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Review

Understanding the Key Quality Factors in Construction Projects—A Systematic Literature Review

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Abstract: Project management frameworks describe the preferred approaches to project quality management, as well as applicable methods and tools. Despite this, quality problems in the construction project are still widespread. This study aimed to identify crucial quality-related factors in construction project management and find relations between them, to help researchers and project managers better respond to quality issues. A systematic literature review (SLR) was used to identify previous studies on quality-related factors. Literature review and further quantitative analysis revealed that quality-related factors are related to three categories: Quality of project process, quality of organisational processes, and quality of results (products), which together create the quality of the whole construction project. The results highlight quality-related factors (14 related to the quality of processes, 6 to quality of an organisation, and 13 to quality of products) that should be taken into account in further research, as well as planning and executing construction projects. Their inclusion at the planning stage should help project managers, sponsors, and steering committees avoid or minimise quality-related problems. Moreover, this study sheds an interesting light on quality. We found that the quality of processes and quality of an organisation has precedence over the final product quality. Based on the results of the study, structural equation modelling (SEM) was used to create a null model that will be the starting point for further research in the construction enterprises.

Keywords: quality management; project management; systematic literature review; factors

1. Introduction

Construction companies have to improve their competitiveness continuously, in order to achieve success in the market, and it is possible mainly through better performance of construction projects. For many years success of that kind of project was associated with high-quality material products. In recent years that approach was also extended to accompanying services. For example, the Standish Group report defines the project's success as delivering some construction and customer satisfaction and high return on value to the organisation [1]. According to that report, only 14% of projects are successful, 67%—challenged, and as much as 19% are unsuccessful.

Nowadays, the majority of standards are oriented on procedures and processes such as PRINCE2 and MSP by Axelos, PMBoK by PMI [2–4]. Furthermore, there are many studies about project management, quality management, process, project life cycle, project products, and stakeholders requirements in the literature. Even though there is a vast spectrum of literature written on project

management (PM) standards [5–7], there were only a few research results concerning the relations between them. Some studies on project management are analysed from the international perspective of project management development. Modern project management processes have to be adaptable, and an experimental approach to the project cycle should be taken in many cases. The current project management practice is questioned in the scientific literature on project management due to insufficient effectiveness and efficiency. Authors offer new approaches to processes combining empirical research with theoretical insights. The business environment becomes complicated, and rapid changes require a creative approach to project management processes [8,9]. The other literature trend highlights the impact of the quality management system on cost-saving and making processes more efficient [10,11]. Multiple authors refer to the life cycle management's significant role in the construction, project quality management (as a general idea), cost management, and schedule management [12]. Important areas of study in construction project management are the wastages and defects during work, which are caused by low quality. Up to 40% of the poorly managed construction enterprise's revenues can be spent on low quality. Studies suggest that the teamwork and the implementation of quality management systems could help lower those costs [13].

In project management, the quality of results should be treated as a relation between the requirements and needs of customers and what was delivered by the project team [14]. To fully understand that relationship, the delivery should be treated and analysed as a process, including its dynamics, not only as a static element.

Many factors related to the external environment and the company's internal units affect any modern enterprise performance. For a long time, the compliance of products with technical documentation and contractual specifications has been considered sufficient for their quality. In the same manner, the fulfilment of project requirements should result in high project quality. However, the modern approach to quality issues led to the finding that the project's final quality is often determined not only by the sole results, but also by how those results were achieved. Ron Basu defined three aspects of project quality: Product quality, quality of management processes, and quality of the organisation, i.e., leadership, skills, and communication [15]. Therefore, every company and project team needs to improve the efficiency and effectiveness of processes to respond correctly and promptly to changing market challenges [16]. In the case of projects, one of the ways it can be achieved is by implementing and improving the quality management process [17]. There are multiple studies on the implementation and improvement of quality management in organisations and projects. However, they are not clear about evaluating the impact of the quality on final project results. Some authors have proposed measures. However, to this date, there was no systematic approach to the measurement of the relationship between project quality management and project results quality. For example, Duskocil and Lacko identified sustainability project's critical success factors [18], while Wu, Zhao, and Ma described factors related to green construction management [19]. The most advanced approach was proposed by Wang et al., who used the European Foundation for Quality Management (EFQM) model criteria to evaluate construction projects from the maturity point of view [20]. Later on, Vukomanović et al. [21] proved that the EFQM model's criteria weights do not entirely correspond with how quality is achieved within the construction processes (mainly in projects) and how the end-user and society perceive it. Therefore, it remained unclear how quality is conceived and delivered within construction project-oriented processes. Ljevo, Vukomanović and Džebo [22] found the relation between quality factors of the project management process and products throughout the definition and planning projects phase. Still, it did not include the organisation's quality factors, but only the project ones, not considering the influence of organisational factors.

Earlier studies and the literature review show that the quality of the final project product can be monitored through the organisational and processual quality factors. Finding relations between those factors can help project managers to identify a potential quality problem at the early stage of project implementation. The authors found no previous SLRs on quality-related factors in construction project management as a significant gap in the current body of knowledge. The lack of a systemic approach to

hidden quality factors prevents decision-makers from making decisions with full awareness of their effects. It can also lead to fragmentary analyses that do not explain the essence of the construction industry quality problems. Given this background, the SLR is an essential and necessary step allowing to complete understanding of the field of study. The study should help answer the following questions:

- What are the quality-related factors identified covering issues of quality management in construction projects?
- What are the relations between factors of organisation, project and product?

According to this, we defined the following objectives:

- Identification of quality-related factors in construction projects present in the literature and their grouping.
- Comparison of the obtained results by reviewing the literature and previous studies of the authors.
- Construction of the preliminary model showing assumed relations between groups of factors.

This study contributes to the field of project management and quality management in several ways. First, we provide critical long-term analysis of previously published papers. As we found no previous SLRs on quality management in project management published in recognised journals, the results of our research can be used by other authors as a starting point for more in-depth analyses of this field of study. Second, we present organisational, processual, and product-related quality factors essential in construction projects. Quality is often associated with project managers and even researchers with the final results of the project. Third, we offer a framework for quantitative studies on relations between those factors. Furthermore, the results of this study can be used as an input to further development of process-based project management standards, such as PRINCE2 and MSP by Axelos, PMBoK by PMI. This study serves on the one hand as a presentation of partial results, but on the other, it opens a discussion that will help authors to improve the next stage of the research project.

Its results will help participants' different managerial perspectives from investors, project managers, designers, consultants, contractors, supervisors in construction projects to understand the organisational, processual, and product-related quality factors more clearly.

Finally, the study adopts the post-positivist position of critical realism, where the reality exists independently of the researcher. The interpretation of the nature of reality requires the researcher to recognise and minimise biases [23].

The paper is organised as follows. In the next section, we present steps of an SLR methodology. We present a descriptive analysis that covers identified regularities and trends in studied papers. After that, we present the results obtained through the analysis and compare them with the previous author's study. Then we present preliminary null scanning electron microscopy (SEM) model that results from this study.

2. Sources and Methods

2.1. Systematic Literature Review

SLR is an exact and reproducible method for identification, evaluation, and interpretation of predefined fields of study. Researchers use it for summarising previous studies, as well as establish a framework for future research [24,25]. The approach is particularly suitable when the analysed subject is fragmented across fields of study, as in quality management in construction project management [26].

The literature review process is performed according to predefined steps and search strategy, which increases transparency, reproducibility, and quality of results. That can be further improved using a standardised approach proposed in PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The PRISMA statement consists of a checklist covering all critical issues that should be reported and a flow diagram that presents the research procedure [27]. The paper adopts the PRISMA statement to avoid errors and bias and provide high-quality results.

2.2. Research Procedure

The SLR approach is consistent with suggestions made by [26]. It is compatible with PRISMA method and includes the following steps:

- identification of studies,
- title, abstract and keywords screening,
- full-text screening,
- analysis of included papers,
- definition of a null SEM model,
- discussion of the results and their comparison with previous research.

In the first step, the search criteria were established and applied. The search was limited to peer-reviewed papers in English that were published in recognised journals or proceedings listed in Scopus or Web of Science databases. These databases provide complementary bibliographic information. Additionally, a snowball approach was applied in step three. As no SLR that integrated the findings on quality management in managing construction projects was performed, we decided to adopt a long-term approach. The oldest paper found was published in 1983 and the latest in 2019. The search rule applied to titles, abstracts and keywords were: “project management” AND “quality management”. Due to the way the databases work, that rule also covered: “quality” AND “project management” as well as “quality management” AND “project”. No further criteria were defined to limit the impact of classification errors in the databases, which increased effort in the following steps, but at the same time, it increased the quality of results.

The screening was divided into two stages. In stage 1, the authors focused on the relevance of papers. The adopted criterion was raising the topic of quality management in project management. Even though the keywords “quality management” and “project management” were defined in the papers. They were used in some cases despite a faint relationship with the content. In stage 2, the authors focused on fields of study covered in the papers.

Both stages of screening were performed using spreadsheets and data imported from databases in CSV files. Apart from default fields offered by Scopus and Web of Science, e.g., authors, title, year of publication, source title, abstract, keywords, additional codes were defined to help achieve the objectives of this study. These include industry, country, used methodology, number of objects in research, project management category, quality management category, described methods, findings, identified gaps, and quality factors related to organisation, process, and product.

In the next step, papers were read, and screening was performed based on the full-texts of papers. Full-texts were downloaded from databases authors were eligible to (EBSCO, Science Direct, Emerald, JSTOR, Wiley, and Academia, Research Gate, Google Scholar). The whole process is presented on Figure 1.

This study leans on the prior research the authors did in Croatia, Bosnia and Herzegovina. Through the questionnaire, the participants evaluated factor’s importance according to the Likert scale, 154 professionals contributed to the final list of quality factors at different project stages. Further information about the research can be found in the paper analysing the significance of critical quality factors for the management of construction projects [28].

The last step of this study was defining a null SEM model, which is an entry point for the following parts of the research project mentioned above. SEM is defined as a statistical approach that takes a confirmatory approach to the analysis of structural theory [29]. Based on this approach, the studied phenomenon can be conceptualised more clearly by highlighting causal relationships between its parts. The results can be tested, and the consistency of the model can be determined. Like some other multivariate techniques, SEM is not limited to the analysis of only a single relationship at one time. It provides a mechanism for the simultaneous examination of multiple dependent relationships [30]. SEM was already used by researchers studying factors affecting quality, e.g., S. Hussain et al. studied factors affecting the quality of social infrastructure projects [31]. That approach has some limitations.

However, the authors strive to overcome them by using a set of different quantitative and qualitative methods throughout the whole research project.

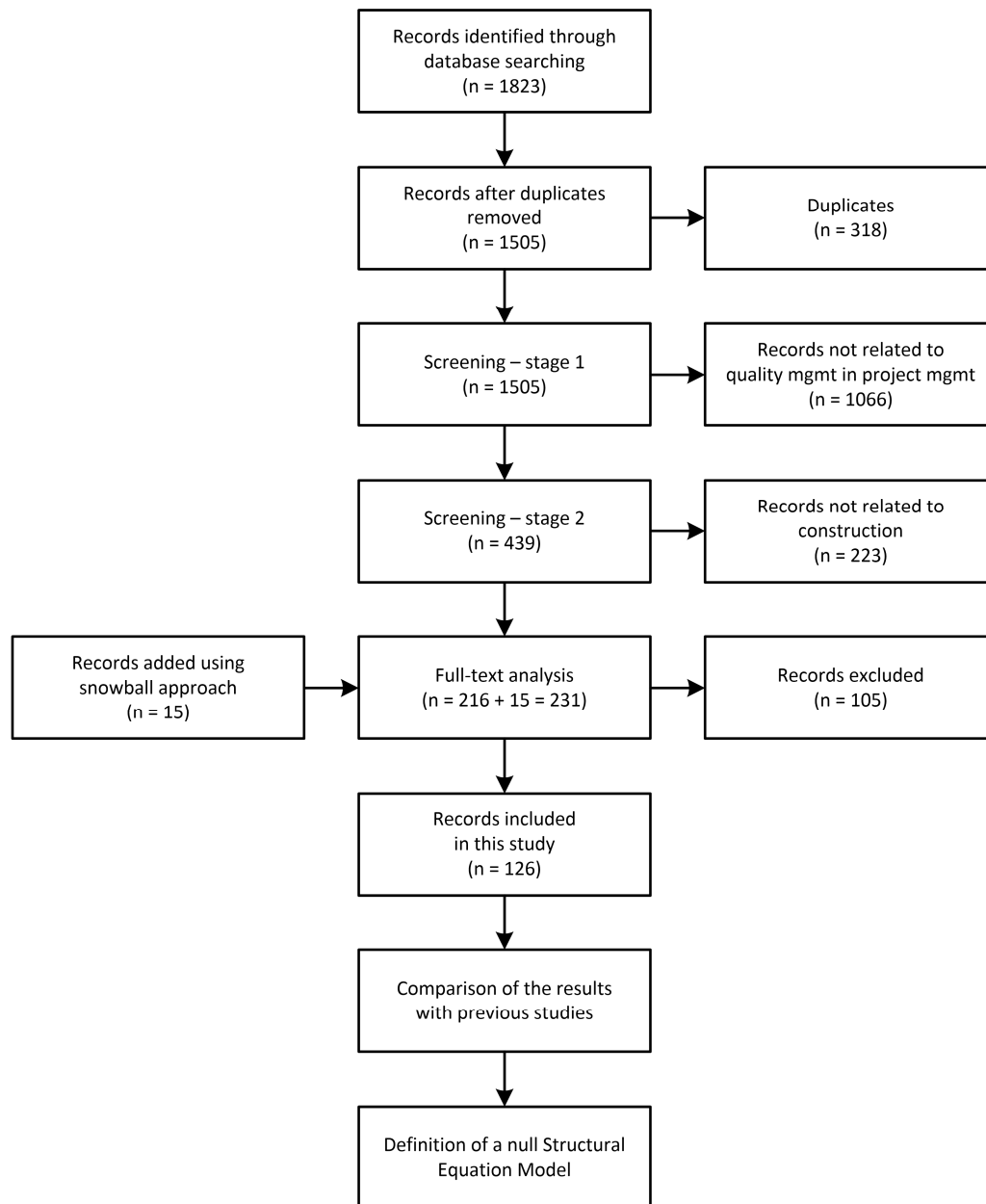


Figure 1. Flow diagram of the SLR and the analysis process. Source: research results.

2.3. Descriptive Analysis

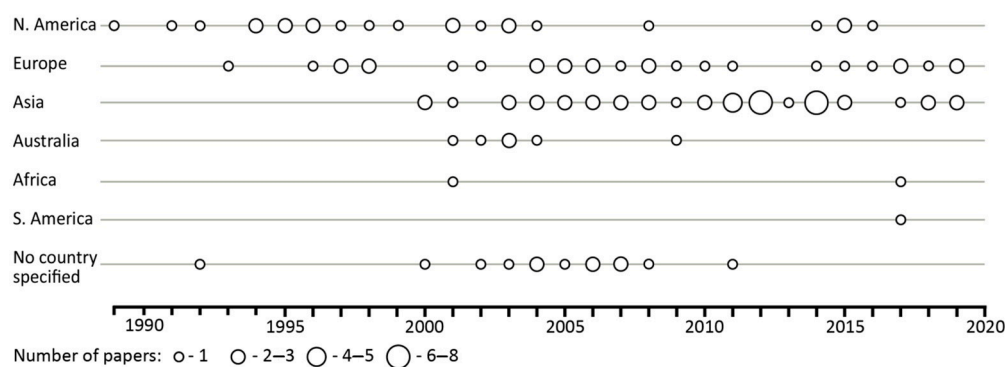
The descriptive analysis of included papers should lead to a reduction of content into codes and identification of the emerging patterns. That allowed us to find regularities and trends in studies on quality management in construction project management. Construction project management and quality management are popular fields of study. However, not many authors study both of them simultaneously. The papers included in this study were published in 61 journals or peer-reviewed conference publications. There is no one leading journal covering that topic. The period of the study was over 30 years. Those are the causes of the widespread of papers across journals. A list of the most popular journals was presented in Table 1.

Table 1. List of the most popular journals.

Journal Title	Papers
Journal of Management in Engineering	17
Construction Management and Economics	14
Journal of Construction Engineering and Management	9
International Journal of Project Management	8
Applied Mechanics and Materials	6
International Journal of Productivity and Quality Management	3
Procedia Engineering	3
Total Quality Management	3
TQM Magazine	3
Advanced Materials Research	2
Automation in Construction	2
Building and Environment	2
Engineering, Construction and Architectural Management	2
Journal of Professional Issues in Engineering Education and Practice	2
Others	50

Source: research results.

In the case of 112 papers, we were able to determine the country where studies were performed. The information was either presented by authors or found based on affiliation. We found 32 countries, with the largest number of papers in the USA (22), China (16), UK (13), and Malaysia (9). Papers grouped by continents and years of publication present how the idea of quality management in construction project management spread throughout the world (Figure 2). It is not surprising that the first English publications were found in North America, then in Europe, and later in Asia and Australia, as the ideas of quality management and project management have spread similar way.

**Figure 2.** Number of publications by year and continent. Source: research results.

The most popular methods used by researchers were: Surveys (42), literature-based considerations (35) and case studies (31). Other methods used were: literature review, document analyses, interviews, statistical analyses and observation (Figure 3).

Each paper, based on full-text analysis, was classified into one of the categories. Further analysis allowed us to define groups of categories and present the popularity of specific categories in the timespan of the study. Categories that contained only one paper were removed. Therefore, in Table 2, only 121 papers are presented. Overall, eight groups with 20 categories were found. The most popular subjects covered in the papers were performance issues in projects, system approach to project quality management, costs of quality, and methods. The grey bars on Table 2 present timespans between the first and the last publication in each category. We do not suppose that some categories are no longer studied. The table refers only to the corpus of papers included in this study to better understand its structure.

Table 2. Number of papers by categories and timespan of their publication.

Group	Category	N	1990	1995	2000	2005	2010	2015	2020
Organisation quality management related	Quality culture	9		█					
	Process vs. organisation	2						█	
	Design phase	8		█					
Quality Management System	QMS	13	█	█					
	QMS implementation	3						█	
Satisfaction	Customer satisfaction	3						█	
Performance related	Performance	15		█					
	Critical Success Factors	5						█	
	Quality factors	3					█		
	Costs of quality	10		█					
Quality Assurance related	Improvement	5						█	
	Quality inspection	5						█	
	Rework	3						█	
	BIM	6						█	
External relations	Procurement	6	█	█					
	Partnering	4						█	
	Suppliers QM	5						█	
Other management systems	Environment	2					█		
	Safety	3					█		
Methods	Methods	11		█					

Source: research results.

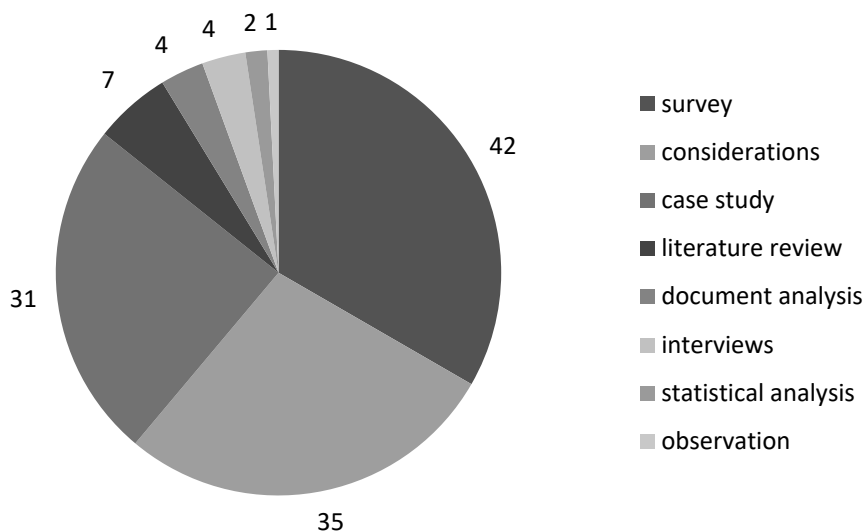


Figure 3. Methods used by researchers. Source: research results.

The list of papers included in this study was presented in Appendix A. The papers were sorted according to group and category presented in Table 2.

3. Results

3.1. Selection of the Papers

Overall, 1823 records were identified, of which 318 turned out to be duplicated. Therefore, only 1505 papers were screened.

The causes of papers exclusion in that stage were: title or abstract not related to the subject of this study in 730 records, only quality management covered in 183 papers, 49 papers covered only project management, description of quality management implementation project in 49 papers, 55 are not a paper, e.g., book chapter, editorial, report.

Overall, 1066 records were excluded, and 439 were considered in further steps. We found 216 papers related to construction. Papers related to software (104) or other fields (119) were excluded. Unfortunately, 36 papers were not available in databases: EBSCO, Science Direct, Emerald, JSTOR, Wiley, Academia, Research Gate, Google Scholar.

An analysis of references led to the inclusion of the other 15 papers (snowball approach). According to Kitchenham and Charters [32], quality criteria were defined: enumeration of objectives or questions, description of the methodology, presentation, and discussion of findings. In the results of full-text screening, several papers were excluded. The causes included; not meeting quality criteria (31), content faintly related to the subject of the study (32), duplicated content despite different titles and abstracts (4), retracted papers (2). Overall, 105 papers were excluded. Finally, 126 papers were included in this study (Figure 1).

3.2. Phases of Construction Projects

For this research, we chose a five-stage model of the construction project: initiation, planning, execution, monitoring and control, and closure [33]. The most impact on the quality of the project results is performed in the first four phases, while in the last achieved quality can be observed. In this study, the authors attempted to identify critical quality management factors in all construction projects. Only in 54 papers, authors narrowed their study to one or more project phases. In other cases, a different point of view was adopted, e.g., quality management methods or areas. This number includes all papers published before 1995. No papers referring to the closure phase were found, and only a few referred to the initiation phase. The initiation phase can have a significant impact on results quality; however, it is often overlooked by researchers, as that impact is often indirect and difficult to measure. The

interest in the planning and execution phases was high throughout the whole study period. On average, the planning phase was analysed in 18% of the paper, while the execution phase in 20%. In phase 4—monitoring and control—we noticed a substantial increase in the number of studies since 2015. A quarter of the papers included in this study and published in the years 2015–2019 covered monitoring and control. The number of papers by project phase and publication year was presented in Figure 4.

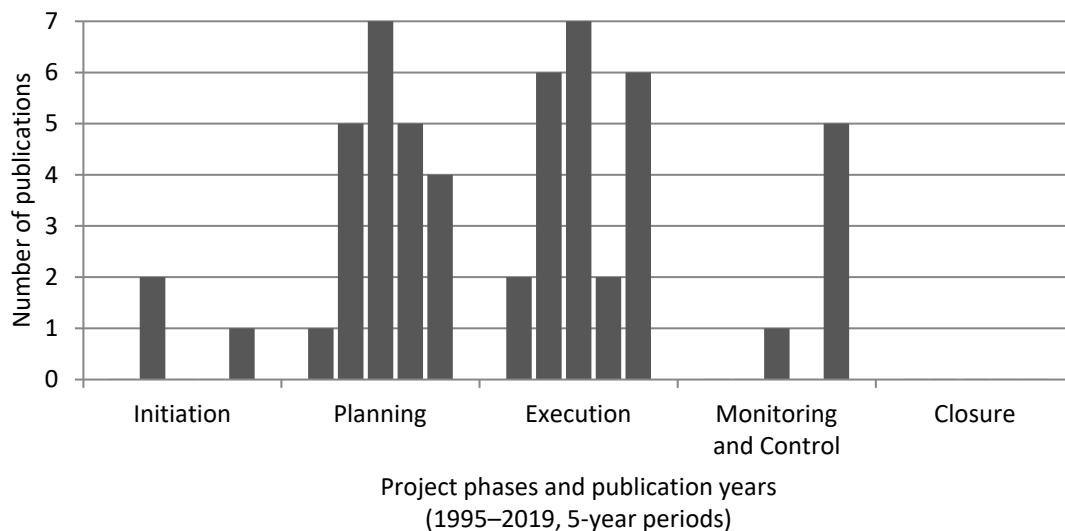


Figure 4. Number of papers by project phase and publication year. Source: research results.

3.3. Identification of Quality-Related Factors

The current study revealed the third type of quality factors related to the organisation, as well as several new process-related factors. The most popular group of quality factors is related to processes performed in construction projects. In over 80% of analysed papers published after 2010, process quality factors were mentioned and studied. Due to the popularity quality approach based on TQM and ISO 9001, they are well-acquainted by managers and researchers and relatively easy to observe. The second popular type is quality factors related to the product (results). They can be divided into subgroups based on project phases: Initiation, planning, and execution. Over 50% of papers published after 2005 mentions them. Most of the authors, however, focus on factors occurring in the execution phase. The last group, namely organisational quality factors is related to the organisation’s permanent elements that do not change from project to project and form the foundation for efficient quality management in subsequent construction projects. As visible on Figure 5 they are the least popular. However, after 2010 more studies covered them. It should also be noted that 29% of papers published before 1995 mentioned those factors. Therefore, the importance of permanent organisational structures for quality assurance and management was again appreciated. The drop in the number of publications visible on the figure in the last group (2015–2019) is related to the general decline in the number of papers covering quality management in construction projects in those years. The full list of quality factors was presented in Table 3. Appendix B contains their interpretation given that all factors are self-explanatory.

Table 3. Quality factors by types.

Process Quality Factors	Organisation Quality Factors	Product Quality Factors
F1: Planning and control (29 *)		<i>Phase 1. Initiation</i>
F2: Involvement and teamwork (15)		S1: Accuracy of specifications (15)
F3: Expertise and knowledge (24)		S2: Transfer without errors and shortcomings (3)
F4: Customer satisfaction (8)		S3: Downtime (0)
F5: Top management commitment (16)		<i>Phase 2. Planning</i>
F6: Communication (19)	O1: Quality department (7)	D1: Complete technical documentation (13)
F7: Continuous improvement (10)	O2: Long-term partnering (3)	D2: Permits acquired (0)
F8: Coordination between project participants (11)	O3: Quality audit (4)	D3: Difference between predicted and planned budgets (1)
F9: Quality policy (5)	O4: Clear responsibilities (8)	<i>Phase 3. Execution</i>
F10: Availability of resources (9)	O5: Quality culture (4)	E1: Customer satisfaction at the end phase (12)
F11: Supplier quality management (23)	O6: Formalisation (9)	E2: The viability of the project (2)
<i>Identified in this study:</i>		E3: Compliance with scope (32)
F12: : Quality supervision (11)		E4: Contribution for future projects (0)
F13: Requirements management (9)		E5: Completion of inspection and use permit (7)
F14: Health and safety (8)		E6: Transfer without errors and shortcomings (9)
		E7: Initial budget change (8)

* the number of papers mentioning the factor. Interpretation of the factors can be found in Appendix B. Source: research results.

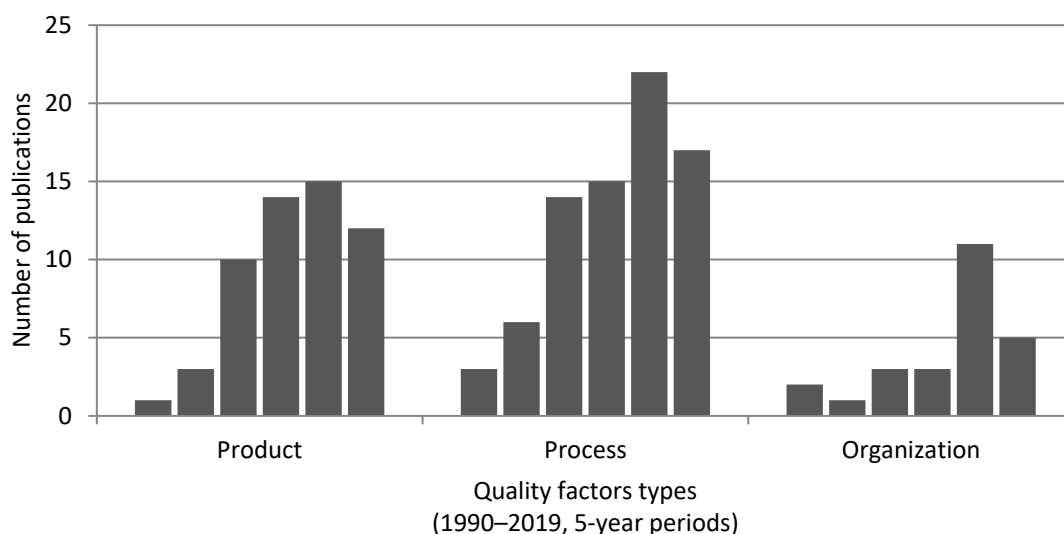


Figure 5. Number of papers describing quality factors by factor type and publication year. Source: research results.

3.4. Quantitative Description of Quality-Related Factors

The process quality factors can be observed mainly during the planning and execution phases. The single most often studied factor is F1 “planning and control”, which has been increasingly mentioned by authors, even 40% in recent years. Other factors, which are being studied more and more, are: F5 “top management commitment”, F8 “coordination between project participants” and F11 “supplier quality management”. Factors of constant and robust interest are: F2 “involvement and teamwork”, F3 “expertise and knowledge”, F6 “communication” and newly identified F12 “quality supervision”. Only in a few papers were mentioned: F4 “customer satisfaction”, F9 “quality policy” and F14 “health and safety”; however, in the case of F9, most of the papers were published in recent five years. The most surprising is a low number of papers mentioning F4 “customer satisfaction”. That shows a higher focus on technical factors related to quality assurance and lower on soft ones related to quality management, even though many authors refer to TQM philosophy. Customer satisfaction is treated more as a result (factor E1) than part of the process.

The organisation quality factors referring to the permanent structure are essential even in strongly projectized construction companies. They speed up the start of the projects due to the provision of staff, training and procedures. They also can store and share knowledge and lessons learnt between projects. They work in background and are easily omitted. In this study, six factors of this type were identified:

- O1 “quality department”—permanent manager or department that covers quality issues in multiple projects with own budget,
- O2 “long-term partnering”—developing long-term cooperation with selected suppliers,
- O3 “quality audit”—monitoring of the project from the company point of view,
- O4 “clear responsibilities”—an unequivocal division of tasks, powers and responsibilities,
- O5 “quality culture”—systematic actions to build an organisational culture based on quality and continuous improvement,
- O6 “formalisation”—recurrent procedures used in many projects, project methodologies.

Two of them, O2 and O5, were mentioned only by a few authors and not in recent years. Concerning factors O1, O3 and especially O6 we found growing interest of authors in recent years. In the case of factor O4, we found that it was very often mentioned in the first five years of the studied period (almost 30% of papers), then the interest of authors dropped to increase again after 2010.

Among product quality factors, the single most important and growing is E3 “compliance with scope”, which was mentioned in 40% of papers in recent five years. The large group of factors

encounters a constant level of interest: S1, D1, E1, E5, E6, E7. In the case of several factors (S2, S3, D2, D3, E2 and E4), we found only a little or no interest of researchers. These are again soft factors related to customer satisfaction during and after finishing the project.

3.5. Relations between the Factors

Apart from observing changes in quality factors in time, it is also interesting how authors see relations between them. The factors presented in Figure 6 are connected with lines of different thickness, which refers to how often they were studied together in one paper. Factors that were the most popular (F1 and E3) were also perceived by the largest number of authors (16 papers) as linked. Other important relations are F11-E3, F3-E3, F1-F11, S1-D1 (more than ten papers). That observation also confirms that compliance with the specification is the leading approach adopted by researchers.

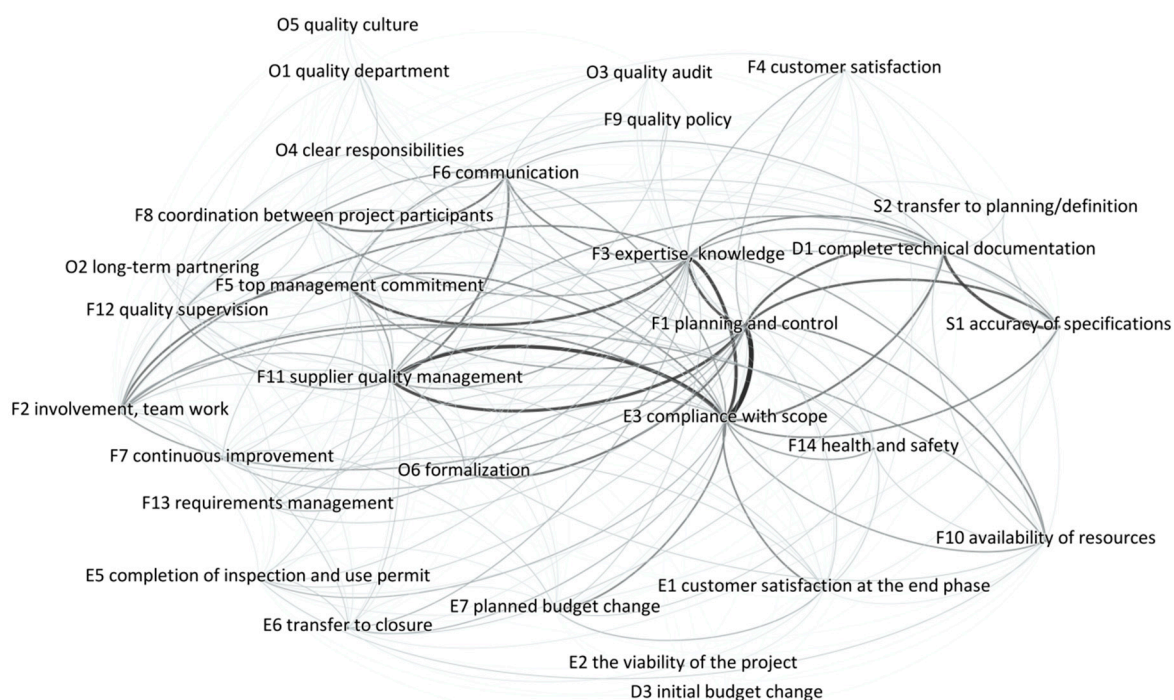


Figure 6. Relations between quality factors based on analysed papers. The thickness of lines means the number of papers with relation identified (max. 16—the thickest line). Source: research results.

4. Discussion

The analysis showed that a pattern related to the place of research is visible among the articles. The corpus consisted of articles written in English, which meant that most of the publications published before 2000 were in the US or Canada. In the last 20 years, publishing in English has become more popular in Europe and Asia, which is one of the reasons why more publications from these continents appeared between 2000 and 2019. However, that does not explain why the number of publications in North America dropped significantly after 2004 and the reason most publications in Australia were published between 2001 and 2004. That decline occurred at the same time as the general decline in interest in TQM [34]. The increase in English-language publications on quality in projects among European researchers mainly concerns Western Europe. Only four publications from recent years came from the countries of Central and Eastern Europe. It can, therefore, be assumed that it is associated with more frequent publication in English. In the case of Asia, the increase in the number of publications may also be due to the dynamic development of the construction industry and the implementation of modern project management methods that were already used in North America or Europe.

The quality-related factors are identified in the literature review within three groups (Table 3) covering quality management issues in construction projects. The most mentioned process quality

factors are F1 “planning and control”, F3 “expertise and knowledge”, F11 “supplier quality management”, and F6 “communication”. O6 “formalisation”, O4 “clear responsibilities” and O1 “quality department” are the most mentioned organisation quality factors. Most mentioned product quality factors are E3 “compliance with scope”, S1 “accuracy of specifications”, and D1 “complete technical documentation”.

The previous study performed by authors analysed F1–F11 (Table 3) process factors, factor F8 “coordination between project participants” (investor, contractor, and project manager) ranked first [22]. The survey participants believe it is the most important, but it is not the most mentioned factor in analysed papers. Factor F4 “customer satisfaction” and F6 “communication” were mentioned in over 20 papers (e.g., [35,36]), and research showed that they are crucial for participants. The most mentioned factor in papers was F1 “planning and control”, and it is ranked in fourth place in research. That can be because the survey participants do not see the importance and benefit of it in practice. Factor F11 “supplier quality management” was often mentioned in the papers, but in the research, the participants believe that it is not much important (last ranked). Meanwhile, the contractors believe that it is quite essential, and they ranked it in fourth place because they are in a direct link with suppliers, and supplier quality management is vital for their work.

The impact of the process quality factors on the quality of results is visible mostly during the planning and execution phases in a relatively short time. For example, wrong planning can lead to delays or excess tasks, while supplier quality management errors show up in deliveries non-compliant with the specification.

The organisation’s quality factors were not analysed before, giving this study more significance. This study identified organisation factors in the SLR, long-term partnering and clear responsibilities are not often mentioned. This result can be linked to a change in the way projects are run in recent years. The link between all organisation quality factors and all process quality factors is essential (over 80 papers), showing the importance of understanding what links mean and which factors are most influential. The fewest links were found between F10 and organisational factors. The F10 “availability of resources” links only to the O6 “formalisation”, which shows that depending on the availability of resources, it is possible to work on project methodologies.

Identified product factors (through the project life cycle): accuracy of specifications, transfer without errors and shortcomings, downtime, permits acquired, the difference between predicted and planned budgets, the viability of the project and the contribution for future projects are the least recognised in this study. That can be because these factors are more difficult to observe due to necessary contact with an investor, not only a construction company. That can also stem from a more narrow definition of quality, often used in the construction industry, as only compliance with the written specification and not the customer’s soft expectations.

In the papers factor D1 “complete technical documentation” was mentioned by 13 authors, D2 “permits acquired” and D3 “difference between predicted and planned budgets” we found only in one paper. In practice, these factors are recognised as necessary for the planning phase, which was shown in the previous study. The survey participants (previous study) recognised process factor “customer satisfaction” as very significant in all project phases. For example, this factor (measured by the use of new processes, methods, or technologies) is for over 55% of participants very significant in the planning phase. Still, it is not found in this study for this phase. The factor E1 “customer satisfaction at the end of the phase” (construction object) in the execution phase is recognised in the literature in twelve papers, and that is because, in this phase, customer satisfaction is essential for its completion.

Graphical analysis of relationships between quality factors presented in Figure 6 helps to understand essential links and trace how authors of previous studies saw connections between them. However, that approach has some severe limitations. The relations can be observed and counted, but they may not explain the real-world issues well, as they stem from the meta-analysis. To overcome this limitation, a statistical, quantitative approach has to be applied. Therefore, the next step is defining a

null SEM model, which shows links between the three groups of quality factors: quality of a process, quality of an organisation, and quality of the product (Figure 7, markings described in Table 3).

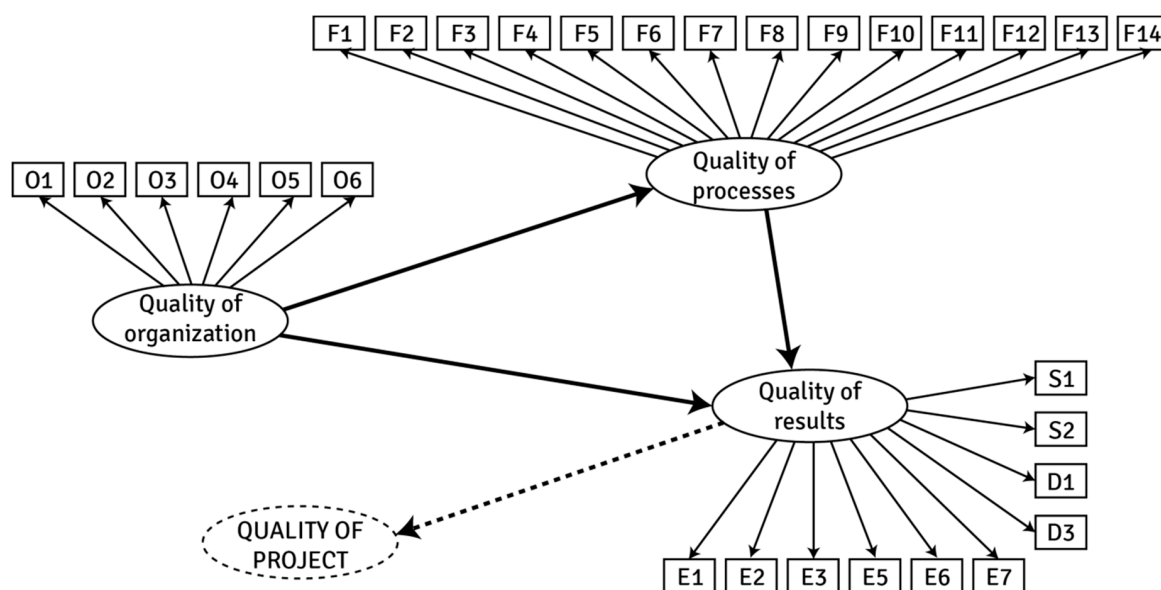


Figure 7. Null SEM model—the link between Quality of organisation, Quality of process, Quality of results. Source: research results.

The factor F1 “planning and control” is the most often mentioned in analysed papers, and its impact in the SEM model was found in the previous study as significant. The author’s SEM model from the previous study showed that the factor D2 “permits acquired” in the quality of results is important, but it was not found in this SLR [28], and thus, it was not presented in the new null model. The other factors that were identified in the earlier stages of the research project, but not found in the SLR, were also excluded. Therefore, S3 “downtime”, D2 “permits acquired”, and E4 “contribution for future projects” were removed from the SEM model. To discover the real relationships and links between the process, organisation, and product-related quality factors and improve the presented null SEM model, it is necessary to perform the next steps of our research project. The comparison of results achieved in this study with previous ones leads to some insights. This study identified the quality-related factors in construction projects present in the literature and their grouping and constructed the preliminary null SEM model show assumed relations between groups of factors [28]. The new group was identified—quality factors related to the enterprise in which a project is executed (quality of organisation). In previous studies, it was found that the most significant impact on the quality of results had the quality of processes (found to be significant) [28]. In the next step, it is necessary to determine the impact of both quality of processes and quality of organisation on the quality of results and how new factors impact previous results. That will be achieved through a survey in construction enterprises in several European countries, and it will lead to the presentation of the final SEM model.

5. Conclusions

In this study, two objectives were defined: Construction of the preliminary model showing assumed relations between groups of factors and its comparison with the literature and previous studies. An SLR approach was applied to identify papers that covered identifying factors that impact quality management within construction project management.

After a two-stage screening process and following full-text analysis of papers, we selected 126 papers related to the topic, which allowed for a review of previously identified quality-related factors, supplementing them with newly found and creation of null SEM model for further research. We found no earlier SLR on that subject; therefore, the extended classification of the quality-related factors in

construction projects is one of the significant results of this study. This study should help researchers and project managers, project sponsors, and steering committees. Knowledge of the quality-related factors and understanding of relations between them can significantly impact the ways the construction projects will be planned and executed.

Due to the advanced quantitative and qualitative analysis of the papers, we were able to track the evolution of the studies of quality-related factors in construction projects. We identified how the interest spread across continents and the main topics raised by researchers since the early nineties. The network analysis revealed relations between studied factors accepted and verified by authors of previous studies.

We identified three limitations of this study. Due to the limitation of academic databases, we limited the search to English-language papers only. Studies on that subject could be performed in other languages. We also hoped to find other approaches to the construction of the SEM model. Unfortunately, no attempts were found and we cannot compare our null model with other ones in this paper. The study was also limited due to the unavailability of 36 papers, which could enrich the conclusions.

This paper is part of a long-term project on quality in construction project management. In the next study, the authors plan to prepare and perform the survey in construction enterprises in several European countries. The results of that survey will be used to create the final SEM model, which will allow authors to present all significant links between the quality of organisation, quality of process, and quality of results.

Furthermore, the findings can be valuable to the current global associations such as Project Management Institute (PMI), International Project Management Association (IPMA), International Organization for Standardization (ISO) and similar when developing further their bodies of knowledge and process-based standards. Also, construction companies can use these results and the quality factors, presented in Appendix B when implementing their self-tailored project management methodologies or trying to align generic principle-based standards of managing construction projects, such as PMI's Construction Extension to the PMBoK Guide.

Although we have tried to grasp the quality story of project management processes holistically, we acknowledge that each theory or model might not be successful in any setting [37,38]. The field is just far too vast, occupying almost every industry. Creating a new or updating a current standard is a complicated and long term process, where it is arguable as to whether there is any such thing as a "best" solution. Still, we hope that both construction companies and project management professional bodies will find the results valuable in their future work.

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Appendix A List of Papers Used in The Analysis by Group and Category

Appendix A.1 Organisation Quality Management Related

Appendix A.1.1 Quality Culture

Acikara, T., Kazaz, A., Ulubeyli, S. Evaluations of construction Project Participants' Attitudes toward Quality Management in Turkey. *Procedia Engineering* 2017, 196, 203–210.

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Appendix A.2 Quality Management System

Appendix A.2.1 QMS

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Appendix A.3 Satisfaction/Customer Satisfaction

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Appendix A.4 Performance-Related

Appendix A.4.1 Performance

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Appendix B Interpretation of Quality-Related Factors

Appendix B.1 Process Quality Factors

- F1 Planning and control—use of methods, techniques, and technologies for planning and control in project implementation;
- F2 Involvement and teamwork—project participants involved in the project, and an efficient team;
- F3 Expertise and knowledge—people involved in the project are qualified, possess competencies, know and apply techniques, methods for the work they perform;
- F4 Customer satisfaction—focus on understanding and customer expectations and fulfilling them;
- F5 Top management commitment—managers available, responsible and involved in the project, contribute to the quality;
- F6 Communication—effective transmission of information, lack of misunderstanding, conflict management;
- F7 Continuous improvement—effects of improvement visible in the project, employees involved in the implementation of new methods or technologies;
- F8 Coordination between project participants—work performed by different contractors or employees is coordinated in time;
- F9 Quality policy—the formal quality policy was described and implemented; employees act according to the policy;
- F10 Availability of resources—resources are well planned, controlled and adequately utilised;
- F11 Supplier quality management—quality management practices extend to suppliers, including at least supplies control and effective information exchange;

- F12 Quality supervision—team members were assigned to monitor and control quality; quality monitoring procedures are present;
- F13 Requirements management—elicitation, documentation, change management, configuration management.
- F14 Health and safety—team members were assigned to monitor health and safety; H&S procedures present and implemented; absence of unsafe behaviours among employees;

Appendix B.2 Organisation Quality Factors

- O1 Quality department—a permanent department in the organisation that coordinates quality management throughout the company and projects;
- O2 Long-term partnering—cooperation with suppliers and partners is not limited to one project only, but it is based on long-term relations, which allows continuous improvement;
- O3 Quality audit—quality management system is regularly monitored; quality audits results in change requests;
- O4 Clear responsibilities—the responsibilities of all employees in the organisation and project are precisely described and well known;
- O5 Quality culture—pro-quality attitude is present among managers and employees even before the project begins.
- O6 Formalisation—all quality-related processes are described in procedures or other documentation; employees act according to the documentation; document change management process implemented;

Appendix B.3 Product Quality Factors

Phase 1. Initiation

- S1 Accuracy of specifications—initial specifications are precise and accurate;
- S2 Transfer without errors and shortcomings—no rework or delays during transfer between phases;
- S3 Downtime—the downtime, if necessary, is planned and optimised (e.g., brownfield projects);

Phase 2. Planning

- D1 Complete technical documentation—documentation includes all necessary information and takes into account known limitations (e.g., space, technology, resources);
- D2 Permits acquired—all permits before the execution phase acquired on time;
- D3 Difference between predicted and planned budgets—planned over-budget not higher than admissible by project management frameworks;

Phase 3. Execution

- E1 Customer satisfaction at the end phase—the delivered result consistent with customer requirements;
- E2 The viability of the project—the profitability of the project is consistent with the initial assumptions;
- E3 Compliance with scope—the project delivered according to time, cost and scope;
- E4 Contribution for future projects—good practices and lessons learned can be transferred to the organisation or the following projects;
- E5 Completion of inspection and use permit—all permits after the execution phase acquired on time;
- E6 Transfer without errors and shortcomings—no rework or delays during the transfer of the final result;
- E7 Initial budget change—final over-budget not higher than admissible by project management frameworks;

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