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A Review Analysis of Cost of Quality, Cost of Poor Quality, and Hidden Quality Cost

APPLIED RESEARCH

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VIRGINIA TECH PUBLISHING

ABSTRACT

This paper aims to conduct a review analysis related to the terms cost of quality (COQ), cost of poor quality, and hidden quality cost. The analysis of publication data provides insights on understanding historical publication trends for the identification of research gaps related to hidden quality costs. The SCOPUS database was searched, which included journals only. This involved analysis via historical and current research, trending across different countries, academic journals, academic institutions, and prolific authors' analyses. This literature review revealed that research on COQ spans across various disciplines such as manufacturing, management, healthcare, and construction, with increased interest starting in the 1980s. This trend of increased research around COQ has continued to increase, with a cumulative trend of publications showing steady linear growth over time. This paper has categorized the research trend based on core journals, countries, authors, etc. Although there has been extensive research on COQ, there has been limited research specifically focusing on cost of poor quality and hidden quality cost. The findings from this review analysis reinforce the need for future-focused research on hidden quality cost, research to identify and calculate hidden quality cost, and research towards the development of a comprehensive COQ model encompassing hidden quality cost.

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INTRODUCTION

Cost of quality (COQ) includes costs related to ensuring good-quality products are made and poor-quality products are scrapped or fixed (Guinot et al. 2017). This can be in the range of 15–40% of total costs, impacting profitability (Brust & Gryna 2002; Guinot et al. 2017). Thus, COQ is a topic that relates to technology management through the applications of both quality systems and quality management. The goal of COQ is to both understand and help minimize costs associated with poor quality while enabling the maximization of value for customers. COQ models enable the identification and measurement of costs associated with quality assurance, which returns the capability to minimize these costs while maintaining quality levels appropriate to customer expectations.

Some of the earliest work related to quality and cost was from Dr. Armand V. Feigenbaum in his book (Feigenbaum 1945). Shortly after this publication, Dr. Joseph M. Juran published his Quality Control Handbook in collaboration with multiple authors, which, according to W. Grant Ireson, was presented as an easy-to-read introduction to all things related to quality control at the time (Ireson 1952). Juran's work on quality cost included accounting and introduced the concept of the "cost of poor quality," which suggests there are other types of quality costs beyond prevention, appraisal, and failure costs (Juran 1951). Dr. Feigenbaum was interested in the COQ under a holistic umbrella and published *Total Quality Control* in the Harvard Business Review (Feigenbaum 1956). Later, W. J. Masser published an article related to quality cost systems (Masser 1957), and Harold Freeman gave a conference proceeding on "how to put quality costs to use" (Freeman 1960). Many additional works and activities connecting quality and cost were published resulting from these early works. Quality engineers in industry try to design products to avoid poor quality. This role is considered as 'preventive', whereas the role of Six Sigma Black Belt holders is considered 'reactive.' Despite recognizing the concept of cost of poor quality, industry unfortunately undervalues the function of quality engineers in comparison to Six Sigma Black Belt holders (Short et al. 2020).

There is a subset of COQ called hidden cost of quality, which is referred to as hidden quality cost, which is discussed during this review. This area of research remains under-explored by comparison to COQ. Those who have spent time in industry or studied business may understand that hidden costs can significantly impact a company's overall performance because expenses that are not being measured and tracked are a risk. The authors believe that examining hidden cost is essential to gain a comprehensive understanding of quality cost management. Hidden quality cost could include examples such as lost sales, lost profits, and damage to the company's reputation leading to the loss of repeat business (Geyer, Sousa, & Silveira 2018). In the dissertation, Guinot (2015) stated in his defense the approach to using the 'Failure Mode and Effects Analysis as a mechanism for assessing the cost consequence of a failure'. Guinot et al. (2016) and Guinot et al. (2017) mentioned a missing link in the COQ models related to the production of invisible quality costs. Teplická & Hurná (2021) showed that in small and medium enterprises, methods to measure COQ, including prevention, appraisal, internal failure, and external failure cost analysis, led to financial savings. Despite this, there have been recent efforts to investigate the hidden costs of quality using Taguchi's quality loss function and other approaches (Jenoui & Abouabdellah 2018). In addition, several researchers have proposed integrating COQ into supply chain network design models to reduce overall costs and avoid expensive product recalls (Haq 2021).

There is a lot of research that covers the topic of COQ. In order to understand the scope of all the research that has been carried out, an extensive review analysis was conducted in this study. The aim of this review analysis was to enhance academic rigor by enabling a comprehensive examination of historical research trends and providing valuable insight into potential gaps in research related to hidden quality cost.

PROCEDURE

To understand all research conducted on the topics of COQ, cost of poor quality, and hidden quality cost, an extensive review analysis was conducted. This study aimed to enhance academic rigor by enabling a comprehensive examination of historical research trends and providing valuable insights into gaps in research related to the hidden quality cost. This approach helps by providing an overall perspective on the research topic, using the terms provided in the search, and exploring the landscape of all published work. The review analysis approach has gained significant attention among academic researchers across various disciplines, and the method has been extensively used going back to 1970 based on the work in Garfield (1970). The approach is used to help trend and rate journals, articles, and other factors with various indexes and scores like the g-index so that researchers can analyze and evaluate scholarly publications' impact, authors' productivity, and citation patterns in different fields of study (Egghe 2006). The use of the review analysis approach for the present work aims to accomplish the objectives listed below based on a combination of the methodologies used in Gholami et al. (2023a) and Gholami et al. (2023b).

1. Show historical and current research that has been published on the topic of COQ and the other

equivalently used terms cost of poor quality and hidden quality cost.
2. Present an in-depth analysis of research trends across different countries and their contributions to the field academically.
3. Analyze and present the trends in academic journals that publish related subjects.
4. Explore the academic contributions of institutions on various subjects and identify trends in their impact over time.
5. Utilize review analysis to demonstrate trends in research contributions by prolific authors within the area of study.

This review analysis article is organized first by presenting the methodology used to conduct this study, which is followed by a presentation and an analysis of the data. This includes historical trends in research publications on COQ, the geographical distribution of research contributions, prominent academic journals, and prolific authors. The final part of this article concludes by discussing the significant findings and their practical implications for both academia and industry.

METHODOLOGY

The review analysis method is an academically rigorous approach that utilizes statistical techniques and quantitative analysis to examine trends in global research related to a particular field of study (Broadus 1987). The method employs relevant keywords extracted from the abstracts and titles of scholarly publications and then uses tools like VOS Viewer 1.6.19 and other tools to establish linkages and create a comprehensive map that depicts their interrelationships (Van Eck & Waltman 2020). This methodology was discussed by Garfield (1970) as a historical research tool for mapping citation networks and understanding Nobel Prize winners. The review analysis method is a valuable tool for identifying and analyzing research trends related to the COQ, cost of poor quality, and hidden quality cost. By employing the methodology in this research paper, the objective is to gain insight into the historical and current landscape of publications on the terminologies cost of quality, cost of poor quality, and hidden quality cost and identify gaps for research. Additional objectives are to identify influential authors and any emerging themes in cost of quality research.

Researchers use this type of analysis to examine the landscape of publications around terms to help structure the historical and current publications as well as map what gaps to explore in the future. The SCOPUS database is widely recognized as one of the most comprehensive and reliable sources of academic research literature. It provides access to peer-reviewed journals, conference proceedings, books, and other scholarly publications from various fields, including science, technology, medicine, social sciences, and humanities. The database is used by researchers around the world for their literature search needs due to its extensive coverage and indexing capabilities that help users locate relevant articles quickly.

SEARCH STRATEGY AND SCOPE

The data from the search was collected on April 10, 2023, using SCOPUS. The goal and scope of this review analysis was to find journal articles with 'cost of quality' in the title, abstract, and keywords. There are some limitations to a review in that it is possible that it does not take into account the overall significance of the body of the text. To combat the concern of missing articles, the authors chose to use the three terms: cost of quality, cost of poor quality, and hidden quality cost.

During the search, the following query was used: TITLE-ABS ('cost of quality' OR 'cost of poor quality' OR 'hidden quality cost') AND LANGUAGE (English) AND (DOCTYPE (ar)) AND (SRCTYPE (j)). The result of this search provided 666 publications. We were able to identify the most frequent keywords and co-occurrence of terms related to COQ and hidden quality cost in these publications. After obtaining the 666 results, the *.RIS file format was exported from SCOPUS and imported into VOSviewer 1.6.19 software for analysis. The search results from this study were also exported from SCOPUS as a *.RIS file, which was imported into Zotero 6.0.23 for an accuracy check. The export of the SCOPUS search was also used with Litmaps, which is a web-based service that facilitates literature reviews, to further analyze and visualize the search results. The SCOPUS database was utilized in this study to conduct a comprehensive review analysis on the topic of the COQ. A flow diagram outlining the steps taken is shown in Figure 1.

MAPS AND ANALYSIS

After using the SCOPUS database, various tools were used to deploy review analysis. Various tools were adopted from the approaches discussed in Donthu et al. (2021). Zotero 6.0.23 allowed for imports and exports of the SCOPUS database. An open-source tool called JabRef version 5.9 was used to run a quality analysis on the exported data and export it to a format compatible for word citations. The web-based Litmaps tool provided a wizard that allowed for the import and bridging of connections between citations as a map. Another open-source tool called VOSviewer ver. 1.6.19 was used to create a heat map by country of origin. The export from SCOPUS as a *.RIS file was imported into Zotero 6.0.23, JabRef ver. 5.9, and Litmaps wizard.

When the references were analyzed using JabRef ver. 5.9, there was one citation that was found to be in error because it was a duplicate. This means that the actual number of citations was 665. When the citations were imported into the Litmaps wizard, only 591 articles were

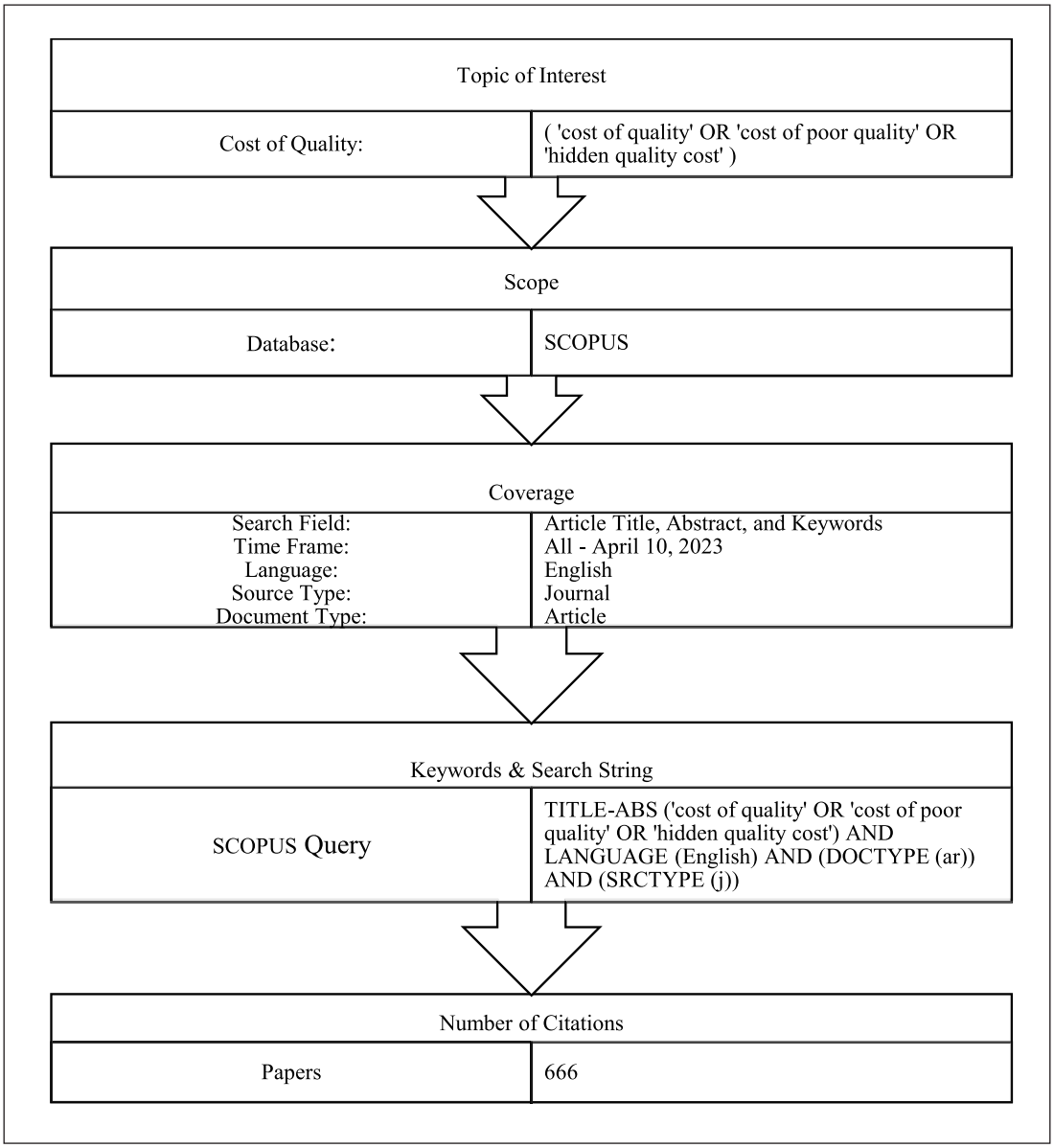

Figure 1 Flow diagram for the SCOPUS search strategy.

correlated with their database. Due to the limitations of their database to have access to all articles, it will only be used to produce graphics. Zotero 6.0.23 was used to filter down the results by the contents of the article titles by terms of interest. The term 'poor quality' netted only 20 out of the 665 articles. The term 'hidden' was able to filter down to only 13 out of the 665 articles.

RESULTS AND DISCUSSION

The results and discussion section follows the research objectives presented in the procedure section. These results of the research objectives use various approaches. The performance analysis approach is key to providing an overview of the contributions made to COQ research. This includes an analysis of the top countries, journals, and authors found from the SCOPUS search. Each subsequent header leading up to the conclusion will discuss the details of the objective results and discussions.

HISTORICAL TIMELINE OF RESEARCH ON COQ

The results of the SCOPUS search were exported in a format that allowed Excel to be used. This was used to create the chart shown in Figure 2 to showcase the trending of publications from the SCOPUS search from the earliest to the latest publication. The earliest publication was from 1924 and ranged through 2023. The chart shows that publication activity on the topic increased in the 1980s and 1990s and has continued to increase over time. The cumulative trend of publications has shown an almost steady linear growth trend except for a few dips in publications on the topic in 2002, 2003, and 2005. Other than the insight that these terms in publications show a healthy amount of activity, there are no additional insights that could be ascertained from this.

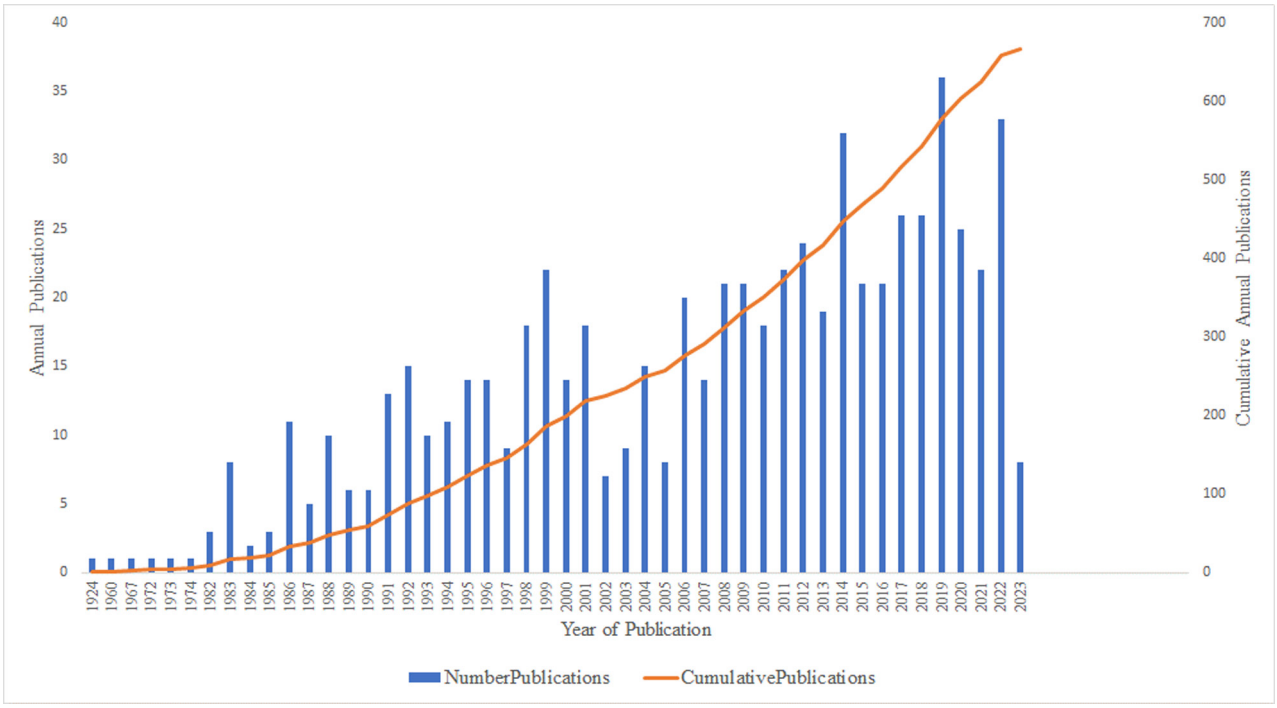

Figure 2 Trended dataset of number of annual publications vs year and cumulative number of annual publications vs year of publication. Compiled from results of SCOPUS query: TITLE-ABS ('cost of quality' OR 'cost of poor quality' OR 'hidden quality cost') AND LANGUAGE (English) AND (DOCTYPE (ar)) AND (SRCTYPE (j)). Chart created using Excel. The total cumulative number of publications was 666.

HISTORICAL TIMELINE OF RESEARCH ON COST OF POOR QUALITY (COPQ)

The results of the SCOPUS search were exported in a format that could be imported into Zotero, and then this dataset was searched using a co-word analysis timeline for the terminology 'cost of poor quality' in the title. The result of this was exported into an Excel format, and this was used to create the chart presented in Figure 3 in order to showcase the trending of publications from the SCOPUS search from the earliest to the latest publication referencing cost of poor quality. The earliest publication was from 1992 and ranged through 2022. The chart shows that there is a consistently low number of publications per year when there is publication on the subject. Most years had only one publication, while three was the maximum in any year. There are multiple years throughout the 1990s and early 2000s with no publications during that year. The cumulative trend of publications seems linear, but there are gaps in publications during some years. There was a small increase in activity in 2014 and 2015, but then it decreased again only to increase in 2021. The number of overall publications, 20, is low relative to the overall SCOPUS search of 666.

HISTORICAL TIMELINE OF RESEARCH ON HIDDEN QUALITY COST

The results of the SCOPUS search were exported in a format that could be imported into Zotero, and then this dataset was searched using a co-word analysis timeline for the terminology 'hidden' in the title. The result of this was exported into an Excel format, and this was used to create the chart shown in Figure 4 to showcase the trend of publications from the SCOPUS search from the earliest to the latest publication referencing hidden quality cost. The earliest publication was from 1999 and ranged through 2021. The chart shows that there is a consistently low number of publications per year when there is publication involving hidden quality cost. Most years had only one publication, while a few years had two. There are gaps with years without any publications during that year. The cumulative trend of publications added up to a total of only 13 publications. The number of overall publications on the topic, which is 13, is very low relative to the overall SCOPUS search of 666.

CONTRIBUTING COUNTRIES ON COQ

From the SCOPUS search, the output results of the articles found were sorted by the top 10 countries with publications on the search terms. This data was used in Excel to create a chart as shown in Figure 5. The number of articles published per country shows that the United States ranked number one with 198 articles on the topic. Second to that was the United Kingdom with 59, and then in close third place was India with 53 articles. The other countries listed in order are Australia, China, Canada, Taiwan, Iran, and Germany. This data shows that there is a clear majority of activity on these topics being published out of the United States. The additional bulk of the activity is being published out of the United Kingdom and India. The distribution in Figure 5 makes sense, keeping in mind that the countries in the top four have a greater focus on regulations and, therefore,

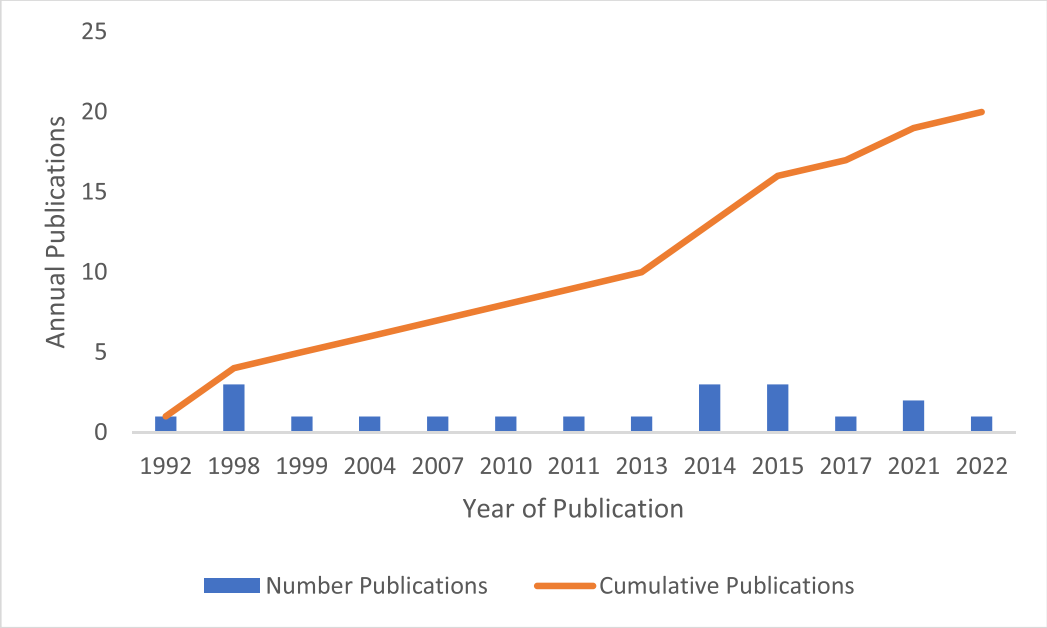

Figure 3 Trended dataset of number of annual publications vs year and cumulative number of annual publications vs year of publication. Compiled from results of SCOPUS query: TITLE-ABS ('cost of quality' OR 'cost of poor quality' OR 'hidden quality cost') AND LANGUAGE (English) AND (DOCTYPE (ar)) AND (SRCTYPE (j)). Filtered results using 'cost of poor quality' by title using Zotero and created the chart using Excel. The total cumulative number of publications was 20.

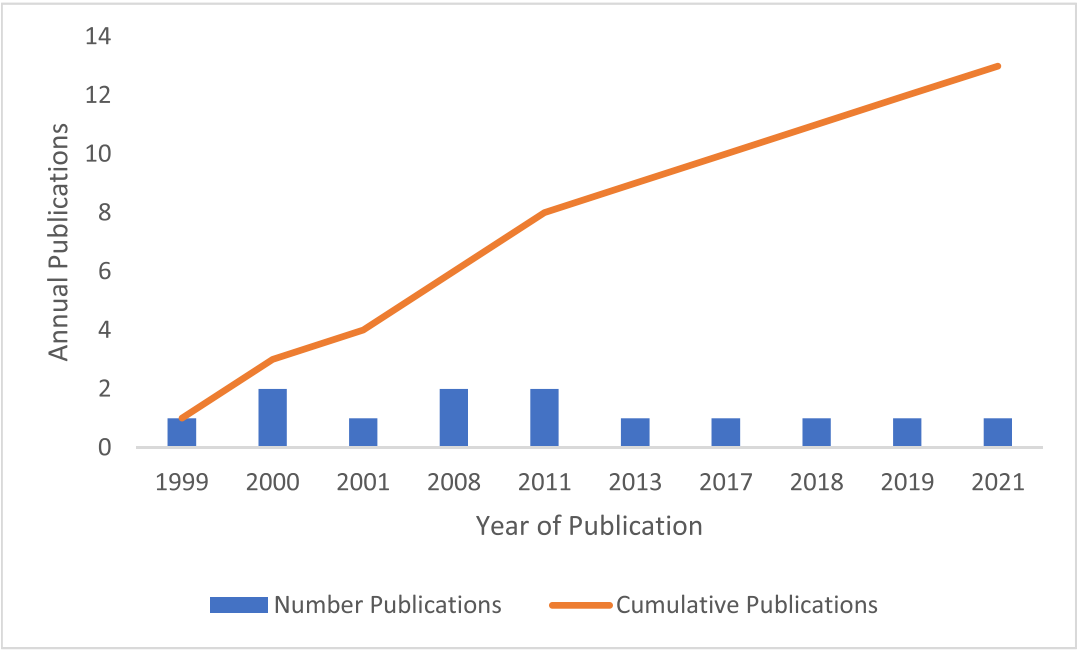

Figure 4 Trended dataset of number of annual publications vs year and cumulative number of annual publications vs year of publication. Compiled from results of SCOPUS query: TITLE-ABS ('cost of quality' OR 'cost of poor quality' OR 'hidden quality cost') AND LANGUAGE (English) AND (DOCTYPE (ar)) AND (SRCTYPE (j)). Filtered results using 'hidden' in the title using Zotero and created the chart using Excel. The total cumulative number of publications was 13.

have developed more focus on quality cultures within organizations.

In addition to the chart in Figure 5, where the top 10 countries were analyzed, VOSviewer 1.6.19 was also used to create a heat map of countries and co-authorships. This can be seen in Figure 6, showing the connected countries with co-author relationships. Larger circles represent more publications. Lines represent connected co-authorship. This data shows the United States ranked number one and maintained a lot of co-authorship with the United Kingdom, which was in second. India ranked third and maintained many co-authorships with the United Kingdom. The other countries displayed give an idea of all the countries involved in the landscape of this and all the co-authorship.

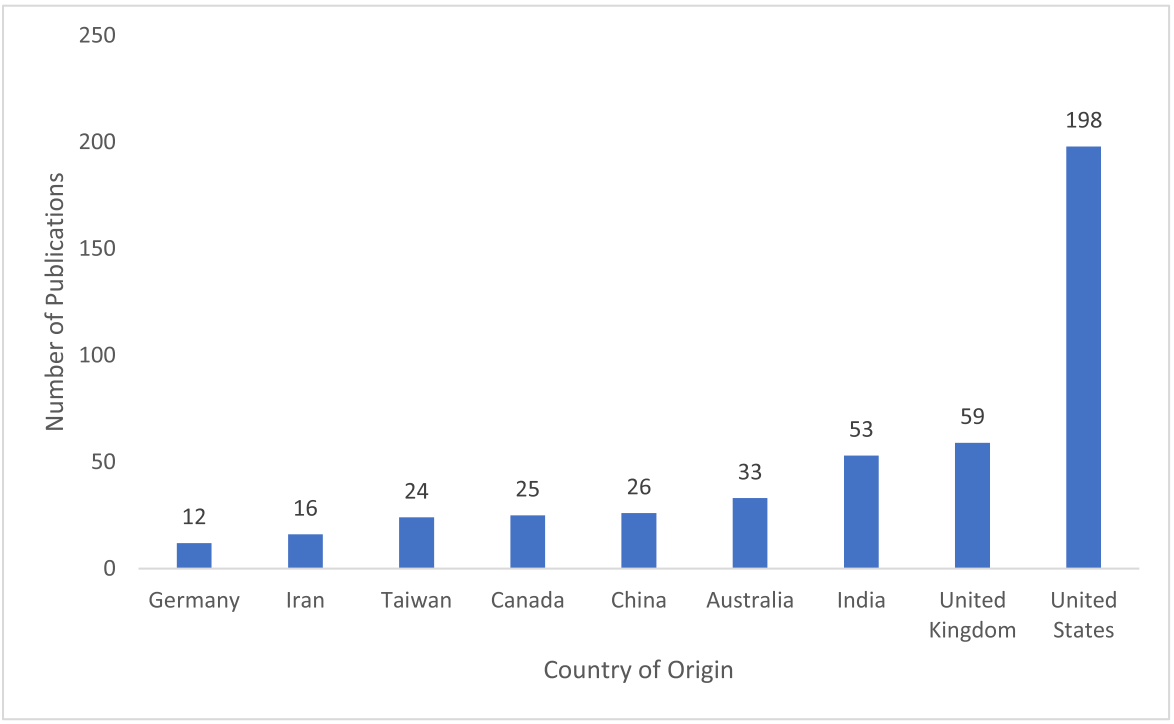

Figure 5 Trended dataset of number of publications by top 10 countries. Compiled from results of SCOPUS query: TITLE-ABS ('cost of quality' OR 'cost of poor quality' OR 'hidden quality cost') AND LANGUAGE (English) AND (DOCTYPE (ar)) AND (SRCTYPE (j)). Results exported from SCOPUS and chart created with Excel.

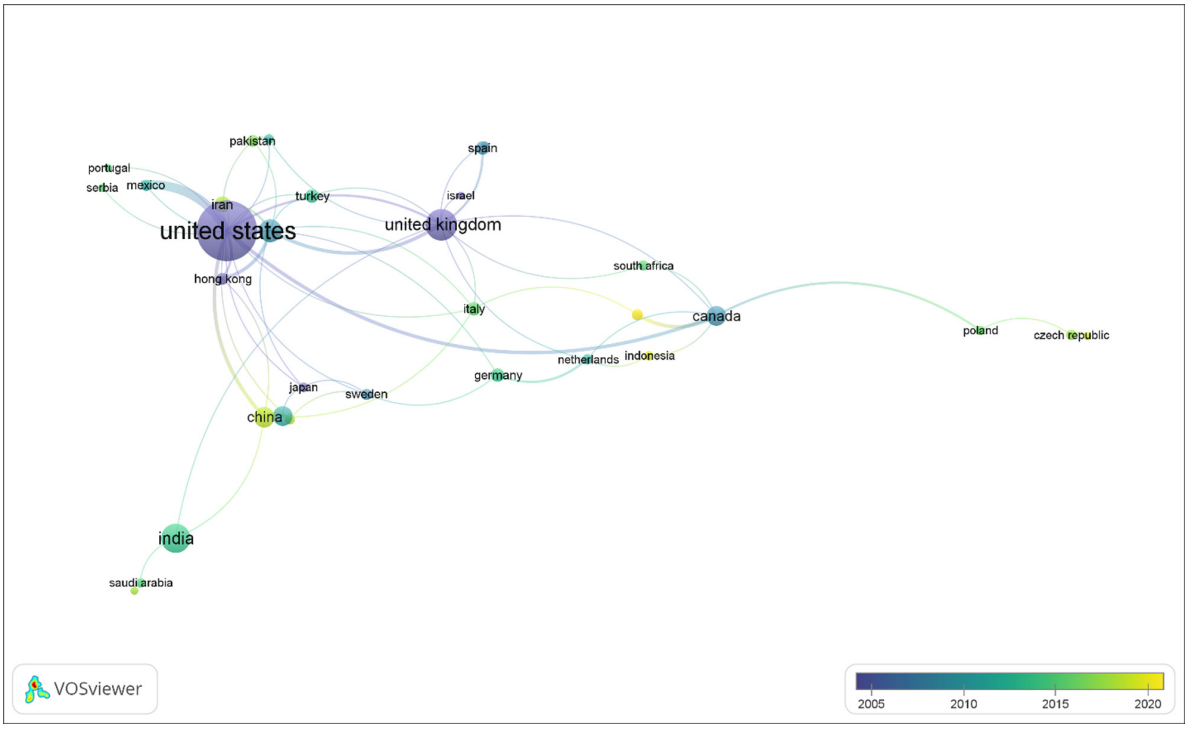

Figure 6 Visualization of co-authoring network map with countries that published on cost of quality, created using VOSviewer 1.6.19. Map showing connected countries with co-author relationships. Larger circles represent more publications. Lines represent connected co-authorship.

CORE JOURNALS

The top 10 core journals were analyzed in Table 1. The journal source title was sorted by the number of articles. The country, publisher, and SCOPUS Cite Score 2021 were also shown. For the SCOPUS CiteScore 2021 a higher number is more favorable. The number of citations per document published and the percentage of cited sources within the journal all seem to have an impact on increasing the score. This would mean that a journal with the highest number of citations per article and as close

SOURCE TITLE	NO. OF ARTICLES	COUNTRY	PUBLISHER	SCOPUS CITE SCORE 2021
International Journal of Quality and Reliability Management	29	United Kingdom	Emerald Group Publishing Ltd.	4.9
Quality Progress	23	United States	American Society for Quality	0.3
Total Quality Management and Business Excellence	18	United Kingdom	Routledge	7.2
International Journal of Production Research	13	United Kingdom	Taylor & Francis Ltd.	14.6
International Journal of Productivity and Quality Management	11	United Kingdom	Inderscience Enterprises Ltd.	2.2
TQM Journal	11	United Kingdom	Emerald Publishing Ltd.	4.9
TQM Magazine	10	United Kingdom	Emerald Publishing Ltd.	N/A
Journal of Construction Engineering and Management	8	United States	American Society of Civil Engineers (ASCE)	6.3
International Journal of Production Economics	7	Netherlands	Elsevier	14.3
International Journal of Industrial and Systems Engineering	5	United Kingdom	Inderscience Enterprises Ltd.	1.4

Table 1 Top 10 journals from SCOPUS search with research on COQ.

to 100% of articles cited may rank high on the SCOPUS CiteScore.

AUTHORS CONTRIBUTION TO THE DEVELOPMENT OF THE TOPIC

An analysis of the SCOPUS search was also conducted by filtering the top 20 articles with the highest number of citations. Table 2 listed the authors, the title of the article, the journal, the year published, and the number of citations. The results of this analysis show that the subject appears to span across many different journals and disciplines. The majority of the articles in the top 20 are noteworthy to the author because they seem to have a theme around manufacturing, management, and healthcare topics, which are all of interest to the authors of this article in future research. Other areas of heavy citations are in construction and electrical engineering, which are not of interest to the authors of this paper.

Having presented the review analysis of the COQ landscape, it was noticed that there was a low number of papers related to hidden costs. To understand how the papers on hidden costs were connected to other influential papers on COQ, an analysis of the SCOPUS search was also conducted utilizing the Litmaps tool online. The results of the SCOPUS search were filtered to only include the 13 papers with hidden costs, and an additional two degrees of freedom search was added. This was done to present a bibliographic coupling and network visualization map using their engine. All direct citations within two degrees of freedom related to the terms 'cost of quality' and 'hidden cost'. This tool allowed for the creation of the map showing all papers connected through citations about hidden cost of quality to the original 13 papers on hidden quality cost. The results of this map can be seen as Figure 7, and the link can be used to explore this map (https://app.litmaps.com/shared/983e2c83-7fec-4560-842a-376a01294647).

SUMMARY OF RESULTS AND DISCUSSION

The analysis of the SCOPUS search in this review revealed that research on COQ spans across various disciplines such as manufacturing, management, healthcare, and construction. COQ is well studied across many different disciplines, and activity in the topic increased starting in the 1980s. This trend of increased research around COQ has continued to increase, with a cumulative trend of publications showing steady linear growth over time. There has been extensive research about COQ, but limited research specifically focusing on cost of poor quality and even less on hidden quality costs.

This literature review's findings highlight that hidden quality cost is an area of research that has not been extensively explored. Research into hidden quality costs has multiple opportunities, including research related to accurate and standardized methods for discovering and measuring hidden costs, exploring the specific impact of hidden quality costs on different industries, and analyzing connecting verified hidden quality costs into holistic COQ calculations.

CONCLUSIONS AND RECOMMENDATIONS

In this paper, we have carried out a review analysis to recognize and assess all current research trends

NO.	AUTHORS	TITLE	JOURNAL	YEAR PUBLISHED	NUMBER CITATIONS
1	S. Albliwi, J. Antony, S.A.H. Lim, T. van der Wiele	Critical failure factors of lean Six Sigma: A systematic literature review	International Journal of Quality and Reliability Management	2014	333
2	E. Peter, D. Love, L.I. Heng	Quantifying the causes and costs of rework in construction	Construction Management and Economics	2000	316
3	S. Baiman, P.E. Fischer, M.V. Rajan	Information, contracting, and quality costs	Management Science	2000	266
4	A. Ha, X. Long, J. Nasiry	Quality in supply chain encroachment	Manufacturing and Service Operations Management	2016	219
5	H. Birnbaum, C. Pike, R. Kaufman, M. Marynchenko, Y. Kidolezi, M. Cifaldi	Societal cost of rheumatoid arthritis patients in the US	Current Medical Research and Opinion	2010	171
6	R. Shapiro, A. Basu, H. Tan, E. Gray, A. Kahn, P. Randhawa, N. Murase, A. Zeevi, A. Girnita, D. Metes, R. Ness, D.C. Bass, A.J. Demetris, J.J. Fung, A. Marcos, T.E. Starzl	Kidney transplantation under minimal immunosuppression after pretransplant lymphoid depletion with Thymoglobulin or Campath	Journal of the American College of Surgeons	2005	159
7	P. Barber, A. Graves, M. Hall, D. Sheath, C. Tomkins	Quality failure costs in civil engineering projects	International Journal of Quality and Reliability Management	2000	157
8	P.E.D. Love, P. Mandal, H. Li	Determining the causal structure of rework influences in construction	Construction Management and Economics	1999	154
9	S. Thirumalai, K.K. Sinha	Product recalls in the medical device industry: An empirical exploration of the sources and financial consequences	Management Science	2011	151
10	R. Isaksson, U. Steimle	What does GRI-reporting tell us about corporate sustainability?	TQM Journal	2009	145
11	M. Kaya, O. Özer	Quality risk in outsourcing: Noncontractible product quality and private quality cost information	Naval Research Logistics	2009	136
12	R.B. Franca, E.C. Jones, C.N. Richards, J.P. Carlson	Multi-objective stochastic supply chain modeling to evaluate tradeoffs between profit and quality	International Journal of Production Economics	2010	125
13	J.J. Plunkett, B.G. Dale	Quality costs: A critique of some economic cost of quality models	International Journal of Production Research	1988	116
14	B. Al-Najjar	Total quality maintenance: An approach for continuous reduction in costs of quality products	Journal of Quality in Maintenance Engineering	1996	112
15	M.A. Bergman, S. Lundberg	Tender evaluation and supplier selection methods in public procurement	Journal of Purchasing and Supply Management	2013	101
16	W.-H. Tsai	Quality cost measurement under activity-based costing	International Journal of Quality and Reliability Management	1998	101
17	V. Šmídl, A. Quinn	Variational Bayesian filtering	IEEE Transactions on Signal Processing	2008	98
18	K. Davis, W.B. Ledbetter, Jr. Burati, J.L.	Measuring design and construction quality costs	Journal of Construction Engineering and Management	1989	88

(Contd.)

NO.	AUTHORS	TITLE	JOURNAL	YEAR PUBLISHED	NUMBER CITATIONS
19	J.A. Douglas, J. Antony, A. Douglas	Waste identification and elimination in HEIs: the role of Lean thinking	International Journal of Quality and Reliability Management	2015	85
20	S.A. Starbird	Penalties, rewards, and inspection: Provisions for quality in supply chain contracts	Journal of the Operational Research Society	2001	83

Table 2 Citation analysis of top 20 most influential articles from SCOPUS search with research on COQ.

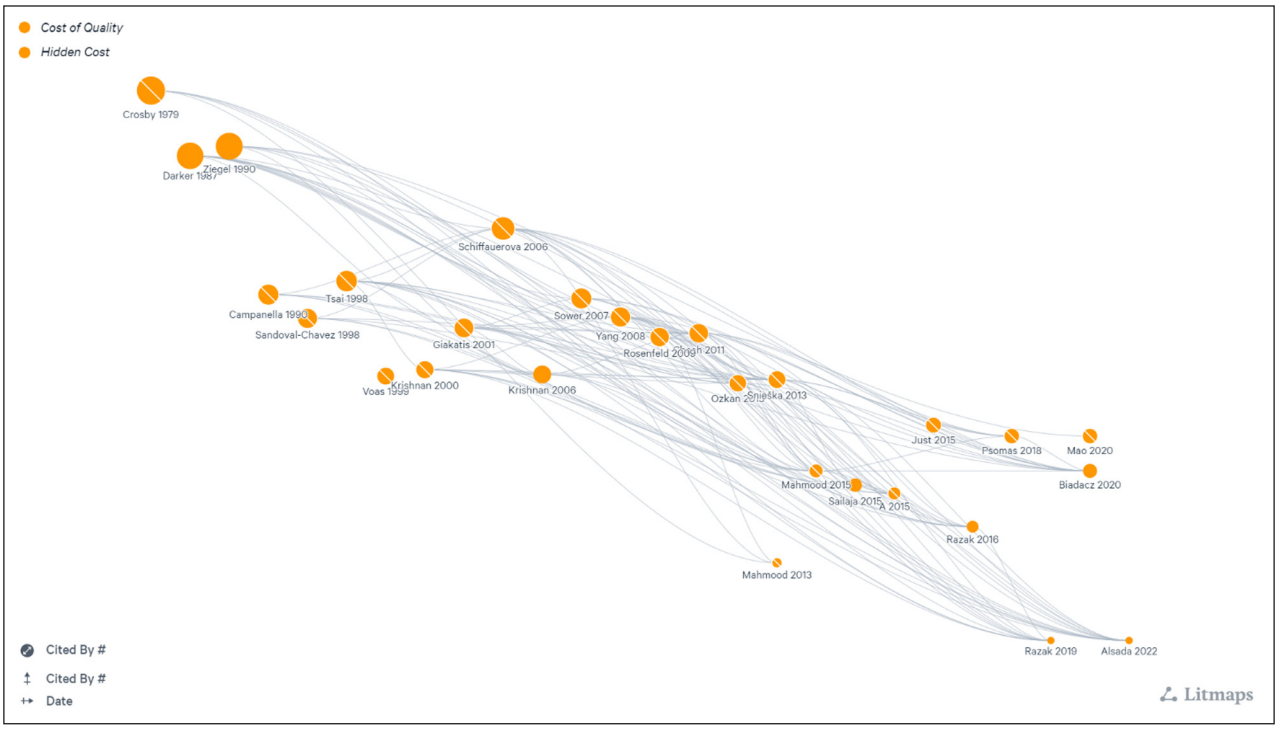

Figure 7 Visualization on COQ SCOPUS results filtered down to hidden cost and created using Litmaps. The Bibliographic Coupling and Network Visualization Map shows the flow of influential papers referencing hidden costs with an additional two degrees of freedom of connection added based on Litmaps capabilities. Larger circles represent more citations. Lines represent citations by other papers connected on map.

that are associated with the COQ, cost of poor quality, and hidden quality cost. The aim was to acquire a comprehensive overview of the existing research landscape to better understand and help pinpoint potential gaps in the literature that can be further explored for future research purposes. The authors believe that the findings suggest that the area related to hidden quality cost remains a very underexplored area of research. COQ research, as a whole, has gained significant attention due to its various applications across industries and its value to improving quality and cost. Despite the extensive research in this area, some gaps and challenges remain to ensure all areas of quality cost are accounted for. A few gaps identified during this review are related to identifying hidden costs related to poor quality, quantifying the hidden costs related to poor quality, and working towards a holistic approach to calculating COQ, which includes hidden costs of poor quality.

COQ is a topic that relates to technology management through the applications of both quality systems and quality management. The goal of COQ is to both understand and help minimize costs associated with poor quality while enabling the maximization of value for customers. COQ models are of key importance for the future of industries as a tool for identifying and measuring the costs associated with quality assurance to help minimize these costs while maintaining acceptable levels of quality. While extensive research has been conducted based on the analysis of this review, there are still gaps that need to be explored with future research. This literature review highlights the need for more research to further enhance our understanding of hidden quality costs.

LIMITATIONS

This review analysis searched only publications found in SCOPUS journals. Although the SCOPUS database is broad

compared to other approaches, like Web of Science, there's still a possibility of the SCOPUS database missing research published in other avenues that are not found in SCOPUS journals.

IMPLICATIONS

The findings from this review analysis show that there has been extensive research about COQ but limited research specifically focusing on cost of poor quality and even less on hidden quality costs. Thus, research into hidden quality costs has multiple opportunities. Such opportunities include research related to identifying hidden costs associated with poor quality, accurate and standardized methods for measuring hidden costs, exploring the specific impact of hidden quality costs on different industries, and analyzing connecting verified hidden quality costs into holistic COQ quantifications.

RECOMMENDATIONS FOR FUTURE WORK

As a result of this work, several recommendations can be made for future work. One recommendation is to conduct further research on the identification of hidden quality costs in all aspects of quality assurance and management. This can be done by using standardized frameworks to identify and quantify hidden quality costs, specifically related to poor quality. Additionally, future research should explore the development and implementation of a holistic approach to calculate COQ that also includes hidden costs associated with poor quality. Finally, there is a need to address the challenges in quantifying hidden quality costs and developing reliable data sources for conducting COQ research. Future work in these areas will help us gain a better understanding of the cost of poor quality in all its dimensions, thereby enabling organizations to make informed decisions regarding quality management and improvement strategies.

COMPETING INTERESTS

The authors have no competing interests to declare.

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