State of Art in Value Engineering: A bibliometric based review for future research

Vasava Erick Francis[1], Alok Yadav[1], Anbesh Jamwal[1], Rajeev Agrawal[1], Jinesh Kumar Jain[1], Sundeep Kumar[2]

[1]Department of Mechanical Engineering, Malaviya National Institute of Technology, J.L.N. Marg, Jaipur, Rajasthan-302017 (India)

[2]Center for Electronic Governance, Department of Technical Education, Govt. of Rajasthan, Jaipur-302004 (India)

Corresponding author: ragrawal.mech@mnit.ac.in

Abstract

In today's world the market is very competitive and complex to survive innovative identity and values propositions of the company. In several past decades the evolution of value engineering as a successful and important tool to company is remarkable and still there is an opportunity which is needed to be addressed. This review intends to identify how value engineering helps in improvement of design and cost of developed products. In this review numbers of value engineering published articles are extracted and investigated from top journals, productive articles and citied conferences papers. The considered papers to summarize the research growth in value engineering have been published from year 2001 to 2020. Our analysis of this papers provides informational insight on value engineering and might be resourceful for those who are research oriented towards value engineering.

Keywords: Value engineering; Cost reduction; Value Management; Value Methodology; Value Analysis; bibliometric analysis.

1. Introduction

Globally companies give careful consideration to clients or customers' needs and quality item because competition in the modern economy is towards gaining superior capabilities to create high value-added products and services rather than just focusing on output [1-2]. This leads global market towards new area of increasing importance-high value engineering, which is focused on how to effectively create value through engineering excellence in the current business environments and for the future [3-4]. So new strategy has found that called value engineering [5]. During the Second World War when there was a shortage of raw materials, component parts, and skilled labor. Lawrence Miles, Harry Erlicher, Jerry Leftow, and other engineers at General Electric Co. in 1947 who was charged with maintaining production at a time of limited availability of materials [6-9]. They sourced for acceptable substitutes that would reduce the production costs without compromising the functionality and quality of the products. What started as an accident turned into a systematic process that not only reduced the cost of production but also provided better products or better performance [10-11]. The engineers named this technique "value analysis." In 1954, this technique was adopted by the US Department of Defense and renamed as "value engineering". In 1959, the formation of the Society of American Value Engineers (SAVE) formalized the term 'value engineering', which the term is mostly used in USA [13-14].

The Society of American Value Engineers (SAVE) as a professional society dedicated to the advancement of Value Engineering through a better understanding of the principles, methods, and concepts involved. The Society of American Value Engineers defines Value Engineering as "the systematic application of recognized techniques that identifies the function of the product or service, establishes a monetary value for that function, and provides the necessary function reliably at the lowest possible cost" [15]. Value Engineering is also known as Value Management and Value Methodology [16].

Competition in market sectors have constrained numerous organizations' capacity to keep up their best levels of productivity through cost builds [17]. Keeping costs low with traditional methods has been a common practice to improve competitiveness [18]. Reducing money and at the same time, provided that better value is a concept that everyone emphasizes [19]. So, it is crucial for organizations to set up another technique to 'take the expense out of products or Services' [20]. Value Engineering has proved to be best tool as a result of its orderly approach,

concentrate on client or customers to provide what they need [21]. With growing demands for sustainable products, there are clear implications for developing high value engineering capabilities from the perspectives of industrial sustainability [23].
Presently, there are numerous challenges facing in developing countries. Most reported challenge is the failure to meet deadlines, and to deliver within budget and to the specified quality [24]. Consequently, Value Engineering can help to find ways to improve solutions to these challenges by providing a measured balance in cost, schedule, and scope via the generation of a large quantity of innovative alternatives [25]. Although some studies have focused on various implementation challenges, none examines the underlying factors of such challenges [26].
Value Engineering in the construction industry is mainly an organized effort to challenge the design and construction plans of projects to provide the required facility at the lowest overall cost consistent with requirements for performance, reliability, and maintainability [27-28].
VE has been progressed a lot because of studies have done; despite of these productive studies, there are still numerous opportunities for further studies and scientific investigations [29-30].

In the present study following research questions are raised which are:
RQ1: Which authors, countries and Institutes are working in the area of Value Engineering?
RQ2: What is a current research status and future opportunity of work?
Research Methodology:
The purpose of this study is to understand the state of 'value engineering' research by examining published literature to provide intuition for 'value engineering' practitioners and researchers. Since, the research in this area is relatively massive; the scope of this study mapping is limited to a period of 2001–2020. All reports in this study mapping were used from the database of the Google Scholar, Web of Science and Scopus for bibliometric analysis. Bibliometric analysis helps to evaluate the published books, articles, conference papers or chapters statistically. It is an effective way to measure the influence of a scientific document in the scientific community. Giving this Value Engineering literatures, it is vital for us to examine, evaluate and coordinate former studies related to the topic of Value Engineering, so the aim of this study is to talk about the condition of Value Engineering research by examining the published literature to prepare Value Engineering practitioners and researchers to comprehend the Value Engineering implication better and realize the point of weakness and future direction. That is really important for us to examine to end up duplicating what has already been studied and find a new approach for researchers to proceed.

2. Methodology

The purpose of this study is to understand the state of 'value engineering' research by examining published literature to provide intuition for 'value engineering' practitioners and researchers. Since, the research in this area is relatively massive; the scope of this study mapping is limited to a period of 2001–2020. All reports in this study mapping were used from the database of Web of science for bibliometric analysis [31-35]. Bibliometric analysis helps to evaluate the published books, articles, conference papers or chapters statistically [36-37]. It is an effective way to measure the influence of a scientific document in the scientific community.
By considering previously published studies on value engineering in different research areas it is evident that systematic literature review is an effective approach to identify the research progress direction and identify new research gaps in a particular research area. Generally, a systematic literature review is composed of three main stages that are 1st scope of the study is planned or defined as it is considered as a critical stage because range and subject area discrimination are defined in this stage only. This stage helps to identify what has been covered in research until now. 2nd we have used the relevant search strings to shortlist the range of articles. We only included those articles which meet the criteria. We considered only Journal and conference papers. Some of the articles from the peer-reviewed conference were found as the most cited articles on the Web of science database. We considered conference articles from reputed publishers to provide a more holistic view. The final segregation of articles is done by reviewing the abstracts and keywords of each article. 3rd Reporting and Dissemination. We have discussed the different criteria and factors, of value engineering related studies and will help the researchers to get a vision about the different factors considered in past studies.

To maintain the quality of work letters, review paper and undefined sources documents were excluded from the

study. Publication trend over the 20 years, top authors working, top countries, top institutes and top subject areas were identified. Further, top keywords were found out and keywords co-occurrence is analyzed with the help of network analysis of keywords done with R Studio.
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Table 1. Criteria considered for study

The present study uses the systematic literature review which generally is the type literature review with systematic method to collect the data (secondary data), synthesize findings (quantitative or qualitative) and critically appraise research studies.	
Criteria	Value
Keywords	Improve developed product; Cost reduction; Improve cost of developed product; Improve design of developed product; Design improvement; Value Management; Value Methodology; Value Analysis; Unnecessary costs
Main keywords	Value engineering
Databases Selected	Web of science
Bibliographical criteria	Jan 2001 to Oct 2020

3. Results and Analysis:

3.1. Descriptive analysis

In the present study Web of science database is used for bibliometric analysis. In the keywords search (TITLE-ABS-KEY (" Value Engineering" OR "value management" OR "value Analysis"). There are total of 163 documents were found from 2001 to 2020 after the analysis. In this study total of 163 documents were finalized and investigated. Web of science database is used to maintain the quality work and undefined articles or conference reviews were excluded from the study. The conference papers are more in the web of science database with 163 publications.

3.2. Publication trend

Figure 1 shows the publication trend of Value Engineering especially in the field of industrial area. The number of articles published in this area during the period of 2001-2020 is shown below. The publication trends was mostly lean towards construction, six sigma, the public projects, recently trend was focused on the engineering field like industrial facility and in 2020 trend was focused on the sustainability of the value engineering. The publication of conference paper and review paper is seen less in 2020 but it is expected to increase till the end of the year 2021.

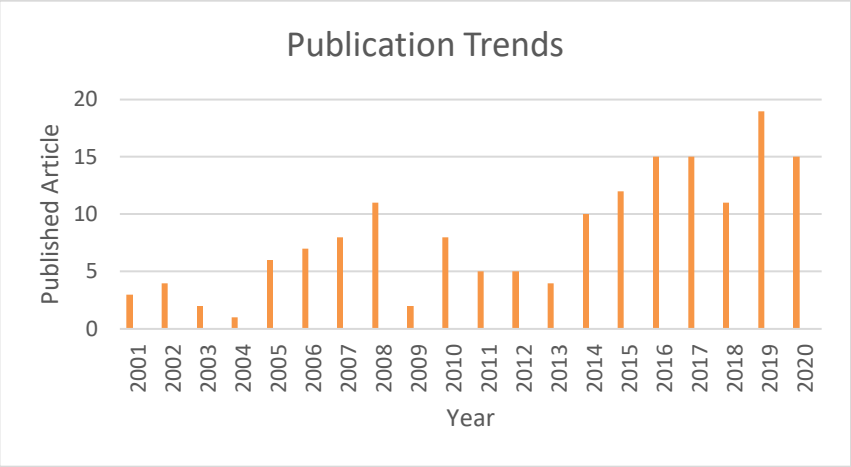

Fig. 1. The publication trend of Value Engineering

3.3. Subject Area

The application of Value Engineering is in almost every field is shown in figure-2. As shown in figure-2 use of Value Engineering in the Engineering and Computer Science is more. In Engineering field Value Engineering is most commonly used in the construction field which is expected to increase in the field of industrial area. In business and economics field the value engineering is mainly applied in area like six sigma and cost reduction or economic development. Whereas in environmental science field it's mainly applied on the greenhouse gases and water supply project.

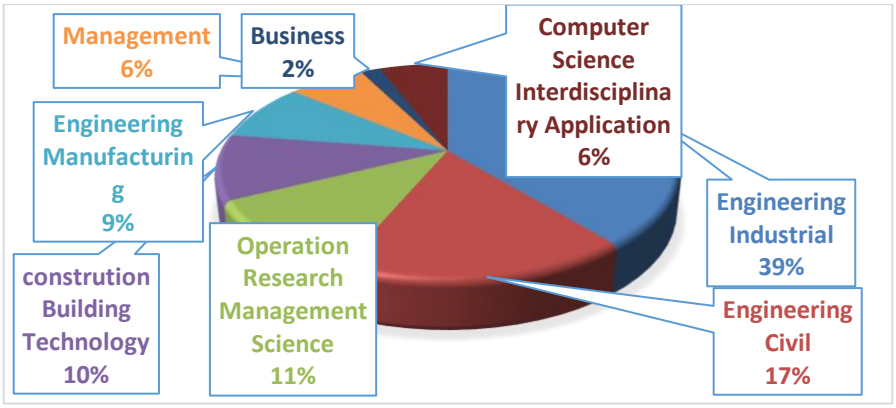

Fig. 2. Subject area of Value Engineering

3.4. Top Journal and Top Authors working on Value Engineering

Top authors and Journal working on the value engineering is shown in Table-2 below. It is found that in top author KIM BC has the highest productivity work of publishing 8 articles on this field, followed by VANHOUCKE M with the productive work of publishing 5 articles and so on. Whereas the sources JOURNAL OF CONSTRUCTION ENGINEERING AND MANAGEMENT has the highest productive work by publishing 33 articles, followed by JOURNAL OF MANAGEMENT IN ENGINEERING with productive work of publishing 20 articles and so on.

Table 2. Top authors and Journal working on the Value Engineering

Author	TP	Sources	TP
KIM BC	8	JOURNAL OF	33

		CONSTRUCTION ENGINEERING AND MANAGEMENT	
VANHOUCKE M	5	JOURNAL OF MANAGEMENT IN ENGINEERING	20
SHEN GQ	4	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH	15
BAGHERPOUR M	3	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS	13
JUN CH	3	ENGINEERING CONSTRUCTION AND ARCHITECTURAL MANAGEMENT	11
KIM S	3	COMPUTERS \& INDUSTRIAL ENGINEERING	10
LIN G	3	INDUSTRIAL MANAGEMENT \& DATA SYSTEMS	8
PARK Y	3	JOURNAL OF CONSTRUCTION ENGINEERING AND MANAGEMENT-ASCE	8
SHEN Q	3	ENGINEERING MANAGEMENT JOURNAL	7
SMITH JMG	3	COMPUTERS \& OPERATIONS RESEARCH	6

3.5. Top countries working on the value engineering in the industrial field

Table-3 shows top countries working on the Value Engineering. It is found that USA has the highest productive work by publishing 49 articles and china stand second in productive work by publishing 27 articles following South Korea with 14 articles, England with 13 and Iran with 10 at fifth place and so on. Whereas in this field India has to progress a lot because it is not in even top 20 list.

Table 3. Top countries working on the Value Engineering

Country	**TP**	**Country**	**TP**
USA	49	Italy	5
China	27	Malaysia	5
South Korea	14	South Africa	4
England	13	Finland	3
Iran	10	Netherlands	3
Taiwan	9	Singapore	5
Belgium	7	Spain	5
Canada	7	Scotland	3
Australia	6	Turkey	3

Brazil	5	Chile	2

3.6. Keyword occurrence in value engineering

Table-4 shows keyword occurrence in Value Engineering. Keyword's co-occurrence is analyzed with the help of network analysis done with R Studio. The minimum keyword occurrence is set for 10 occurrences. It is found that Management has maximum keyword occurrences of 39 which is followed by Project with 32, Analysis with 26, Performance with 25, construction with 23, earned with 21, control with 17, engineering with 16, study with least of 16 Occurrences. Figure-3 represents keywords word cloud on Value Engineering.

Table 4. Keyword's occurrence in Value Engineering

Keywords	Occurrences
management	39
project	32
analysis	26
performance	25
construction	23
earned	21
control	17
engineering	16
study	16

Fig. 3. Keywords word cloud on Value Engineering

As discussed above this study mapping will help the researchers to work in Value Engineering. Some opportunities, while avoiding the duplications of past research efforts are:
Increasing grouping system that is informed by existing value research.
Using the classification framework to show what is thought and known about value research.
Reviewing and analyzing the valuable literature with respect to development in a way that can be useful for all those interested in this field.

Based on the study mapping following research questions for future research directions have been proposed:

RQ1: What are the frameworks that will help to enable the Value Engineering in Developing countries?
RQ2: What are different barriers in the adoption of Value Engineering in Developing countries?
RQ3: How the Value Engineering will impact the global market of companies in developing countries?
These are some future research questions which need to address in the future studies. These questions will help the researchers to work in this area.

4. Conclusion

This study helps to contribute the various research scopes in Value Engineering. Value Engineering is an emerging research area for most of the authors. It is found that research articles in this area are increasing rapidly. Various research gaps in Value Engineering is expected to fill in upcoming years. It is suggested that in future studies conference papers shouldn't be excluded from the bibliometric analysis. Procedia Environmental Sciences and Procedia Engineering having most of publications in period of 2001-2020 while other reputed journals have fewer publications which is expected to increase in upcoming years. Most of research work is in the developed nations. India and China are the only developing nation in the top 10 countries working on the Value Engineering. Developing nations are working collaboratively with the developed nations to promote and explore the research of Value Engineering. A factor analysis, the challenges facing the implementation of Value Engineering in developing countries considered in the study are team obstructions; study obstructions; implementation difficulties; conceptual problems and developing economies. These identified challenges should be considered by the governments of various developing countries. The research questions raised in the present study will help the researchers to decide their future research directions. It is expected that these research gaps will be answered in next few years. The concept of value engineering indeed does have a good growth in the construction industry. However, for it to become a general practice, the fulfilment of certain conditions is regarded to be a prerequisite of the Value Engineering process. The quality and costs of public projects can benefit by the application of well-elaborated Value Engineering methodologies. Application of value engineering can achieve the following benefits: resolve technical problems of complex projects, gain additional technical expertise, give emphasis to efficient use of resources, improve project performance and achieve cost savings. The Value Engineering methodology provides for analyzing the project objectives and attributes, which, in turn, focuses the development of alternatives in the value study. Since value engineering affects all areas and fields, more endeavors ought to be taken to further studies and investigations in these fields.

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