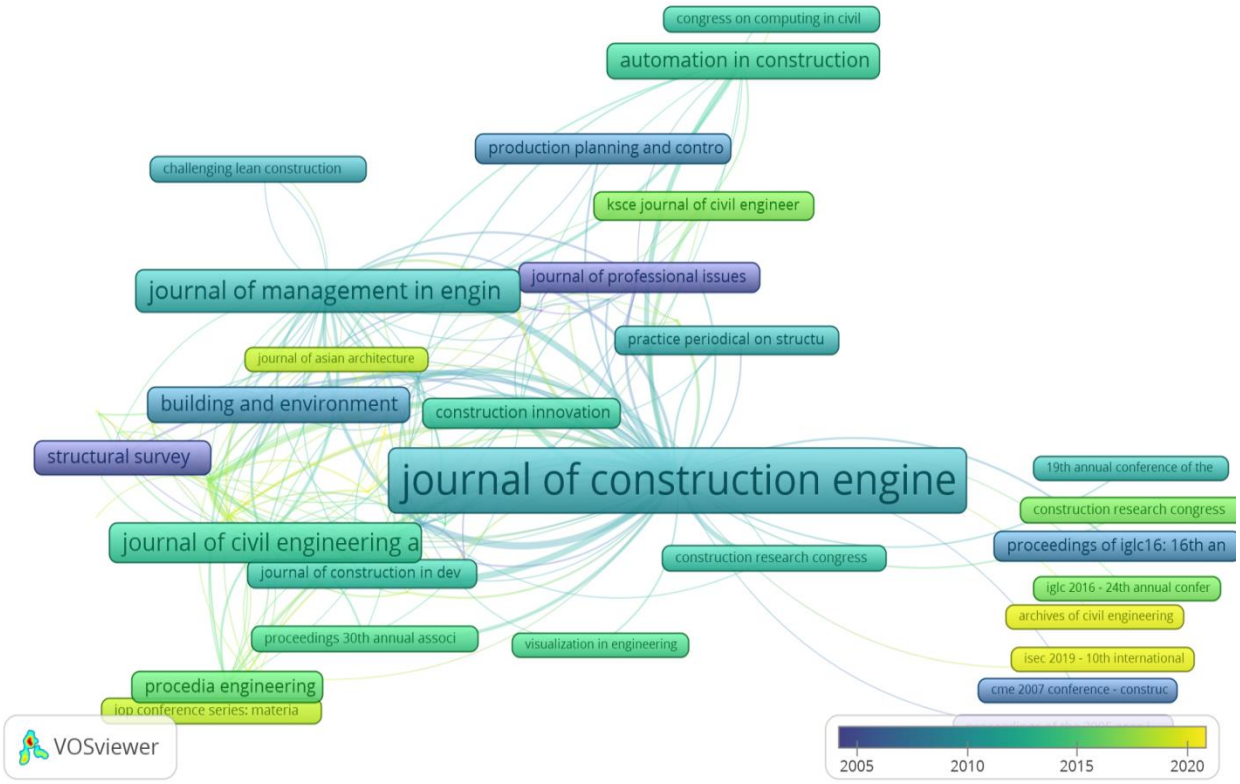

Figure 9: Network of the relationship between source and their citation

Figure 9 indicates a network of citations by sources concerning average publication year for set I in the form of overlay visualization. It shows the network between sources of publication, such as journals and conference proceedings. The size of the node represents the relative number of citations with the largest node having the highest number of citations. Colours of the nodes are based on their year of citation. Blue colour represents the journals cited in 2005, and the yellow

colour represents the most recently cited journal. JCEM has the maximum number of citations of around 2335. It has a total of 55 links, i.e., 55 different journals have cited JCEM. The total link strength for this journal is 344, which indicates the total number of citations by 55 journals.

4.1.2 Citations by Authors

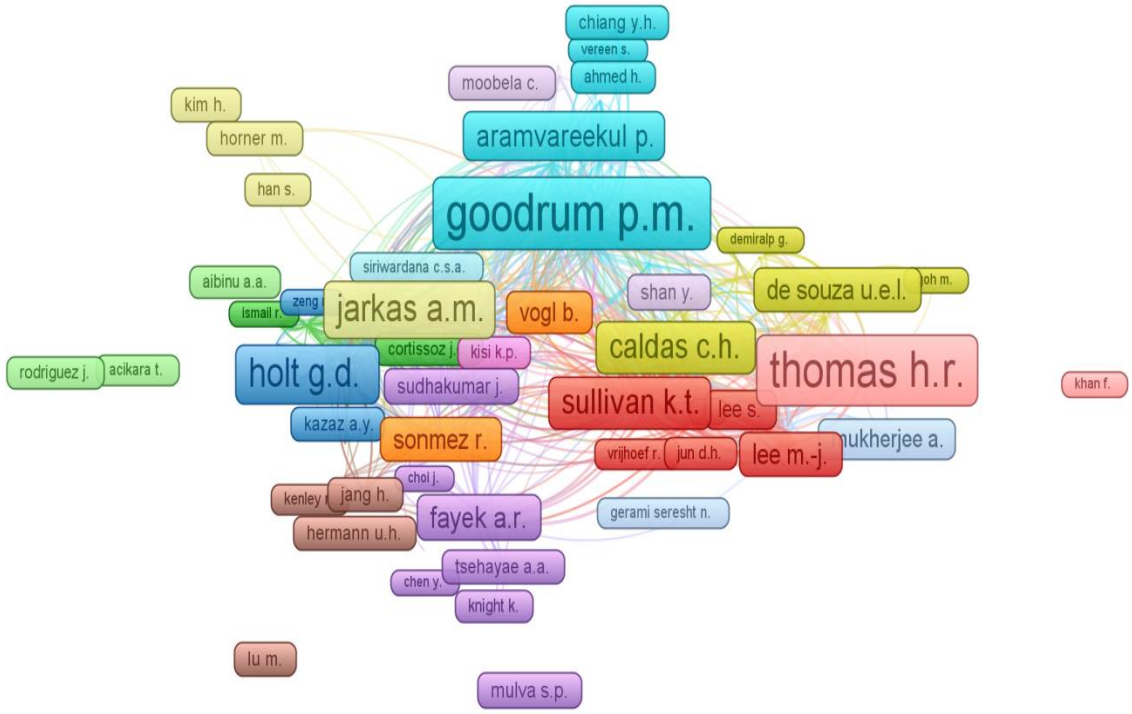

Figure 10: Network of the relationship between countries Authors and their citation

Figure 10 indicates a network of citations by authors. It is carried out using another form of display called network visualization that does not have time mapping as in the previous clustering. It shows the network between authors and their citations. It is observed that Goodrum P. M. has the maximum number of citations with 158 links, i.e., 158 different authors have cited the publications by Goodrum. Total link strength for the author is 397, indicating the total number of times the publications of Goodrum are cited by 158 authors.

4.1.3 Citations by country

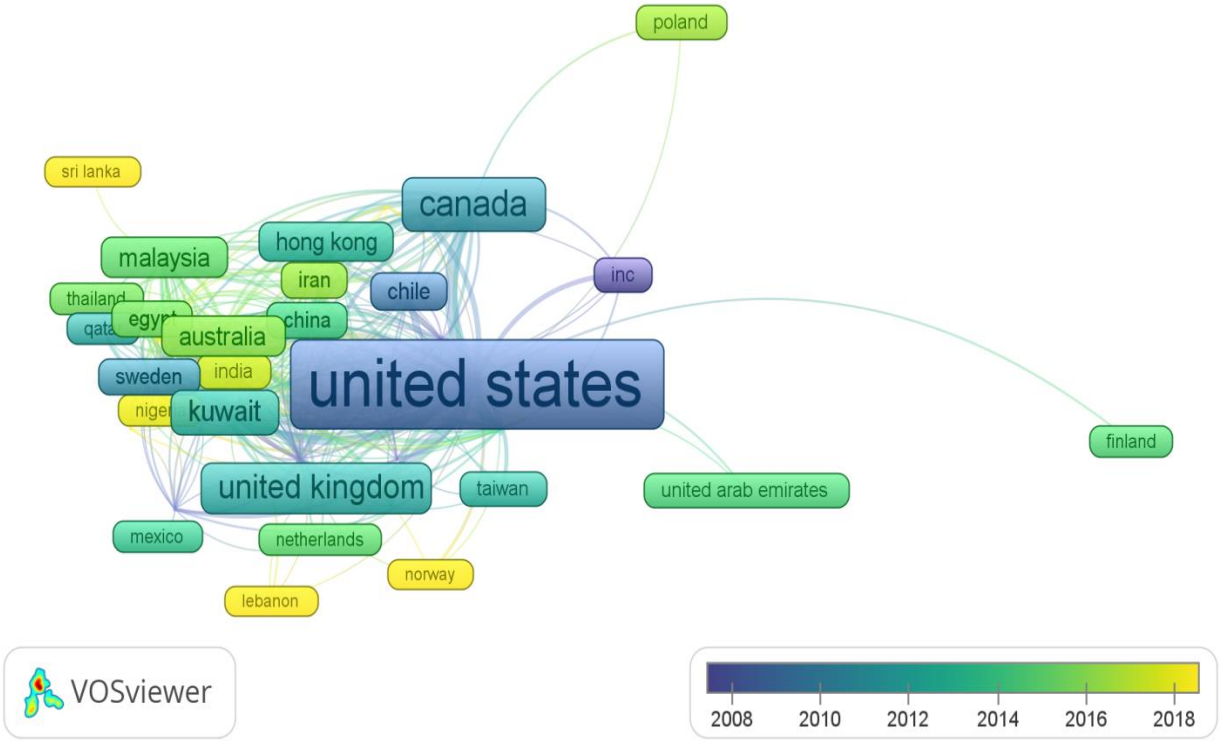

Figure 11: Network of the relationship between countries and their citation

Figure 11 shows an overlay visualization of citation received by various countries with a time scale of average publication year. The United States has a maximum number of citations of 3045. It has 45 links representing that 45 countries have cited publication of the US. The total link strength is 532. Next to the US, Canada has 716 citations with 25 links and total link strength of186. Recently, in the year 2020, Norway has published 1 document with one citation record.

4.2 Part B-Citation analysis of keyword set II data

This section includes a detailed analysis of citations using cluster diagrams for citation statistics as per sources of publications, authors of publications, and countries applicable for keywords set II.

4.2.1 Citations by sources

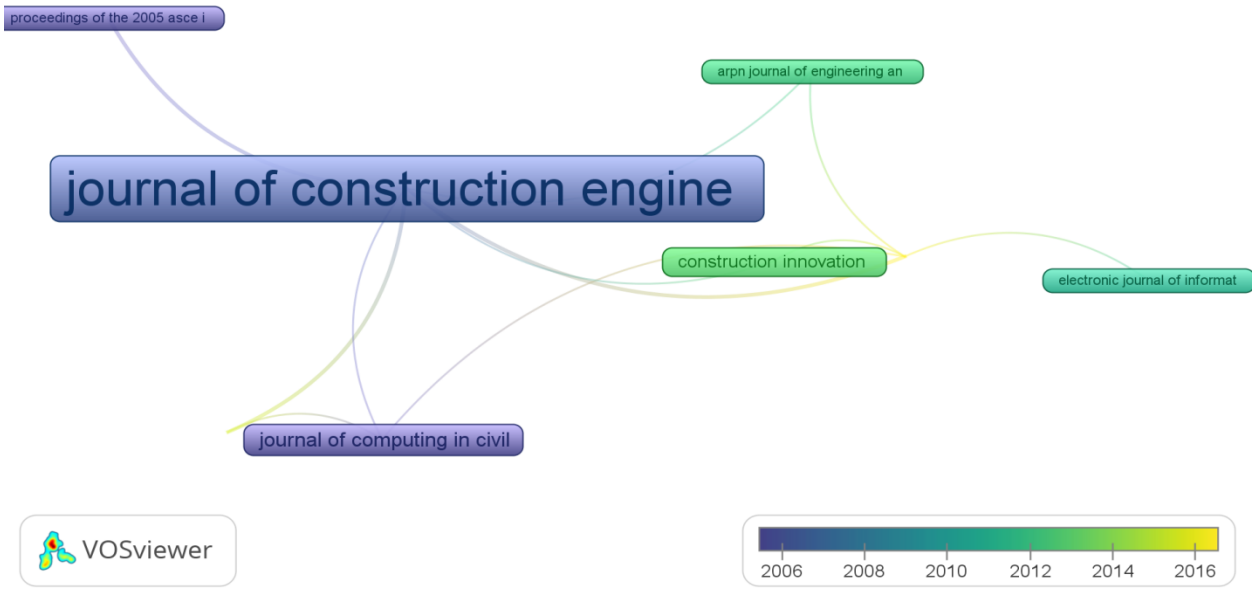

Figure 12: Network of the relationship between the source of publication and their citation

Figure 12 indicates a network of citations by sources with average publication year for set II, in the form of overlay visualization. It shows the network between various sources of publication, such as journals and conference proceedings. JCEM has obtained372 citations marking the highest citations for set II entries. It has 7 links with seven journals citing JCEM. The total link strength for this journal is 9, indicating a total of nine publications cited by seven linked journals.

4.2.2 Citations by authors

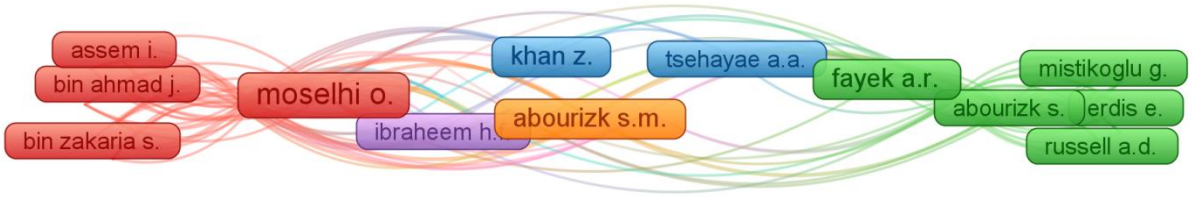

Figure 13: Network of the relationship between authors based on their citation using VOSviewer

Figure 13 indicates a network of citations by authors for set II using network visualization. It shows the network between authors based on citations. It states that Moselhi O. has a maximum number of citations. It has 21 links with 21 different authors citing the publication by Moselhi O. Publications by Mosehi O. are cited 28 times by 21 authors making the total link strength as28.

4.2.3 Citations by country

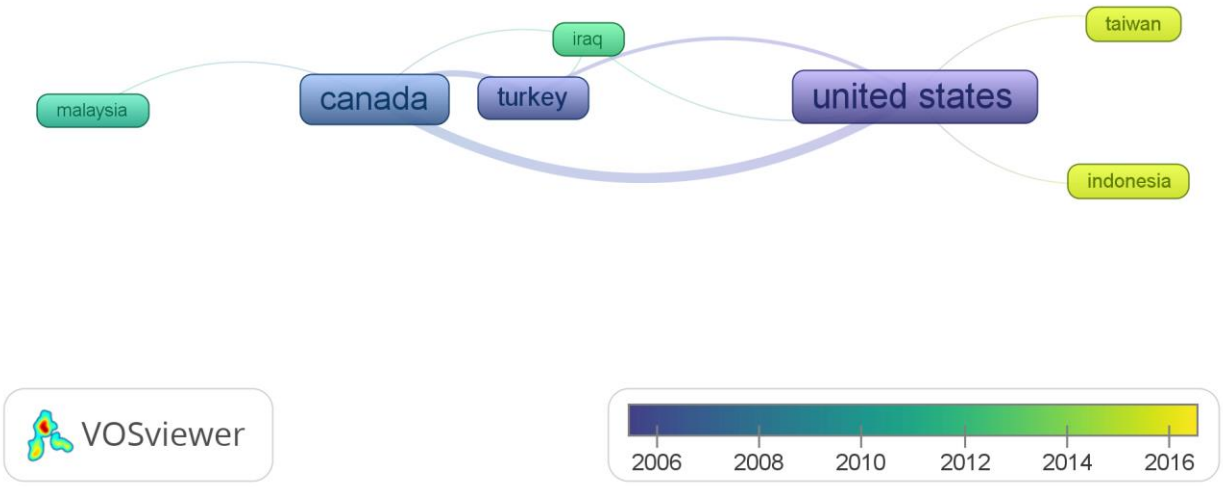

Figure 14: Network of the relationship between countries and their citation

Figure 14 shows a network of countries by citations for set II using overlay visualization. The United States has a maximum number of citations of 363. It has 5 links representing Canada, Turkey, Iraq, Taiwan, Indonesia citing publications of US. Total link strength is 14 out of which maximum connection strength is between the US and Canada with 8 documents cited by Canada, 3 by Turkey, one each by Taiwan, Indonesia, and Turkey. Next to the US, Canada stands second in terms of a number of citations with a total of 301 citations. The number of links are 4 with total link strength as 15.

4.3 Summary of citation analysis for a set I and set II

The analysis conducted for observations from keywords set I and set II, has aided in preparing a summary table to highlight top citation indices as per sources, authors as well as the country of publication in Table 8 below.

Table 8: Summary of citation analysis for Set I and set II

Keywords Set	**Top Citations**			
	Rank	**Source**	**Author**	**Country**
Keyword set I	1	Journal of construction engineering and management	Goodrum P.M.	U.S.
	2	Construction Management and Economics	Thomas H.R.	Canada
	3	Journal of Management in Engineering	Hanna A.S.	United Kingdom

Keyword set II	1	Journal of construction engineering and management	Moselhi O.	Canada
	2	Journal of Computing in Civil Engineering	Abourizk, S.M.	The U.S.
	3	Construction Innovation	Fayek, A.R.	Turkey

It emphasizes on the ranking of the parameters under study. For both the sets under consideration, the U.S. and Canada are leading in terms of research quantum in the selected domain. For the set I, United Kingdom ranks 3rd in the overall country-wise ranking but doesn't get any position in the top ten rankings for set II. For the set I, India ranks fifth for the number of publications in the area of labor productivity. However, when the search is narrowed down with a selection of neural networks as one of the keywords in the modified search in terms of set II, India does not appear to have any publications so far. Similarly, in the case of a set I, Austria and Kuwait find a place in the top ten and do not show any publications in the domain of labor productivity with neural networks. The study throws light on the disparity of research quantum for the two keywords' sets and the need to address this inconsistency through systematic research. India attracts special attention as it is a labor intensive construction industry that ranks as the third-largest industry in the country. Around 30% to 50% of the cost of construction projects is allocated for labor charges, thus needing special attention to optimize productivity to optimize time and cost overruns. The following section reflects upon the observations from the bibliometric study, especially for the Indian construction industry and the selected research domain.

5. INDIAN SCENARIO

Bibliographic survey reveals that for India, the engineering sector represents 4.98 % of the total research is published in the area of general labor productivity prediction and nil in the field of labor productivity prediction using neural network.

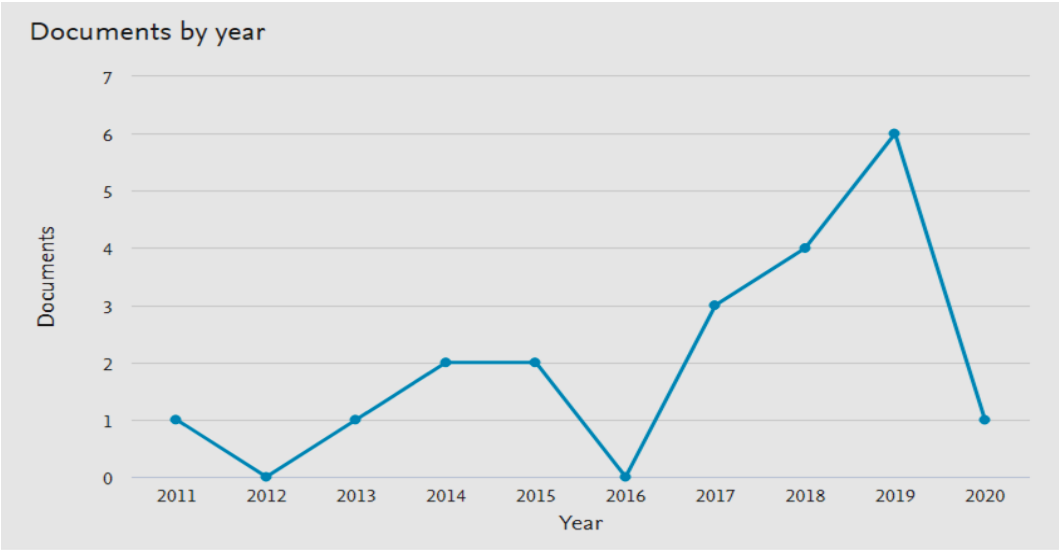

Figure 15: Publications by year in India for set I

Figure 15 exhibits year-wise publications in India for set I. It is observed that from the year 2011 to the year 2020, a total of 20 documents are published in the field of labor productivity prediction in general. Highest publications are witnessed in 2019, all falling in the category of journal publications.

Out of the total fifteen authors working in the area of labor productivity, the top six authors are observed to have published three documents each. Some of these documents, as mentioned in table 9, are published with co-authorship.

Table 9: Top 15 authors in India working in the area of labor productivity

Author Name	**No. of Publications**		
	3	**2**	**1**
Gupta, M.	√		
Hasan, A.	√		
Jain, A.K.	√		
Jha, K.N.	√		
Sudhakumar, J.	√		
Thomas, A.V.	√		
Arora, A.		√	
Choudhary, S.		√	
Karthik, D.		√	
Katoch, P.		√	
Sandbhor, S.		√	
Achuth Kumar, N.V.			√
Agarwal, K.S.			√
Karanjawala, K.			√
Kshirsagar, M.			√

6. CONCLUSION

The construction industry majorly contributes to the overall development of the nation. In spite of the massive labor force requirement, the survey concludes that many countries are progressing slowly in terms of studies that can increase the productivity of labors. Construction mainly involves labor-related activities such as masonry work, formwork, pipe installation, flooring, plastering, and many more where machines cannot replace men. Hence, human resources must be managed efficiently. A small increase in productivity of labors would directly affect the overall productivity of the construction projects. With the application of a neural network for predicting labor performance and optimizing the same, it can overcome the major threats of time and cost overruns in construction projects.

The goal of the present paper is to explore researches carried out in the area of general labor productivity prediction with various techniques as well as labor productivity using neural networks

under the engineering sector as a first step towards systematic study. It is a first of its kind survey in the field of labor productivity analysis. Time span considered for the study is from 1996 to 2020. Although there are many databases for accessing publications, the present study relies only on the information obtained from the scopus database. At the initial stage, results for the selected keywords appear for multiple sectors, including engineering, business management, and accounting, computer science, social science, environmental science. It is also observed to be segregated under undefined sources and undefined countries. In order to reduce the impact of such observations, the search is narrowed down by selecting only relevant information that directly relates to the construction sector. The search includes documents represented under the engineering category, and documents falling within undefined sources and authors are removed. As the bibliometric data available on the web is dynamic in nature, the search limits its data collection only up to 4th February 2020.

Two sets of keywords are selected and compared for the most active authors, topmost journals, countries leading in the proposed area. Citation analysis is also presented with the clustering of data. Study reveals that the US and Canada are dominating countries in this field. 'Journal of Construction Engineering and Management' is the topmost journal with the highest citations for both the keyword sets. Goodrum P.M. and Moselhi O. are the leading researchers in the selected fields of a set I and set II, respectively. For the set, I, i.e., research domain with labor productivity, considerable publications are observed. However, for set II, only 5.48% of the total documents published for a set I are published. The level of performance observed for set II, i.e., for the domain of labor productivity prediction using neural networks, is not up to the mark and has not reached the level of significant citation shares. This emphasizes the need for conducting systematic research in the selected domain that asks attention. It is required to publish documents in quality journals that fetch high citations and reach a maximum audience with better reachability. A comparison of two sets from country statistics reveals that few studies are carried out in India for a set I and none for set II, pointing to a clear research gap in the domain of neural network induced labor productivity assessment. Indian researchers have a huge scope for studying the research domain under consideration.

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