

# A SCIENTOMETRIC ANALYSIS OF RESEARCH ON RESPONSIBLE SOURCING IN THE CONSTRUCTION INDUSTRY

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## **Abstract**

There is currently a drive towards sustainable buildings world-over. Considering the definition of sustainability, sustainable buildings need to demonstrate their performance in respect of environmental, ethical, social, and economic perspectives. One of the challenges for sustainable buildings is to demonstrate to all interested parties that the products and materials contained in any construction phase have been sourced responsibly. Issues concerning the welfare of workers, health and safety practices and environmental sustainability in the upstream supply chains, have brought the question of responsible sourcing to the fore. While other industries such as retail and food have embraced responsible sourcing, this has been slow in the construction industry. Responsible sourcing requires that companies take into account a triad of environmental, economic and social sustainability when managing relationships with suppliers. Although there have been studies on responsible sourcing in the construction industry, there is a limited review that evaluates the current state of research on this subject. The objective of this paper is therefore to undertake a comprehensive literature review of research papers relating to responsible sourcing in the construction industry using bibliometric analysis. While the focus of the analysis is on the main research areas, issues such as timeline trends, authorship, research outlets and research topics are explored. The results of the analysis provide a domain-knowledge map of research on responsible sourcing in the construction industry and the identification of knowledge gaps for future research.

Keywords: Responsible sourcing, sustainability, bibliometric analysis, triple-bottom-line

## **1 INTRODUCTION**

The construction industry plays a significant part in sustainable development and its processes and products impact on the environment. The industry is one of the largest consumers of resources [1] and a significant contributor to environmental degradation [2]. The industry is also regarded as impacting the environment due to the large volumes of waste generated from its processes [3] and it is one of the biggest energy consumer and carbon emitter [4]. It is estimated that the construction industry contributes 40% of raw materials consumption, 36% of energy consumption, 40% of solid waste generation, and 40% of greenhouse gas emissions [5]. Consideration of construction materials is therefore important as they play a crucial role in various aspects of a building, including thermal performance, internal comfort, acoustics, and durability [6]. The extraction, manufacturing, consumption, and end-of-life options of materials have major social, economic and environmental impacts [7]. Indeed, construction material selection can have socio-economic impacts on the surrounding area of a construction project including, economic benefits to the local communities, the use of local materials resulting in the constructed buildings harmonising with existing structures, and other providing a social benefit [8]. According to [8], sustainable construction focuses on how the design and selection of sustainable building materials can complement the environment, improving living quality, user health, and comfort, rather than simply limiting the overall construction activity. Consequently, evaluating the environmental impact of materials consumption becomes critical [2]. The construction industry has been encouraged to adopt sustainable materials. Ding [8] defines sustainable building materials as those that are natural, offering specific advantages such as low maintenance, energy efficiency, improved occupant health and comfort, and increased productivity, while being less harmful to the environment. It's important to note, however, that not all natural materials are environmentally friendly. Therefore, sustainable building materials refer to materials that are either environmentally friendly or responsibly sourced [8]

One of the challenges for sustainable buildings is to demonstrate to all interested parties that the products and materials contained in any construction phase have been sourced responsibly. Issues concerning the welfare of workers, health and safety practices and environmental sustainability in the upstream supply chains, have brought the question of responsible sourcing to the fore. While other

industries such as retail and food have embraced responsible sourcing (RS), this has been slow in the construction industry. RS requires that companies take into account a triad of environmental, economic and social sustainability when managing relationships with suppliers. RS is an important aspect of the broader sustainable supply chain management (SSCM) agenda. To some extent, responsible sourcing has become a question of the ethics of sustainability. Literature is awash with definitions of ethics. The general context however defines ethics in terms of what is right and wrong and also touches on issues of morality. Adnan (2012) viewed ethics as a system of moral principles, which impact people's judgement of actions, whether such actions are wrong or right. Such a definition is useful to place the context of the ethics of sustainability. Thus by implication ethics of sustainability can be construed as a system of moral principles which impact people's judgement when making sustainability-related decisions and actions. Meijboom and Brom (2012) argued that the notion of sustainability as a moral ideal is relevant to understand the possible role ethics can play in sustainability discussions. The roles of ethics in sustainability has therefore been demonstrated. For example, Schults et al (2005) studied the relationship between values, as ethics construct, and environmental concerns and consumer behaviour. Similarly, studies have looked at the impact of consumer ethical behavior as a determinant of consumer behaviour. For example, studies in sectors such as food production, demonstrate that consumers can be active contributors to sustainability by selecting food choices that are both healthy and produced respecting environmental and socially ethical standards (Ghvanidze et al, 2016).

The concept of Responsible Sourcing (RS) can be defined in various ways. According to BRE (2009), RS is a comprehensive approach to managing a product's lifecycle, starting from its raw state through manufacturing, processing, use, re-use, recycling, and ultimately, its disposal as waste with no further value. On the other hand, the International Chamber of Commerce (ICC) (2008) offers a more sustainability-focused definition, stating that responsible sourcing involves companies considering social and environmental factors when managing relationships with suppliers. It is worth noting that there is no universally agreed-upon definition of responsible sourcing, as highlighted by ICM (2015). In different contexts, terms like 'sustainable,' 'ethical,' 'green,' or 'conflict-free' may replace 'responsible,' while 'purchasing' and 'procurement' may be used instead of 'sourcing.' However, the specific terminology used may carry particular connotations. In their study, Van den Brink (4) exclusively used 'responsible sourcing' to analyze research on practices within the mining sector.

To promote responsible sourcing of materials in the construction industry, the Framework Standard for the Responsible Sourcing of Construction Products (BES 6001) (BRE, 2009) and the Responsible Sourcing Sector Certification Schemes for Construction Products (BS 8902) (BSI, 2009) provide guidance for responsible sourcing of materials. BES 6001 provides guidance to construction product manufacturers to ensure and then prove that their products have been made with materials that adhere to responsible sourcing principles, including organisational governance, supply chain management and environmental and social aspects (BSI 2009). BS 8902 (BSI, 2009) on the other hand, is a framework for the development of a responsible sourcing certification scheme for the construction industry. The reference to the BS6001 standards provides an opportunity for supply chains to demonstrate that materials have been sourced responsibly and have achieved certified standards such as BS6001.

The drivers for responsible sourcing include among others, market pressures, government regulation or guidance and sustainability standards. For example, the UK government's 2008 strategy for sustainable construction included a target of 25% of materials to be responsibly sourced by 2012 (HM Gov, 2008). Sustainability frameworks such as BREEM award credits for demonstrating using materials that have been responsibly sourced are also key drivers for responsible sourcing. Considering the importance of responsible sourcing, Ball and Booth [9] suggest that rather than relying on the morals of clients, it is recommended that responsible sourcing is made mandatory on all construction projects.

Although there have been studies on responsible sourcing in the construction industry, there is a limited review that evaluates the current state of research on this subject. The objective of this paper is therefore to undertake a mapping of research papers relating to responsible sourcing in the construction industry using bibliometric analysis. Having conducted a bibliometric analysis of the research on responsible sourcing, the paper ends with the identification of key research themes on the subject, thereby providing a timely summary for researchers and managers alike and the research gaps that need to be addressed in the future.

## 2 METHODOLOGY

This study used scientometric analysis to map knowledge relating to responsible sourcing in the construction industry. The approach is increasingly being used in built environment research.

Thanuskodi, [10] describes scientometric analysis as “The field of study which concerns itself with measuring and analysing scientific literature. Scientometrics is a sub-field of bibliometrics. Major research issues include the measurement of the impact of research papers and academic journals, the understanding of scientific citations, and the use of such measurements in policy and management contexts”. Gavvani, [11] describes it as “The study of measuring and analysing science research. In practice, scientometrics is often done using bibliometrics which is a measurement of the impact of (scientific) publications”. Using information technology, scientific index, and visualization techniques, the bibliometric method provides researchers with a way to understand the trends and connections between fields, specialists, disciplines, authors and publications[12]. Scientometric analysis can be used to explore linkages such, based on the bibliographic records of the literature, such as co-citation analysis, co-occurrence keyword analysis, and timespan analysis (See for example, [13] and [14]. Vosviewer, a software tool for constructing and visualizing bibliometric networks was selected to be used for the analysis of data. While other software has the capability to analyse bibliometric data, Vosviewer was selected as it is freely available online and offers the basic functionality needed for visualizing Scientometric networks [14].

In order to conduct a scientometric analysis, it is a requirement that bibliometric data from research publications are acquired. Figure 1 represents the process involved in the data acquisition and analysis. There are many options for this, such as google scholar, web of Science, Pubmed, and Scopus. Scopus was chosen for its coverage of recent publications in the field. However, in order to test this assumption, the authors, tried using the Web of Science and did not get different results. Therefore both Scopus and Web of Science would be ideal for the collection of bibliometric data.

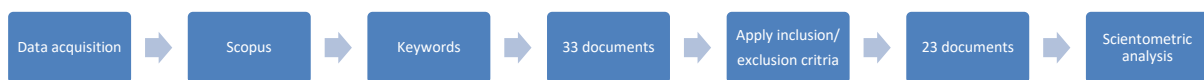


Figure 1: The research design

The search keywords used were a combination of ‘responsible sourcing’ and variations of ‘construction industry’ However, similar to the work of [15] the authors chose ‘responsible sourcing’ as the key search word with the exclusion of other synonyms such as green sourcing, green supply chains, ethical sourcing etc. The following was the search stream:

*( TITLE-ABS-KEY ( "responsible sourcing" ) AND TITLE-ABS-KEY ( construction OR "built environment" OR building OR infrastructure ) )*

Owing to the limited number of studies on the subject, the search strategy did not place a limit on the period for the publications but restricted to collecting bibliometric data from documents that were classified as either, articles, conference papers, or short surveys. The initial search resulted in the identification of 33 documents. However, when the inclusion and exclusion criteria were applied, 24 articles were deemed to be representative of studies that related to responsible sourcing in the construction industry.

The scientometric analysis included the analysis of trends (publications per year), the co-occurrence of keywords, co-citation analysis (references, sources, authors) and co-authorship analysis (author, organization, countries). In addition, to build a picture of the key focus areas of current research, a cluster analysis of keywords was performed.

### 3 FINDINGS AND DISCUSSION

#### 3.1 Timeline trends

Figure 2 shows the trends in research for responsible sourcing in the construction industry. This is an area that, despite its importance, is receiving research attention. The reasons for this are not clear. Therefore it was essential to compare the trends in research that focused on the built environment and the general responsible sourcing field.

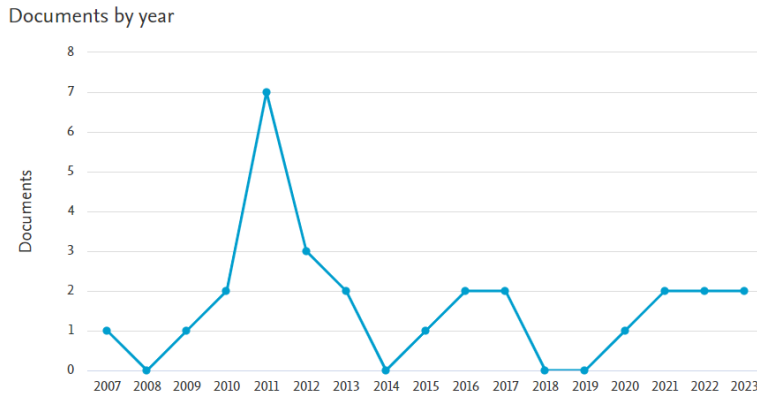


Fig 2: Responsible sourcing- construction industry

Figure 3, shows results for all publications relating to responsible sourcing in general. A comparison of trends shows that while research on RS in the construction industry peaked in 2011, there has generally been limited effort to develop knowledge in this area for the construction industry. In contrast, the data shows that the discussion on RS in general (all research fields) continues to grow with a significant number of articles written between 2016 and 2022. 2016 and 2022 were the peak in terms of the number of papers directly referencing RS. From the data, however, it is not clear, why there is a limited interest in responsible sourcing research in the built environment area of research.

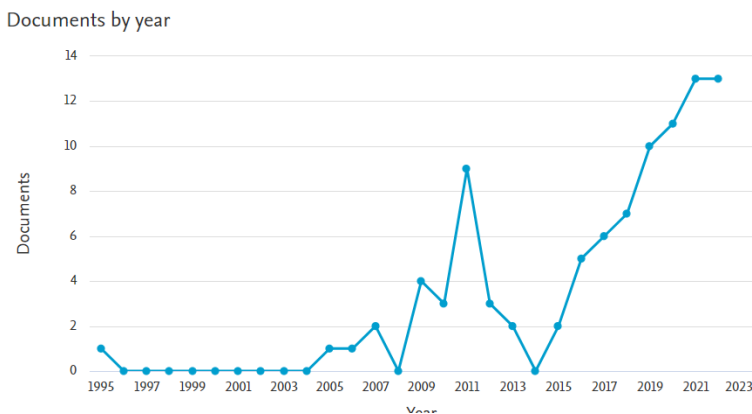


Fig 3: Responsible sourcing- all subject areas

### 3.2 Documents with the most citations

Table 1 shows the journal articles that have received the most citations. The articles by [2, 16-19] are the top five most cited articles. It is interesting to note also the relatively low total citations for the ten articles listed, with a total of 147 citations. This may reflect the lack of interest in RS research in the construction industry. It is noticeable that in the majority of cases, the studies focus on responsible sourcing practices and integration in the supply chain. There is a limited departure from this. The exception is the study on the Modern Slavery Act [20]an issue that is of growing concern in many industries.

Table 1: Most cited articles

Authors	Article title	Citations
[18]	Implementing sustainability in small and medium-sized construction firms the role of absorptive capacity.	53
[17]	Engaging small firms in sustainable supply chains: Responsible sourcing practices in the UK construction industry.	19

[16]	Briefing: Responsible for sourcing construction products.	17
[21]	Integrating responsible sourcing in the construction supply chain.	13
[2]	Investigation into contractors' responsible sourcing implementation practice.	10
[22]	The sustainable construction business: A missing ingredient in creating a sustainable built environment?	10
[19]	Analysis of responsible sourcing performance in BES 6001 certificates.	9
[23]	Developing a LCA-based tool for infrastructure projects.	7
[20]	The UK construction and facilities management sector's response to the Modern Slavery Act: An intra-industry initiative against modern slavery.	6
[24]	Responsible sourcing of construction products and materials - Results from an industry survey.	3

### 3.3 Top authors

The top three authors on RS in the construction industry include Glass, J, Nicholson, I, Upstill-Goddard, J, and Dainty, A. who co-authored most of their journal papers between 2009 and 2012, with one exception published in 2016. It is noticeable that they have not followed up their research since and have not published since their 2016 articles. Other than these joint publications, there is no other author who has consistently published on this subject. I.e. all others have only published one article.

Table 2: Authors with the most publications

Author	Documents	Citations	Total link strength
Glass J.	9	133	21
Nicholson I.	5	97	14
Dainty A.R.J.	3	32	7
Upstill-Goddard J.	3	25	10
Achour N.	2	22	7
Frost M.W.	2	9	6
Ghumra S.	2	9	6
Parry T.	2	22	7
Watkins M.	2	9	6

### 3.4 Organisation

The data shows that most of the interest in responsible sourcing is from researchers associated with Loughborough University. A review of the publications shows that the authors represented in Table 3 below are connected with documents jointly published with researchers from Loughborough University. Taking institutions with at least two articles, it is clear that there is very limited interest beyond the united kingdom., and outside Loughborough University.

Table 3: Author Organisations

Organisation	Documents	Citations	Total link strength
Aggregate Industries, Leicestershire, United Kingdom	2	9	4
BRE Global Ltd., Watford, United Kingdom	2	9	4
Department Of Civil And Building Engineering, Loughborough University, Loughborough, United Kingdom	2	9	4
Responsible Solutions Ltd, United Kingdom	4	62	1

Responsible Solutions Ltd., Unit 12, The Office Village, North Road, Loughborough, Leicestershire, Le11 1qj, United Kingdom	2	32	0
School Of Civil And Building Engineering, Loughborough University, Loughborough, United Kingdom	2	63	1

### 3.5 Countries

This trend is also observed in Table 4 below. Most of the articles published on the subject are from researchers based in the United Kingdom (15 of the 24), with very little interest outside Europe. The only countries outside Europe, represented in the sample include Australia and the United States.

Table 4: Country of origin

Country	Documents	Citations	Total Link Strength
United Kingdom	15	151	1
United States	3	103	0
Australia	1	0	1
Austria	1	0	1
Germany	1	6	1

### 3.6 Top research outlets (direct citation analysis of outlets)

Our inclusion criteria included articles published in conference proceedings, journal articles and short surveys. It is notable that the of the top four outlets- i.e. those that have published at least two articles, two are conference proceedings. Of the journal papers, there is a lack of consistency in publishing research on RS. For example, ECAM and IJCM have each published one article.

Table 5: Research Outlets

Source	Documents	Citations	Total Link Strength
Concrete (London)	5	4	0
Proceedings Of The Institution Of Civil Engineers: Engineering Sustainability	4	37	8
Association Of Researchers In Construction Management, Arcom	3	22	0
Structural Engineer	2	1	0
Business Strategy And Development	1	6	0
Engineering, Construction And Architectural Management	1	53	4
Glass International	1	0	0
International Conference On Construction In The 21st Century	1	0	0
International Journal Of Agile Systems And Management	1	19	5
International Journal Of Construction Management	1	10	0
Journal Of Environmental Management	1	0	4
Journal Of Operations Management	1	102	0
Metszet	1	0	0
Paper Making And Distribution	1	0	0

### 3.7 Main research areas (co-occurrence of keywords analysis and cluster of research areas)

An analysis of the key research areas represented in the data collected was conducted. Author keywords were used as the basis of the analysis as recommended by [25]. The threshold for inclusion in the results was set at 3, meaning that only keywords which have been used in at least 3 documents would be included. A total of 40 keywords were returned. However, on further analysis, it was noted that only 34 items were connected and therefore included in the analysis. Figure 2 represents a network analysis of the keywords. The strength of the connections is identified based on the size of the nodes, the distance among nodes and connection lines among these keywords. In addition, the clustering of keywords was identified, based on various colours. Keywords with similar coloured keywords meant that they belonged to the same cluster and that they are closely linked to each other.

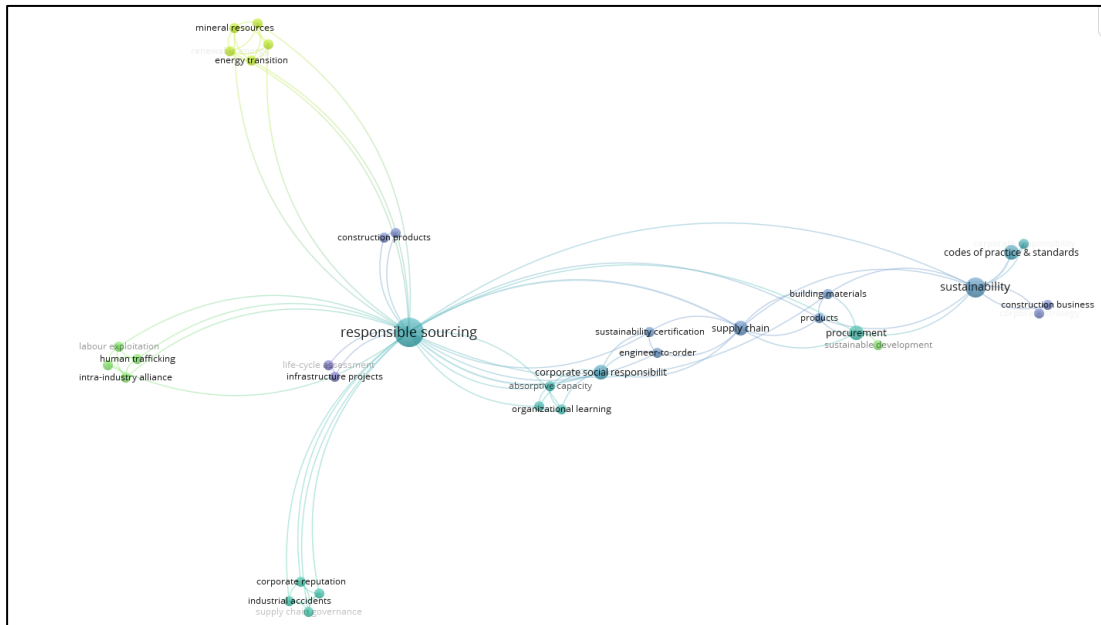


Figure 4: Research areas and clusters

As shown in Figure 2, there are ten main clusters identified by the different colours. However, further review of the clusters suggested a similarity of content and therefore, these were reduced to seven clusters as summarized in Table 6. It is evident based on the size of the nodes and the clusters, that most of the RS research has focused on the general context of RS or a sustainability context. Other research has addressed issues related to supply chain governance, RS in the context of specific building materials and products and RS as a corporate social responsibility issue. It is noticeable, however, that there are research contexts that have received limited attention such as natural resource justice, social justice and supply chain governance. Considering the RS is a growing research area of interest in other disciplines, it is pertinent, that efforts are devoted to this field within a construction industry context.

Table 6: Key Research Clusters

Cluster No.	Research cluster	Key related issues
Cluster 1	Responsible sourcing	Responsible sourcing, Construction products; sustainability indicators
Cluster 2	Corporate social responsibility	Corporate social responsibility, Absorptive capacity, engineer-to-order, organisational learning, sustainability certification, sustainability standards
Cluster 3	Building materials and products	Building materials, products, procurement, supply chain
Cluster 4	Sustainability	Sustainability, corporate strategy, code of practice and standards
Cluster 5	Social justice	Modern slavery, human trafficking, intra-industry alliance, labour exploitation

Cluster 6	Natural resource justice	Natural resource justice, energy transition, mineral resource, renewable energy, resource governance
Cluster 7	Supply chain governance	supply chain governance, corporate reputation, stakeholder reaction to industrial accidents

#### 4 CONCLUSION

The study acknowledges the importance of responsible sourcing as another tool the construction industry can use to enhance its efforts to achieve its sustainability goals. There is evidence that the quest for social, environmental, and economic sustainability is pushing organisations to consider the sustainability impact of their sourcing activities. While there has been research on responsible sourcing in the construction industry, the scale of interest on the subject has not been clear. It was therefore the intention of this study to map research relating to responsible sourcing in the construction to identify, trends, key knowledge contributors, areas of research focus and potential future directions. It is evident from the analysis above, that while the topic received interest from 2009 to 2016, there has been limited research post-2016. Indeed, when the research trends for RS as a general subject are compared to that of the construction industry, the findings show that while in the former there is an increase of publications on the subject from 2013, this is not the same with the construction industry. The reasons for this trend in construction management research are not clear. We call for more research on this research topic considering its importance in helping the construction industry achieve its sustainability target. A review of the keywords also demonstrates some of the potential areas of research. While the focus of the studies on RS has mostly been from a general context, there are other areas in which researchers in the construction industry can focus their attention. We considered that sustainability can be looked at as an ethical issue. Therefore studies on RS from a natural resources justice and social justice context should be considered.

This study adopted a strict interpretation of responsible sourcing. As such the literature search focused on those publications that addressed responsible sourcing in the title, keywords, or abstract. However, we acknowledge that there are other terms, such as sustainable supply chain, green sourcing, or sustainable procurement. However, such terms can be interpreted as being broad or lacking in specificity. Therefore having considered the scope of existing literature, we would encourage others interested in the subject to conduct systematic literature reviews on responsible sourcing in the construction industry to help build a picture of research on the subject.

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