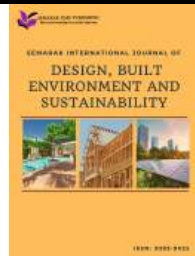




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# A Bibliometric Analysis of The Defects Element and Quality Assurance Implementation Strategies to Reduce Defects in Landed Residential Construction at Johor

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### ABSTRACT

Defects in the construction of residential buildings under land tenure adversely affect performance, customer satisfaction, and asset value, particularly in rapidly developing regions such as Johor, Malaysia. Despite implementing quality frameworks such as ISO 9001 and systematic quality control systems, defects persist during and after the Defect Liability Period, indicating a gap between formal Quality Assurance (QA) practices and their effectiveness. This study explores the evolution of research on construction defects and QA strategies, identifying key themes aimed at reducing these issues. A bibliometric analysis of 58 Scopus-indexed articles published between 2010 and 2025 was conducted using VOSviewer to map trends in publications and citation networks. Four main themes emerged such as Construction defects and quality management; Residential construction performance and housing quality; Defect diagnosis and technical/environmental factors; and Design-construction quality integration strategies. Findings show a steady increase in research output, with a focus on digital inspections, Building Information Modeling (BIM) for quality monitoring, and data-driven QA models. Key issues include weak supervision, non-compliance with materials, poor documentation, and fragmented subcontracting. To efficiently eliminate defects, a systematic, technology-based QA framework supported by ongoing monitoring and defect analysis is recommended. This research highlights the need for a practical, data-driven approach to defect prevention in residential construction.

## 1. Introduction

### 1.1 Research Background

Building failures have been a concerning problem in the world both in developed and developing countries. In most of the fast-growing cities like Johor, the recurrence of defects has been on the rise most especially in the course of the Defect Liability Period (DLP). The cracks, water intrusion,

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electrical malfunctions, and ineffective finishing are the most prevalent complaints that deteriorate structural output and satisfaction of the occupants [1]. Despite the numerous quality management systems that have been developed to monitor the quality of construction like the ISO 9001, QCLASSIC and Total Quality Management (TQM), the frequent repetitive patterns of defects show that these systems are not being properly implemented in-site [2].

The weaknesses linked to the implementation of quality assurance (QA) practices are usually associated with the lack of proper site control, bad workmanship, low design coordination, and low compliance with QA/QC practices [3]. Studies carried out in the residential construction industry in Malaysia have revealed that systemic weaknesses in the inspection procedures, lack of competency among contractors and discrepancies in the supervision of construction processes are some of the main contributing factors of high defect rates particularly in the landed residential developments in Johor [4]. These faults are costly in terms of financial burden in reworking, lack of homeowner satisfaction, and decrease in the long-term value of residential homes [6].

At the international level, construction faults have been identified to be a multi-faceted issue that is motivated by management, technical, and organisational failures. Researchers find the material non-compliance, disjointed communication, and poor implementations of digital quality assurance tools to be among the key causes of defects occurrence [5]. The economic impact of these defects has been estimated to be between 5% to 15% of the total construction costs and rework due to these defects has been termed as an important economic burden to the contractors and developers [11]. The residential housing on land is especially prone to this because it relies on contracting channels and variable levels of supervision [12].

Considering such challenges, efficient QA frameworks are needed in order to reduce non-conformities, enhance the results of construction, and enhance the performance of the assets through the entire lifetime of the buildings. Nonetheless, it has been found that QA systems often fail because of weak enforcement, lack of training, inconsistencies in documentation and lack of traceability [13,14]. Consequently, the fact is that most of the organizations adopt a QA standard like ISO 9001 basically as a compliance tool, but not as a performance-based instrument with effective leadership, constant improvement and organizational culture [15].

## *1.2 Literature Review*

Bibliometric analysis has become an effective tool of mapping research development, defining the significant contributions and tracking down the new trends in the construction management sphere [7]. With the help of such indexed databases like Scopus, bibliometric methods enable researchers to analyse publication trends, co-authorship relationships, occurrences of keywords and citation patterns in a systematic way. These analyses can be improved with visualization software such as the VOSviewer, which graphically represents the relationship between keywords and authors, and allows a researcher to see how the academic interest in defects, QA, and residential construction has changed over time [8].

Themes that have been studied in the previous bibliometric researches include Building Information Modelling (BIM), sustainability, and construction project management. Nevertheless, very little has been done in terms of studying the overlapping of construction defects and QA strategies within residential construction [9]. This is especially wide considering that the Malaysian construction industry, specifically in Johor, has been experiencing problems in defect recurrence, which is a thriving issue in the industry [4].

Defects have always been cited as one of the major causes of delays in projects, lifecycle cost overruns and customer satisfaction by international literature [10,16]. Empirical data indicate that

workmanship failures, inaccurate design, and lack of oversight are the most common causes of defects and residential housing developments are more susceptible as a result of fragmented processes of subcontracting [12]. The results highlight the significance of reinforcing the QA implementation strategies to mitigate the systemic weaknesses and avoid the occurrence of defects.

Even though there are quality frameworks available, there are constraints in the adoption of QA which are noted to persist in literature. In a number of studies, it is stated that QA/QC practices are not always followed regularly because of the lack of training, standardization, enforcement, and loosely coupled design and site work [13]. In addition, documentation flaws and ineffective traceability systems do not allow exposing defects until late construction phases, adding to rework and project risk [14]. Although a framework like ISO 9001 provides systematic leadership, it depends on the dedication of the leadership, organizational culture, and the sufficiency of resources [15].

Considering such findings across the world, the current study will undertake a bibliometric review of the publications pertaining to construction defects, defect management and QA strategies in residential construction between 2010 and 2025. The analysis based on the literature indexed on Scopus and visualized with VOSviewer helps identify key themes of research, authors with the most impact, keywords leading the field, and thematic clusters. Such insights are then put in context to the Malaysian environment of the landed residential construction business and these form part of the improvement of optimal quality assurance measures related to defect reduction in the Johor.

Defect Element is an important established concept in enhancing the Quality Assurance (QA) application in the residential construction sector to allow the systematic identification of the non-conformity and performance gap. Through categorizing defects according to their elemental causes, which include structural defects, architectural, material or building services organizations can identify root causes with greater precision, as opposed to treating symptoms as noted on the surface [17]. This analytical exercise is useful in enhancing efficiency in the inspection and supervision because trends in defects assist the QA teams in prioritizing high risks building components and trades that should be monitored more stringently [18]. The literature also indicates that data on defect elements allow the continuous improvement of QA processes, such as the tailoring of acceptance requirements, site checklist and workmanship standards depending on the actual performance of the construction work [19].

Moreover, the information on the location of the defects can be used to guide focused training to the contractors, supervisors and site operatives, which improves the level of skills in defect-prone tasks, and minimizes the chances of workmanship failure recurrence [20]. The Element-based analysis also enhances the control and procurement decision in the supply chain when the defect pattern can be associated with a particular material or subcontractor [21]. Finally, defect element analytics in the context of QA leads to data driven decision making, facilitating long term improvement efforts and reducing the lifecycle costs through reduced rework, warranty and maintenance overheads [22]. Therefore, it is clear that this defect element provides great benefits in the context of QA, where it helps in reducing the complexity often encountered in buildings when dealing with existing structures, as outlined in Table 1.

**Table 1**  
Benefits of defect element in the QA context

No	Benefit in Defect	References
1	Root cause identification	[23],[24]
2	Targeted inspection & supervision	[25],[26]
3	Development of Data-Driven QA procedures	[27],[28]
4	Workforce competency enhancement	[29],[30]
5	Strengthened material & supplier control	[31],[32]

6	QA benchmarking & continuous improvement	[33],[34]
7	Compliance with audit & certification requirements	[35],[36]
8	Reduction in lifecycle cost & rework	[37],[38]
9	Digital integration & predictive QA	[39],[40]

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In short, the defect element analysis offers a professional support of the enhancement of the Quality Assurance practice in residential construction by allowing clearer identification of root causes, more specific inspection activities, and refinement of QA practices on the basis of evidence. The knowledge acquired during the defect trend analysis is also applicable in competency improvement, supply-chain management and continuous improvement projects, as well as the reduction of lifecycle costs in terms of rework and non-conformities. In general, the defect element analysis is a crucial element of proactive QA implementation, which encourages the increased standards of the construction performance and benefits the overall quality of the created assets in the long run.

Based on the literature above it is clear that a systematic synthesis of literature being done currently is required in bridging the gap between the strategies of defect diagnosis and QA implementation. Hence, the proposed study will attempt to provide an extensive bibliometric review of Scopus-indexed references published between the years 2010 and 2025 on the topic of construction defects and Quality Assurance measures in residential construction. In particular, it is planned to (i) examine the trends in the growth of publications, (ii) define the most powerful authors and citation patterns, (iii) visualize thematic clusters and network of keyword co-occurrences, and (iv) figure out the new research directions that can aid in the implementation of defect reduction strategies. The research results are supposed to provide a theoretical and practical input to the enhancement of the QA framework, prevention of defect management, and future research directions in the form of more systematic and data-driven quality assurance application in landed residential construction.

## 2. Methodology

### 2.1 Bibliometric Analysis with VOSviewer Visualization

Bibliometric analysis is a programmed the gathering, systematizing, as well as investigating bibliographic data based on the scientific publications to recognize research patterns, intellectual frameworks, and thematic progressions in a given field. In this work, VOSviewer, a specific software that was used to create co-occurrence networks, clustering patterns, and relational between key words, authors, nations, and citation paths, helped to analyze the data [41]. In this way, an overall visualization map of the data was created, which allows more profound interpretation of areas of knowledge and research focus [42]. The visual mapping involved some of the most sophisticated analysis methods, such as co-citation analysis, keyword frequency mapping, and descriptive statistics based on source journals, publication dates, and authors who made the largest contribution [43].

In addition, bibliometric analysis is a very systematic process that is carried out in cycles and requires a selection of reasonable search strings, and follows with a systematic literature screening process to guarantee relevance and accuracy of data. It involves a cautious choice of the keywords, critical analysis of the published works, and the critical evaluation of research findings [44]. The cycles confirm the reliability of the data and, as a result, provide the opportunity to construct an extensive bibliography, which can be characterized by its maturity, density, and evolution [45]. Finally, the rigor of the bibliometric procedure generates credible and significant analytical results, which validate the

research stronger interpretations, finding the possible gaps, and forming a reliable basis of the upcoming studies in the chosen field [46].

## 2.2 Publication Dataset

Within the framework of this research, a high-impact scholarly article is narrowed down as a bibliometric search because, in this way, one can grasp the theoretical backgrounds, conceptual dynamics, and methodological trends that define the direction of knowledge in the sphere of construction defects and Quality Assurance (QA) practices. In order to ascertain the data authenticity, comprehensiveness, and citation reliability, the SCOPUS database was chosen as the main source to extract the bibliographic. The comprehensive indexing of peer-reviewed publications, standardized metadata structure, and analytic strengths that SCOPUS has is well known to provide considerable benefits to bibliometric research that needs the correct citation mapping and publication data [47].

Based on this database, the systematic bibliometric review was carried out to investigate the volume of research, development of themes, and the academic development associated with the elements of defects and their correlation with effective QA implementation strategies in residential construction [48]. In addition to identifying the frequency of the publications, the analysis was carried out to identify existing intellectual themes, trends of collaboration between authors, sources of publications, and interdisciplinary connections that lead to the cumulative formation of scholarly discourses on defect causation, management systems, and quality assurance prevention models. With the help of advanced search capabilities of SCOPUS, narrow and focused filtering of the literature was made possible, thereby limiting selection bias and helping to uphold methodological rigor of the screening process.

The keywords search strings were well-designed and implemented with field code functions, phrase searching, truncation, wildcard symbols, and Boolean operators as shown in Table 2. These search techniques enabled extensive data mining to identify useful publications on titles, abstracts, author keywords and thematic descriptors. The systematic refining of the keywords was done to ensure that only a literature that met the objectives and scope of the research was represented in the final dataset. With such an organized and clear search plan, the bibliometric dataset obtained will be in a good position to reflect the depth and scope of research in the discipline hence enhancing validity, transparency, and reliability of the results presented in this study.

**Table 2**  
 The search strings

Database	String
Scopus	TITLE-ABS-KEY ( "construction defects" OR "housing defects" OR "building defects" ) AND ( "quality assurance" OR "QA implementation" OR "quality management" OR "quality improvement" OR "quality control" OR "QC" ) AND ( "residential construction" OR housing ) AND PUBYEAR > 2010 AND PUBYEAR < 2025 AND ( LIMIT-TO ( PUBSTAGE , "final" ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) )

Besides, the ultimate inclusion of publications in this research was also determined by a list of eligibility criteria, which were listed in Table 2. These inclusion parameters were aimed at giving

relevance, maturity, and methodological strength of the bibliometric dataset. Based on the principle of maturity of the research field, the screening was limited to the articles that were published in the years 2010-2025 [49]. Such time frame was selected to accommodate the current research advancement, reflect the changing practices in the construction, and capture the latest advances in the discussion of defect elements and quality assurance application. Based on the fact that empirical publications involve original results obtained after interpreting primary data, the review prioritized journal articles which implemented empirical methodologies, such as case studies, surveys, field studies, and statistical modelling since these types of evidence provide more information on what is really happening in the construction performance and QA practices.

Moreover, the publications were limited to only those in English to ensure that there is clarity and that the same interpretation of findings was used in the research, and to shun inconsistencies that might otherwise be brought about by translation or by differences in the meanings of various languages. The screening process helped the authors to select only very much aligned and contextually valid contributions as the data were narrowed down to specific research areas, authors, years of publication, types of documents, and other pertinent features of the desired data. Such a form of filtering not only helped filter out the unnecessary dilution of the bibliometric outcome, but it also facilitated the extraction of the core of the research findings, the main thematic groups, and gaps that should be considered in the future scholarly focus. In the end, such screening criteria contributed to the topicality, correctness, and analytical rigor of the bibliometric results as the final sample of research materials included the largest extent of academic validity and thematic coherence in the context of defect element analysis and QA implementation in residential construction.

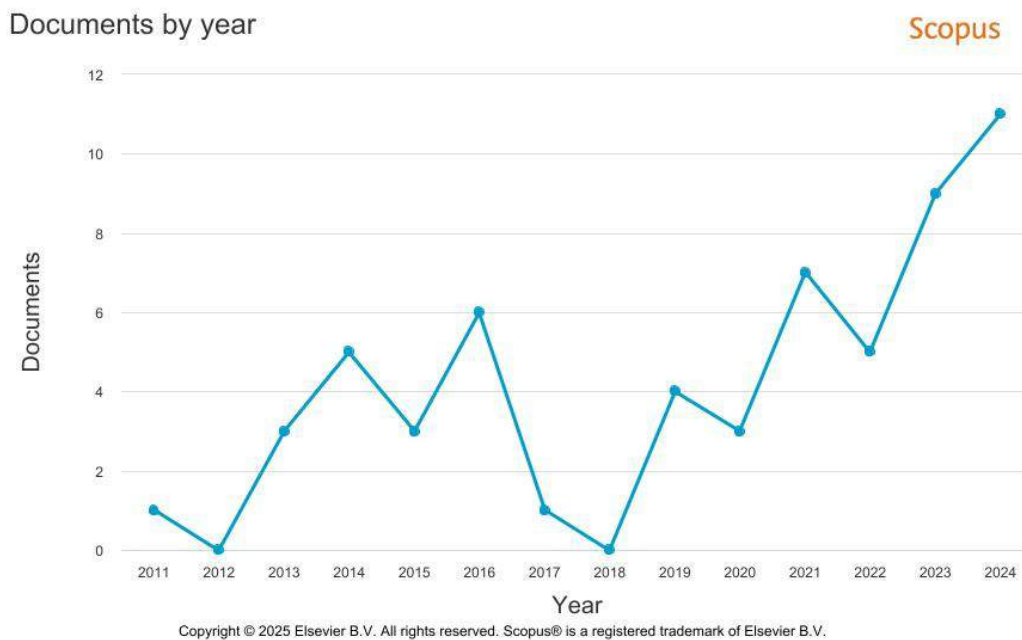
**Table 3**  
The inclusion and exclusion criteria

Criterion	Benefit in Defect	References
Timeline	2010-2025	<2010
Document Type	Articles	Conference Paper. Review. Book
Language	English	Non-English
Publication	Final	Article in press

## 4. Result and Discussion

### 4.1 Research Patterns Based on the Publication Year

Figure 1 shows distribution of 58 Scopus-indexed publications between 2010 and 2025 with an overall steady and increasing growth in research activity with the most significant rise in the last five years. The trend indicates an increasing trend in the level of publication since the first records in 2010, up to the highest point of 11 publications in 2025. The positive trend represents the growing academic interest in the topic under consideration and indicates a growing interest in the research among the academic and professional circles. The trend also suggests that inquiries that are related to this discipline are currently under maturity and that they probably will continue to be a major research priority in the likely future.

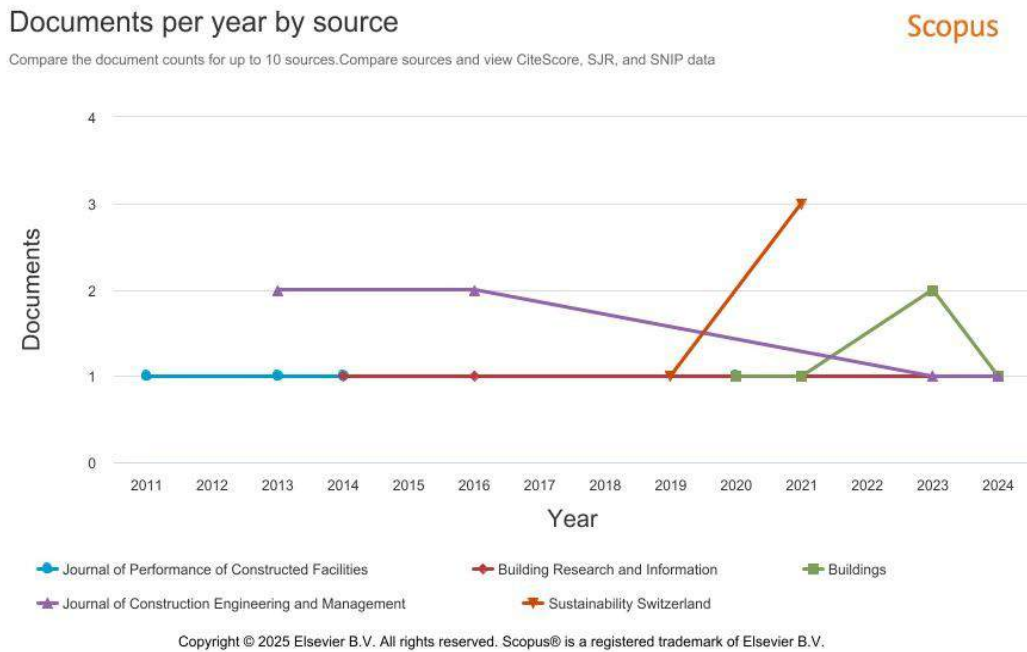


**Fig. 1.** Number of publications by years 2010-2025

#### 4.2 Number of Documents Published by Sources and Authors

As shown in Figure 2, the number of publications per journal source in 2010- 2025 indicates the level at which the study of the chosen subject was spread in various established academic sources. The general pattern of publication is not very high, as the majority of sources publish one or two documents annually. Nevertheless, minor differences can be traced during the period. The stable contribution trend is also demonstrated in journals like the Journal of Performance of Constructed Facilities and the Journal of Construction Engineering and Management, which have always been being present throughout the years. In the meantime, the sources like Sustainability Switzerland and Buildings show an increased interest in the subject, and the number of documents starts increasing around 2019. It is important to note that the highest increase is registered in Sustainability Switzerland where the number of documents has been increasing to its maximum in 2021, after which it has been decreasing.

These trends suggest that the research insight into the areas of construction performance, quality of the buildings, and sustainable development has been receiving a growing momentum in the past few years in the multidisciplinary journals. The increase in the contribution of the sustainability-focused sources can also indicate the alteration in the interest in the inclusion of the environmental and performance-based factors in the construction quality, defect management, and quality assurance research. Although the overall quantity of publications is rather small, the distribution of indexed articles in the technical, engineering, and sustainability-related journals indicates the increasing acknowledgement of the topicality of the topic across the wide area of construction research. The implication of this trend is that the topic is still open to research, and it might be possible to study it further through several academic shelves in the future.



**Fig. 2.** Number of publications by sources

Table 3 provides the top ten most-cited authors whose works contribute majorly to the study of elements of defects, and Quality Assurance (QA) in residential construction. The citation distribution shows that there are several highly influential contributors and there is a great concentration of publications by authors who have continually studied on the causes of defects, defect classification, risk-based evaluation, and after-sale quality implications. The most common and most referenced names seem to be the authors who have published multiple articles in the subject and this reflects productivity as an author as well as lifelong commitment to the research of construction defects. The most significant of them are related to the taxonomy of defects, the comparative analysis of pre- and post-handover defects, and systematic methods of detecting defect risks in residential buildings. The number of citations, 15-79, evidences that these studies have been frequently cited by the later studies, which indicates that the given methodology is relevant and its contribution to the overall body of knowledge is significant.

Another key point that the table helps to understand is the variety of research topics that underlie the modern academic literature, such as quantitative diagnostic model, fault-tree analysis, prioritization of defects types, and the role of digital technologies, including BIM and natural language processing in improving defect detection and evaluation. Moreover, the prevalence of the studies which discuss the defect liability systems, the performance of the construction works, and the post-handover assessment, indicates that the quality assurance in the construction process, as well as operation, of residential properties, is still a concern. The fact that multidisciplinary contributions exist, that include the technical engineering, quality management and the data-driven defect modelling, implies that the area under study is still developing to more systematic and evidence-based defect prevention methods. Generally, the citation profile presented in Table 4 is not only an indication of the scientific maturity of the research area, but also a basis of intellectual leadership defining the present and future trends of the defect-related quality assurance research in residential construction.

**Table 4**

Top 10 most-cited authors on defect element in quality assurance context

No	Authors	Title	Cited by
1	Forcada et al.,	'Handover defects: Comparison of construction and post-handover housing defects'	79
2	Forcada et al.,	'Standardizing housing defects: Classification, validation, and benefits'	66
3	Forcada et al.,	Assessment of construction defects in residential buildings in Spain	66
4	Aljassmi et al.,	Analysis of causes of construction defects using fault trees and risk importance measures	56
5	Forcada et al.,	Post handover Housing Defects: Sources and Origins	79
6	Lee et al.,	LDA-Based Model for Assessing the Defect Liability System in Residential Buildings' Maintenance Phase	6
7	Aljassmi et al.,	Analysis of causes of construction defects using fault trees and risk importance measures	56
8	Biel, S.	Concept of using the BIM technology to support the defect management process	10
9	Piggot-Navarrete et al.,	Investigating the impact of construction workmanship defects on the hygrothermal performance and airtightness of lightweight-structure wooden envelope systems	16
10	Shooshtarian et al.,	Application of natural language processing in residential building defects analysis: Australian stakeholders' perceptions, causes and types	15

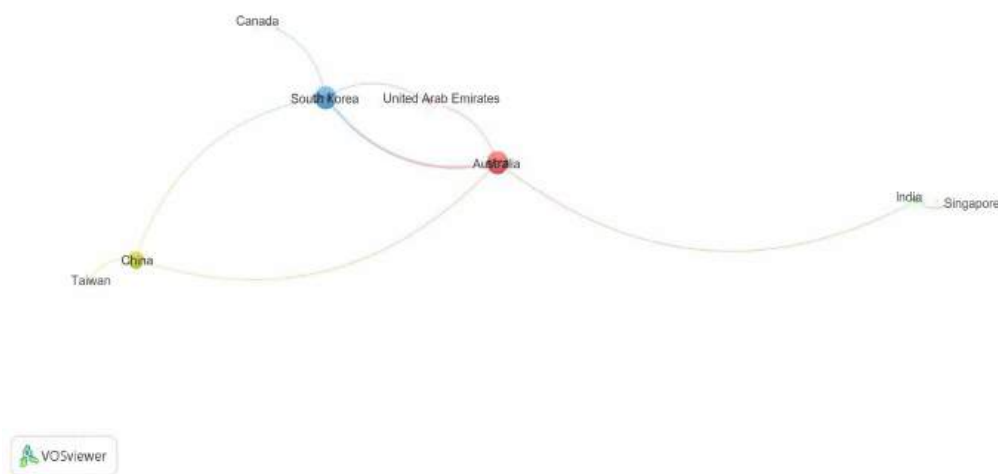
#### 4.3 The Co-authorship Countries' Collaboration

Figure 3 illustrates the country co-authorship network derived from the bibliometric dataset by VOSviewer, showing the publication distribution, citation influence, and collaborative linkages among the contributing nations. The network highlights South Korea as the most prominent contributor in terms of publication volume and citation strength (495 citation), indicating that the country has produced the highest number of indexed documents (13 document) within this research scope and accumulated the largest citation count overall. Its sizeable node and multiple link paths demonstrate an active role in cross-institutional collaborations, particularly with Australia, China, and the United Arab Emirates, suggesting a strong academic foundation and visible research contribution to studies on construction defect elements and Quality Assurance.

Australia appears as the second-strongest contributor, recording a moderate number of publications (13 document) but notable citation frequencies (336 citation), implying impactful research output despite a comparatively smaller document count. Its collaborative connections with South Korea and China indicate ongoing international partnerships that support knowledge transfer on defect causation, inspection systems, and QA implementation strategies. China is another important contributor (2 document), reflected through its node size and citation performance (222 citation), signifying a steady research presence across defect classification, workmanship

investigations, and failure diagnostics. Although Taiwan also appears in the network, its limited node size suggests fewer indexed documents and lower citation counts relative to the core contributors.

In contrast, regions such as Singapore, India, Canada, and the United Arab Emirates show smaller bibliometric footprints, with fewer publications and modest citation numbers. Their presence, however, reflects emerging research participation and potential expansion of scholarly interest in the thematic areas of QA compliance, building quality, and post-handover defect management. Overall, the structure of the co-authorship map demonstrates that the field is led by a small cluster of highly productive and highly cited countries, supported by a secondary layer of developing contributors. The increasing cross-regional collaboration signifies that defect-based QA improvement is gaining international research relevance, while the concentration of output among a few countries suggests opportunities for broader global integration and future research diversification.



**Fig. 3.** The global landscape of co-authorship countries' collaborative research on defects element in quality assurance context

#### 4.4 The Keyword Co-occurrence Analysis

In order to further investigate the intellectual composition and thematic focus of research in this area, a key co-occurrence study was arranged with the help of VOSviewer, which was done on the entire range of 339 documents indexed at Scopus. This analysis aimed to find the most commonly used words and how they can be interconnected in the context of the overall academic discussion of the topic of construction defects and Implementing Quality Assurance. Following the synonymization of keywords and the removal of low-frequency words, 62 keywords with the minimum frequency requirement were saved in co-occurrence mapping, as shown in Figure 4.

The most dominant keywords are shown in Table 4, with the most frequent one being defects (35 times; the link strength is 117), construction defects (23 times; the link strength is 79), quality control (19 times; the link strength is 72), and housing (16 times; the link strength is 61). The salience of these keywords supports the claim that studies in this area have majorly been focused on coming up with defect causations, gauging the consequences of defects in residential construction and the efficacy of the control mechanisms through QA in controlling non-

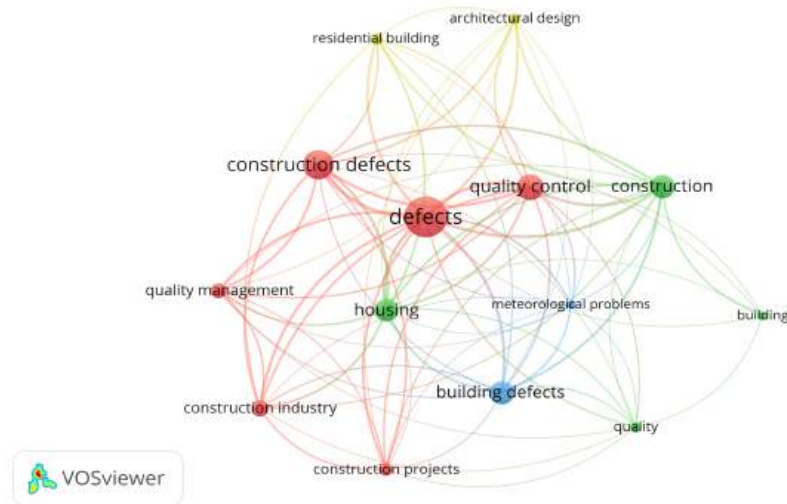
conformities. The other regularly used terms like building defects, quality management, building industry and building projects also indicate the on-going academic interest in systematic defect assessment, quality performance at an industry level and the management-related reaction to the re-emergence of defects.

The emergence of the keywords that reflect design features and environmental factors such as the architectural design, meteorological problems, etc., means that the aspect of more comprehensive contextual factors that can cause the development of defects is recognized, which does not necessarily arise due to the workmanship-related issues. All in all, the distribution and the strength of the connection between the top ranking keywords demonstrate a logical and developing research agenda about defect diagnosis, quality compliance, and strategic preventive actions. This confirms the applicability of defect element analysis as one of the fundamental pillars of the development of QA systems and enhancement of construction performance in the residential building industry.

**Table 5**  
 Keyword used in previous research according to VOSviewer analysis

No	Keyword	Occurences	Total link strength
1	Defects	35	117
2	Construction defects	23	79
3	Quality control	19	72
4	Housing	16	61
5	Construction	17	59
6	Building defects	17	47
7	Construction industry	11	46
8	Quality management	10	35
9	Residential building	7	34
10	Construction projects	8	32
11	Architectural design	6	26
12	Meteorological problems	5	23
13	Quality	6	17
14	Building	5	9

Moreover, the theme mapping study as a part of the study context represented in Figure 4 supports the results of Table 4 by visualizing clusters as well as relationships between frequently used terms.



**Fig. 4.** The outcomes of the research theme mapping conducted with VOSviewer

According to the analysis of the keywords co-occurrence, the thematic mapping shows that the research on the aspects of construction defects and Quality Assurance application is a growing and well-developed sphere of academic research. The visualization of the network shows that there is a significant correlation between various thematic clusters that are predominant, specifically, those linked to assessing defects, quality control systems, residential construction performance, and design-related determinants. The thematic links imply that current studies do not discuss defects on their own, but rather combine the multidisciplinary approach that incorporates the management of construction quality, considerations of design, and performance assessment. These main research themes and their connection are described in more detail in Table 5 that outlines the main conceptual domains that are represented in the analyzed data.

**Table 6**  
 Four key themes associated research on defect element in quality assurance

No	Key Theme	Detail	Explanation
1	Construction Defects & Quality Management Practices	Concentrates on repetitive errors in construction, quality management systems (ISO 9001, QCLASSIC), and on quality control/quality assurance.	This theme brings out the main theme of defects in construction where the poor implementation of QA, low workmanship, low supervision, and poor documentation depict high non-conformities. Studies within this topic address the importance of the structured QA systems, inspection processes, and standardization to minimize the defect and improve the quality results.
2	Residential Construction Performance & Housing Quality	Discusses the issues connected with the quality of buildings, residential structures, housing flaws, and generally the performance of the housing units.	The theme will deal directly with the effects of defects on the satisfaction of homeowners, performance of buildings, and post-handover. It explains the design issues and construction faults, environmental issues, and gaps during maintenance as it affects the quality of housing. Studies highlight the necessity to enhance QA surveillance throughout the lifecycle of the landed residential construction.

3	Defect Diagnosis, Building Defects & Environmental/ Technical Factors	Building defects, meteorological problems, inspection problems, defect classification and diagnostic techniques are included in this.	The studies under this theme examine the underlying causes of defects other than that of workmanship. It consists of environmental factors (humidity, weather conditions), failures of ground floor systems, and diagnostics devices (fault-tree analysis, classification systems). Such studies allow the QA staff to find high-risk factors, learn defect patterns, and come up with specific supervision approaches.
4	Design, Construction Projects & Quality Integration Strategies	Contains architectural design, construction projects, construction industry practices, and integration of QA in project delivery.	The focus of this theme is on the design-construction interface paying particular attention to the level of defects impacted by the design coordination, architectural detailing and planning the quality of projects. It has been discovered that repetition of errors is caused by insufficiency of co-ordination between the design teams and the operations at the site. This theme promotes the need to have a more successful QA integration, digital inspection tools, and quality leadership on the project level.

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In short, the growing number of research publications and their range of knowledge varieties highlights the strategic necessity to pursue the ongoing knowledge improvement in an effort to enhance the Quality Assurance (QA) activities and minimize the defect rates in residential buildings. The results indicate that there are a number of gaps that should be filled in future studies and industry programs. Enhancing national guidelines on digital quality management- especially the adoption of Building Information Modeling (BIM) to identify the presence of defects, coordination, and documentation is very important. Clarity of the regulatory rules, harmonization of the contractual requirements and systematic framework of the BIM-based evaluation scheme with its goals, Key Performance Indicators (KPIs), regular monitoring and feedback mechanisms would be necessary to provide the continuity of improvement and accordance to the project quality objectives.

Additionally, the implementation complexity could be reduced with the assistance of government support in the form of policy requirements, monetary incentives, or subsidies, which will motivate more organizations to adopt digital QA tools in the industry. Parallel activities also need to facilitate systematic renovation and rehabilitation of the existing residential structures to enhance building structural integrity, reduce defects in the long run period, and improvement in the overall building performance. These preventive and corrective purposes have more environmental, economic, and social benefits than complete rebuilding and are beneficial in saving the built environment. These recommendations will help the building industry to move towards a more effective, resistant to defects, and future-grounded quality assurance system.

#### 4. Conclusions

To sum up, the bibliometric analysis indicates that the research interest in the study of construction defects and Quality Assurance (QA) implementation in the context of the residential construction steadily increased and grew since 2010. This trend indicates the growing acceptance of defects as a factor of critical performance concern on the outcomes of projects, customer satisfaction and long-term viability of residential properties. The increase in the publication activity is also in line with the worldwide endeavour to enhance the quality management practices, enhance defects prevention, and introduce more systematized and data-based QA into the process of construction.

The findings also outline the growing application of digital tools, including BIM-based inspection systems, automated quality control, and data analytics, which become more significant in improving the detection of defects, supervising tasks, and decision-making. These changes suggest a definite industry shift and a move toward more proactive systems of technology-enabled QA with the objective of reducing non-conformity and enhancing the performance of the construction. In general, the scientific accumulation of information is emphasised as a strategic method of improving the effectiveness, resilience, and quality of the residential construction industry.

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