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# Performance Measurement Framework for Prediction and Management of Construction Investments

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**Abstract:** Despite good ideas, great efforts, and high investments, many projects do not end with success. Projects often fail due to a lack of understanding of the project requirements and constraints necessary for overall success. Five selected projects were analyzed in detail through the multiple case study method followed by semi-structured interviews with 56 experts to develop a pattern for the future prediction of project success. This paper aims to identify key factors for project performance in a multi-stakeholder environment, define a performance measurement framework for construction investments, and establish a link between performance measurement and prediction of project performance. The findings could help researchers in modeling performance measurement tools for project managers to achieve their designated project goals, reach better decisions, and achieve full potential in their future projects.

**Keywords:** performance measurement; project management; multiple case study; performance indicators; prediction; stakeholder management

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## 1. Introduction

Despite good ideas, great efforts, and high investments, many projects do not end with success. Although there could be several reasons for such, a pivotal task in the study of project management remains the same, as Chen [1] stated, "to identify the critical determinants of project management performance". Therefore, over the years, many researchers and practitioners have examined and identified a wide variety of approaches, tools, and techniques to describe and measure project management performance focusing on input characteristics that affect project outcomes [1–4]. Those studies often focus on the overall project life cycle [2,3,5], with relatively few focused on the perspective level of the project phases [1], especially how various stakeholders will perceive project success [6–8]. The paradigm of focusing solely on technical and economic aspects and areas over the years has shifted towards the integration of social and behavioral areas as well, thus focusing on the interaction between project stakeholders and the project team [8–11]. Both practitioners and academics have difficulties coping with such problems, clearly showing that there is still room to investigate and contribute. Therefore, this article builds on the previous research and stakeholder management theories [12–14] and multi-criteria decision tools [15–18], thus proposing such a framework that considers complex project environment, especially in construction projects, and a multi-stakeholder view to enable reaching full success in future projects.

The complex surroundings and the goal for overall betterment, often viewed as sustainability, have a specific imperative that project performance is recognized and measured on long-term strategic objectives instead of short-term tactical performance [18–21]. While the authors, in general, often focus on achieving short-term project targets as long-term benefits management, especially in public projects [20], there are "significant variations in the levels of success", as Flyvbjerg reported [22]. The PMI's report [23] claimed "only 70% of projects successfully met their original goals and business intent", so, there is still much room for improving performance.

Another aspect is the multi-dimensionality of success, as the interests of different stakeholders imply that they will sometimes have quite different perceptions of the project's success [24–28]. Therefore, project failure is often seen as a lack of understanding of the project requirements and the constraints necessary for overall success, emphasizing the early stages of the project. Such is most evident in the architecture, engineering, and construction (AEC) industry as construction costs are one of the main criteria for decision making in the early stages and of interest to all project participants, i.e., stakeholders [29,30]. Very often, there are discrepancies between the estimated (e.g., planned or contracted) costs concerning the realized (e.g., actual) costs of the construction project [31]. Usually, discrepancies occur due to a lack of data and information in the conceptual phase [32–37]. Therefore, monitoring performance and reward depending on outcomes is increasingly common.

While the studies mentioned above indicate how to approach project performance measurement, they do not address how performance determinants (as both performance areas (PAs) and performance indicators (PIs)) influence project success from a multi-stakeholder viewpoint. Therefore, we aim to define a performance measurement framework that could transparently involve different stakeholders in defining a set of PIs. It could help manage projects based on their current performance to predict future success.

The main goal of this research is to develop a performance measurement framework as a conceptual framework that takes into account different project stakeholders' points of view (POV) as well as projects' performance criteria, i.e., key performance indicators (KPIs), to help project managers to make their decisions in the best possible way to reach project goals and outcomes. In a construction project environment, the stakeholders' POV is represented by clients, contractors, consultants, and their project representatives, i.e., project managers. Therefore, the proposed framework to create a pattern for the future prediction of project success will be based on five case studies, i.e., real construction investment projects, and analyzed with the multiple case study method followed by semi-structured interviews with identified stakeholders. At the same time, the performance management areas are derived from previously performed, detailed bibliographical research analysis [38] and multiple case study that takes into account pre-defined performance measures and their outcomes in selected construction investment projects. The proposed framework takes project data as inputs for successfully managing performance during the whole life-cycle of construction projects. The contribution of this research would be to the better understanding and improvement of project performance in construction projects by providing such a framework that offers project managers the opportunity to evaluate the current state of the project, regardless of its stage, and provides a reasonable possibility of prediction to meet project constraints. Therefore, to achieve the main goal, this research intends to deal with the following three objectives, namely, (1) to create a procedure that can be used in a multi-stakeholder environment to identify project performance indicators for measuring performance, (2) to define a performance measurement framework for construction investments, and (3) to establish a link between performance measurement and prediction of project performance.

## 2. Theoretical Background

### *2.1. Project Management, Success, and Performance of the Project*

Project management theory initially defines project success based on three core criteria: delivery on time, within budget, and to an agreed quality [39]. Such an approach gained popularity thanks to the good measurability of the criteria. However, later studies have greatly criticized this concept as these three criteria are insufficient to capture the project's success from a broader point of view [40]. Accordingly, the required level of performance can only be achieved if other aspects are observed [41]. The project's success is affected, among others, also by its complexity, which may increase the level of cost and time risks [42]. In this context, a breakdown of project success criteria into 29 categories was proposed [43] supplementing traditional criteria (time, cost, and quality) with other macro-level categories covering stakeholders-, deliverables-, and project organization- and management-related criteria.

The theory recognizes project complexity as the number and heterogeneity of different inter-related elements [44]. Vidal and Marle [45] highlighted that complexity renders the project difficult to understand, foresee, and keep under control. The multi-dimensionality of project complexity is seen in the literature from technological and organizational views, while, in our paper, we mostly focus on the organizational complexity relating to both in terms of the complexity of project objectives and related tasks as well as to interactions between a high number of people and stakeholders involved [46]. It is also believed that a higher number of inter-related elements that have to be co-ordinated causes greater exposure to delays and cost overruns [42]. In addition, it is argued that when the scope and complexity of the project increases, the need for a more comprehensive portfolio of criteria increases as well [47].

The later studies have further conceptualized performance management on a project level in a wide range of areas, such as supply chain management [48–50], risk considerations [51–54], safety [55,56], and sustainability aspects [57–59]. In such a way, it is possible to capture a broader range of data necessary for effectively managing the project and evaluating its performance. Such an approach becomes pivotal, especially in an unstable business environment characterized by changes in competition, technologies, and customer preferences and requirements [60]. As ascertained by Ward and Chapman [14], stakeholders represent the main source of uncertainty in the project due to the multiplicity of their objectives, which can be conflicting. From this perspective and in line with performance management efforts, analyzing various stakeholders' POVs on the project's success becomes pivotal. Accordingly, in our study, we investigate the POV on performance management issues of these three central stakeholders of any construction project.

Many root causes of cost and time overruns have already been identified in the literature, including project complexity, price increases, slow decision making, rework, or shortage of equipment [61]. Many scholars have incorporated risk aspect into their performance management approaches in terms of particular KPIs, such as overtime work rate and rework rate [62] or time–cost predictability [33,63–66]. Accordingly, risk performance indexes and measurement systems have been developed [52], mainly covering cost and schedule over-run-related risk.

Available literature suggests numerous models, systems, and frameworks developing performance management issues. As Lin and Shen [67] discussed, the need for so many models arises from the fact that they look at the various facets of performance from different points of view. Furthermore, they argue that multi-perspective indicators are essential for performance measurement and applying the balance scorecard approach [68–71] should help improve overall performance. However, these models are often criticized for grouping causes and effects together as an overall performance indicator [72].

Hence, researchers have generally focused on providing advances (1) for the overall performance measurement and (2) by developing fragmentized forecasting models and models addressing specific aspects of the performance. In relation to (1), several approaches have been built, e.g., to predict project failure at completion by considering seven variables (communication, team, creativity, technology, risk, quality, and materials; as suggested by [1]), in terms of the total performance score that has been developed in order to quantify project performance indicator system based on 18 KPIs covering eight PAs [62], or by a system dynamics approach to predict construction project performance [73]. Regarding (2), the following models can be noted: the operational research model has been developed to predict contractor performance [74], the decision support model for construction supply chain performance management was introduced by Yildiz and Ahi [48], while Kim [52] presented a risk performance management model based on cost and schedule risk considerations.

Stakeholder perspectives and their POVs have been widely studied. Prior analyses have shown that the perception of specific KPIs differs across stakeholders [41], similar to the perception of particular attributes that influence cost performance [28]. That is why engaging stakeholders already at the early stages of the project is of high importance [75–77] in as much as many projects disagree on the priority of particular criteria across individual stakeholders [47]. Previous research also revealed performance objectives and indicators of stakeholder management [75,78,79] and pinpointed collaborative management, which could produce positive effects such as increased cost performance of the project [80]. Considering the various concepts raised, it is desirable to reflect on how much uncertainty exists in managers' predictive models [81], which can adversely affect achieving project success. Therefore, the choice of PAs to be monitored and measured is crucial.

### *2.2. Stakeholders Management*

As ascertained by Ward and Chapman [14], stakeholders represent the main source of uncertainty in the project due to the multiplicity of their objectives, which can be conflicting. From this perspective and in line with performance management efforts, it becomes pivotal to analyze various stakeholders' POVs on the project's success. Stakeholders are defined usually as "groups or individuals who have a stake in, or expectation of, the project's performance". The origins of the stakeholder concept have been described by Freeman [12], highlighting its dynamic aspect as every stakeholder role is temporary and issue-specific. The further development of stakeholder theory has included, among others, the approach of Mitchell et al. [13] regarding the identification (normative theory), salience (descriptive theory), and establishing the typology of stakeholders. It should be mentioned that stakeholder identification belongs to the main challenges of project managers [75,78]. Once stakeholders are identified, Mitchell's theory [13] further facilitates the determination of stakeholders' salience based on three main elements of typology: power, legitimacy, and urgency, and their assignment to one of the nine classes. Accordingly, managers can decide on the priority they give to competing stakeholders' claims. One of the prime project management goals is to support a balance between the needs and expectations of individual stakeholders [79].

A high number of stakeholders raises the need for careful strategic considerations in buyer–supplier relationships. Previous theoretical findings pointed out that there is no single and ideal way to manage these relationships ([82] Kim and Choi, 2015). Deep and long-term relations might benefit from the mutual trust of the parties involved, which is important as trust can influence the success of the project ([83] Cerić et al., 2021). Since the buyer has to control the relationship with its suppliers and is in line with the effort to avoid poor performance, an incentive/disincentive mechanism might be considered as a suitable managerial approach [49,84]. From the construction industry's point of view, private and public projects have to be differentiated. As for public projects, relationships are often limited to a single contract [49]. In this context, supply chain management in construction becomes more complicated. Additionally, available literature recognizes, e.g., in the supply chain operations reference model, its metrics were used to manage the performance of the construction supply chain [48].

While the spectrum of construction project stakeholders is broad, e.g., clients, project managers, designers, subcontractors, supplies, funding bodies, users, community, local authorities, environmentalists [85], project management as well as construction management, the literature recognizes three key stakeholders, namely, clients, contractors, and consultants [75,86]. Especially, as the stakeholders being seen [84] as "one of the underestimated factors of project success". Accordingly, in our study, we investigate the POV on performance management issues of these three central stakeholders of any construction project.

### *2.3. Project Performance Areas*

Previous research has shown that investigations into individual aspects of performance management on the project level have been widely conducted. More specifically, available literature suggests a wider spectrum of areas (apart from time, cost, and quality) that can be suggested as subjects of performance measurement. By conducting an extensive literature review [38], we have identified eight common PAs (namely, profitability, productivity, quality, time/schedule, cost, safety, team satisfaction, and client satisfaction) used to evaluate the project's success (see Table 1). The typical PA list has been developed based on 56 relevant publications and their distribution into individual PAs. Our study uses them to analyze them from a multi-stakeholder's point of view.

**Table 1.** Overview of common performance areas to evaluate project success.

| Decade | Reference | Profitability | Productivity | Quality | Time/Schedule | Cost | Safety | Team Satisfaction | Client Satisfaction |
|---|---|---|---|---|---|---|---|---|---|
| 1980s | [81] | + | + | | | | | | |
| | [40] | | | | + | | | + | + |
| 1990s | [73] | | | + | + | + | + | | |
| | [85] | + | + | + | | | | | |
| | [39] | | | + | + | + | | + | + |
| 2000s | [62] | + | + | + | + | + | + | | |
| | [87] | | | + | + | + | + | + | + |
| | [88] | | + | + | + | + | + | | |
| | [67] | | + | + | + | + | + | | + |
| | [89] | + | + | + | + | + | + | | + |
| | [90] | + | + | + | + | + | | | + |
| | [91] | | + | | + | + | + | | + |
| | [92] | | + | + | + | + | + | | |
| | [93] | + | + | | + | + | + | | + |
| | [66] | | | | | + | + | + | + |
| | [94] | + | + | | | + | | | |
| | [95] | | | + | + | + | | | |
| | [96] | | | | + | + | | | |
| | [97] | | + | + | | + | + | + | + |
| | [2] | + | + | + | + | + | + | + | + |
| | [45] | | | + | + | + | + | + | + |
| | [14] | | | | + | + | | + | |
| | [68] | + | + | + | + | + | | + | + |
| | [98] | | + | + | + | + | + | + | + |
| | [99] | + | + | + | + | + | + | | + |
| | [100] | + | + | + | + | + | + | | |
| | [4] | | + | | | | | | + |
| 2010s | [101] | | + | + | + | + | | | + |
| | [41] | + | + | + | + | + | + | + | + |
| | [102] | | + | + | + | + | | | |
| | [61] | | + | + | + | + | + | + | + |
| | [103] | | + | + | | + | | | |
| | [104] | | + | + | | | | | + |
| | [6] | | | + | + | + | | + | + |
| | [105] | | | + | + | + | + | | + |
| | [31] | | | | + | + | | | |
| | [69] | + | + | + | + | + | + | + | + |
| | [106] | | | + | | | + | | |
| | [107] | | + | + | + | + | + | | + |
| | [108] | | | + | + | + | + | | |
| | [3] | | | | + | + | | | |
| | [109] | + | + | + | + | + | + | | + |
| | [1] | | | + | + | + | + | | |
| | [19] | + | + | + | + | | | | |
| | [110] | | + | + | + | + | + | | |
| | [111] | + | + | + | + | + | + | + | + |
| | [27] | | | + | + | + | + | + | + |
| | [60] | | | | + | + | | | |
| | [112] | | + | + | + | + | + | | |
| | [57] | | | | | | | + | + |
| | [72] | | | + | + | + | | + | + |
| | [113] | | | + | | + | + | + | |
| | [113] | | | + | | + | + | + | |

**Table 1.** *Cont.*

| Decade | Reference | Profitability | Productivity | Quality | Time/Schedule | Cost | Safety | Team Satisfaction | Client Satisfaction |
|---|---|---|---|---|---|---|---|---|---|
| 2010s | [78] | | | + | + | + | + | + | + |
| | [58] | + | + | | | + | | | |
| | [114] | + | | | | + | | | |
| | [115] | | | + | + | + | + | + | |
| | [116] | | | + | + | + | + | + | + |
| | [117] | + | + | + | + | + | + | + | + |
| | [79] | | | | + | + | | | |
| | [118] | | | + | | + | | | + |
| 2020s | [7] | | | + | + | + | | | + |
| | [8] | | + | + | + | + | + | + | + |
| | [119] | | + | + | + | + | + | | + |
| | [43] | | | + | + | + | + | + | + |
| | [9] | | + | + | + | + | | + | + |
| | [49] | | | + | + | + | + | | |
| | [38] | | | + | + | + | + | + | |
| | [76] | | + | + | + | + | + | | |
| | [10] | | + | + | + | + | + | + | + |

As previously shown in the above theoretical studies, there is a consensus that the improvement of project performance represents a difficult task in a complex construction environment. Diversity of projects, variability of stakeholders, differences in external influences or exposure to various risks, among others, complicates the easy implementation of performance management systems. Recognizing this challenge and given its importance in the broader project literature, we would contribute to a better understanding of performance management in construction investment projects by proposing a framework built on the combination of stakeholder theory and PAs.

Therefore, the performance measurement framework is developed and described in the following section to offer not only an insight into how PAs mutually interact and have an impact on the project's success in a multi-stakeholder environment but also be a framework for the prediction and management of construction investments based on accumulated past project performance and knowledge.

## 3. Research Methodology

### *3.1. Developing Performance Measurement Framework for Predicting and Managing Construction Investments*

A performance measurement framework for predicting and managing construction investments is proposed to address the previously defined main goal. It consists of three parts (see Figure 1), each defined with a particular added value to the decision-maker. Firstly, defining common PAs to evaluate project success is essential. Such can be achieved through an extensive literature review. In this particular case, an extensive literature review has previously been done by Marović et al. [38], as the research query was focused on performance management in civil engineering. This resulted in 1240 documents published in Scopus and Web of Science databases from 2000 to 2021. The results were extended with the theoretical background previously stated, resulting in 8 common PAs shown in Table 1. Such provided a level playing field for the following multi-stakeholder analysis of performance criteria. Once stakeholders are defined and start with project-related communications, PAs serve as well-needed constraints to define performance criteria. Therefore, performance criteria are defined transparently, in the stakeholders' hands, and their exclusive responsibility. As it can be conducted in different ways and using different techniques, the hierarchical goal structure procedure [75,120] showed promising results in dealing with multi-stakeholders in the construction project environment. Therefore, we are keen to use it in this particular framework as well to not just define performance criteria for each PA but also to develop a hierarchical criteria structure to evaluate projects' performance.

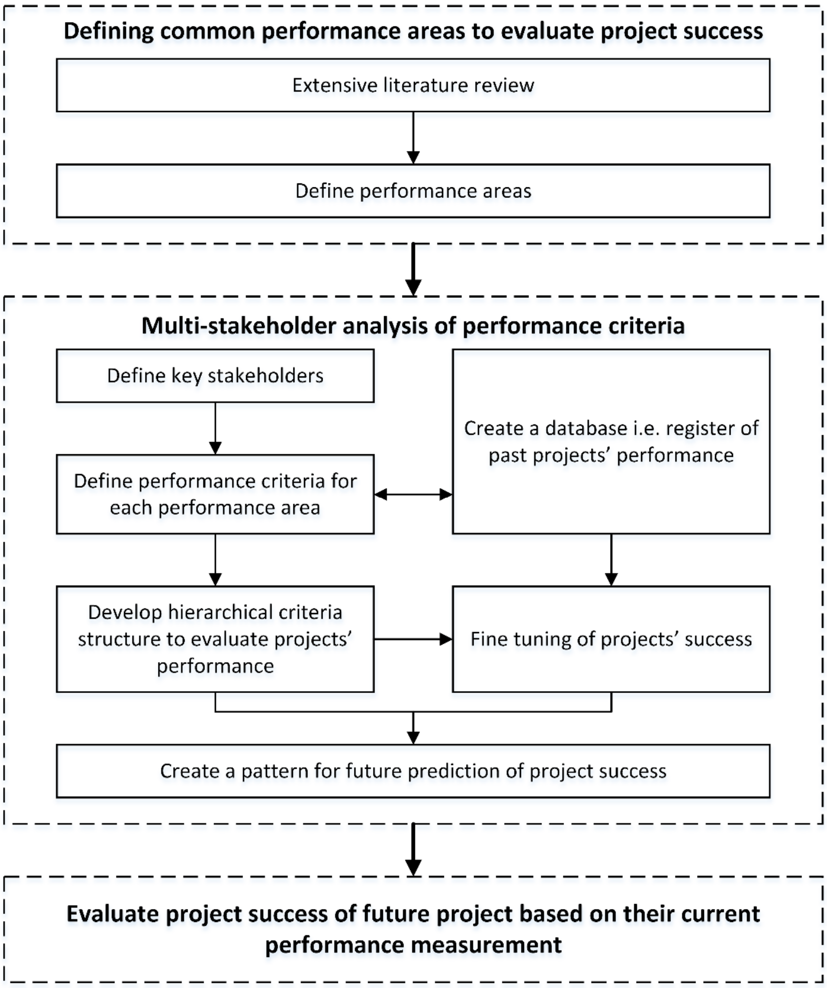


**Figure 1.** A performance measurement framework for predicting and managing construction investments.

A register of past projects' performance can also be of use to help stakeholders to develop it. As such development is an iterative process, an additional fine-tuning of projects' success can be done either quantitatively or qualitatively. It is an open loop, so applied in different constraints and project environments will bring additional needed aspects to the framework and, therefore, new added value. The aforementioned enables us to perceive how PAs mutually interact and the potential impact of the project's success from the different stakeholders' points of view. As herein, the proposed framework is qualitative and will, undoubtedly, provide insight to create a pattern for a future prediction of project success. Therefore, addressing more and more project cases to create a pattern using multiple case study is expected to bring more precision to future predictions. Such a pattern could undoubtedly serve as a valuable tool to evaluate project success of future projects based on their current performance measurements.

A multiple case study research approach [121] is adopted to understand and facilitate the identification of projects' performance criteria and, based on them, to develop a pattern as a decision-maker's tool for future prediction of project success. The central issue is developing a theoretical performance model based on a detailed literature review and stakeholder inputs on one side and construction project data on the other to help project managers decide the best way to reach project goals and outcomes. To differ between case study and multiple case study approaches, it is necessary to highlight adequate terminology that is used in this manuscript. Therefore, as stated by Yin [121], we adopted the notions that the case study research stands for the mode of inquiry, case studies for the method of inquiry, and the case is related to the unit of inquiry in a particular case study. Additionally, illustrative case studies used herein serve primarily "to make the unfamiliar familiar and to give readers a common language about the topic in question". Therefore, our multiple case study protocol consists of three phases (1) Define and Design Phase, (2) Prepare, Collect, and Analyze Phase, and (3) Conclude Phase, as [121] suggested. During the first phase, some additional methods were used to develop the theory, such as review methods for analyzing the existing literature [122], selecting a representative case sample, and designing a data collection protocol. Throughout case selection, it is essential to ensure a valid variation on the dimensions of theoretical interest [123].

In order to identify projects' PAs (defined as objective no. 1), several review methods for analyzing the existing literature, such as critical review, literature review, meta-analysis, and systematic search and review, were used. This was predominantly used to develop a theory as the first step of the protocol mentioned above (research background is given in Section 2). For this purpose, bibliometrics [38,124,125] was used, as a systematic quantitative literature review, followed by a transparent and systematic method for reviewing collected bibliography and systematization of information. Therefore, by combining the quantitative and qualitative approaches, the goal is to identify performance areas for project performance and achieve its success. This approach can be used particularly for trans-disciplinary and interdisciplinary research to identify the literature's geographic, scalar, theoretical, and methodological gaps [126].

### *3.2. Brief Description of Analyzed Cases*

The boundaries/restrictions for selecting cases were the following: (1) public investments; (2) in the area of Primorje Gorski Kotar and Istria County (Republic Croatia); (3) contract value in the range of 15–25 mil. EUR; (4) contracted and being active from 2016 onwards; (5) executed by the same contractor. In order to collect data from selected cases, the data collection protocol is developed. The interview guide has been prepared and used as a tool during semi-structured interviews with the experts involved. Each case study was separately discussed with clients, contractors, and consultants to gather different points of view regarding the success of a particular project. As previously published works mainly adopt collecting data from various companies/institutions [61,88,108,112,115,116,127], we focused just on construction projects executed by the same contractor in a geographically limited locality with a more significant volume of work. In order to ensure the diversity of analyzed projects, this study purposefully examines public projects of different natures as well as under various supplier arrangements (single contractor vs. consortium). Therefore, it is possible to document how the approach to performance management may differ across the projects despite having an identical entity responsible for carrying out the construction works. The selected company represents the biggest contractor with 65 years of tradition in the surveyed area.

The second phase was conducted in detailed case studies and their analysis based on those above. Data derived from these case studies are robust in underpinning the case analysis, which consists of information for (1) Case A—multipurpose logistics center; (2) Case B—water utility infrastructure; (3) Case C—clinical hospital facility; (4) Case D—road infrastructure (highway); and (5) Case E—road infrastructure (state road). Each case was analyzed in detail (Section 4), resulting in writing an individual case report according to a defined protocol. In addition, once the case studies were analyzed, a dash–dotted-line feedback loop is given the possibility to update or redesign the approach if it is a situation where an important discovery occurs during the study of one of the individual cases. One of the essential aspects of Yin's case study research [121] is having a strict procedure or protocol that enables later investigators to arrive at the same findings and conclusions.

### *3.3. Sample and Data Collection Procedure*

Once the theory had been developed, it was necessary to select cases and design a data collection protocol to conclude the "Define and Design Phase" as the first phase of the multiple case study protocol. As previously mentioned, five cases were selected based upon five restrictions and studied in detail. Knowing that the construction cost is one of the main criteria for decision making in the early stages of the construction process, and, therefore, their prediction is of interest to all project participants [29], the focus was placed on all time–cost related documentation related to selected projects throughout the projects' life-cycle. Therefore, to identify discrepancies between the estimated time–cost and the project's realized time–cost and avoid or minimize time–cost overruns, importance was placed on collecting planning data, i.e., contracted and realized values. Such was performed throughout the project documentation from the initiation and planning stage (main contracts), execution stage (monthly reports of planned and realized works, annexes, internal communication within the contractor team, and official communication between project stakeholders), and closure stage (records of handover of the facility).

In addition to the project documentation, semi-structured interviews were performed with all identified stakeholders to gather their POVs. Stakeholders of all selected projects were identified according to their connection to the projects and grouped as clients, contractors, and consultants. There were several experts in each group reflecting on the project performance. The overall list of interviewed stakeholders consisted of 65 people, i.e., experts involved in all phases of a particular project. In the end, 56 experts were involved (8 clients, 28 contractors, and 20 consultants; see Table 2) in the interviews, which represents a relatively high response rate (86%).

**Table 2.** Overview of the experts involved in this study.

| Stakeholders | Case A | Case B | Case C | Case D | Case E |
|---|---|---|---|---|---|
| Clients | 2 | 2 | 1 | 2 | 1 |
| Contractors | 5 | 6 | 5 | 7 | 5 |
| Consultants | 3 | 4 | 3 | 4 | 6 |

During the second part of the interviews, an additional 13-question questionnaire was given to each stakeholder group so they could reflect upon their project with a Likert scale of 1–7. In addition to scoring the statements, there was a conversation with the participants about the problems and challenges of the project. The gathered attitudes of clients, contractors, and consultants served for fine-tuning of projects' success but also served as insights into the dynamic of a particular project and problems that occur. All gathered information has been normalized to each stakeholder group to have comparable insight into stakeholders' POV throughout the particular projects and across other projects. Based on those mentioned above, the second phase of the multiple case study protocol was executed to achieve this study's second and third objectives.

## 4. Results and Discussion

The following results are presented according to the defined protocol. As the projects' data are bulky, herein are only presented the necessary ones to validate the proposed performance measurement framework.

### *4.1. Conducting Multiple Case Study Analyses*

To perform the "Prepare, Collects, and Analyze Phase" of multiple case study protocol, all collected data were systematically analyzed for a particular case, focusing on its execution stage, and presented below. During interviews, stakeholders were asked to reflect upon defined PAs and give their POV regarding the case project performance by assigning "+" (i.e., green) to those that have been taken into account to manage project performance successfully, with "±" (i.e., yellow) to those that have been partially taken, and with "-" (i.e., red) to those that have not been taken into account.

#### 4.1.1. Case A—Multipurpose Logistics Center

The Case A project is a public investment of 15.2 million EUR for the construction of a multipurpose logistics center. The project commenced in August 2016, with a planned completion date of November 2017. While the contractor claimed that the project was completed within the contractual deadline, which was regulated by annexes on several occasions, the project was finished in February 2019 (time over-run approx. 94%). The construction costs were also 88% higher compared to the original contract.

The major challenge encountered in the project was the bankruptcy of one of the bidders in the contractor consortium during the first half of the planned project duration. This led to the remaining construction works being divided between the two contractor companies, resulting in additional tension between them. Another challenge faced by the project was financing. The client faced difficulties in continuing to finance the project, which necessitated significant alterations to the project scope to achieve most project goals and outcomes. Several unforeseen works and significant shortcomings were encountered during the project. Some works were not designed at all, the correct fitting into the existing condition was not foreseen, and there were shortcomings in the design and planning stages. During the construction works, geological problems were discovered that were not documented during the design stage, leading to several months of delays.

Despite these difficulties, all stakeholders were satisfied with the completion of the project. However, it is important to note that better planning, communication, and coordination could have prevented or minimized many of the issues encountered during the project.

#### 4.1.2. Case B—Water Utility Infrastructure

Case B is a public investment of 18.7 million EUR for the construction of new water supply and sewerage systems and rehabilitation of the existing ones. The project started in November 2017 and was scheduled to be completed in April 2020. However, the project was completed in March 2021 (time over-run approx. 37%), with a 5% increase in construction costs compared to the original contract. Although the increase in cost was only 5%, significant changes occurred during the execution phase of the project. The contracted cost was initially reduced by 30%, but with the addition of new infrastructure network, the contractor and the client agreed on a new contract cost, which was similar to the original.

During the construction works, historically valuable remains were discovered multiple times, which required conservation surveys as unforeseen works. This resulted in the interruption of the works and extension of the deadline for 11 months which was initially contracted. All stakeholders involved in the project expressed dissatisfaction with the contract documentation, and additional and unforeseen works arose frequently, requiring constant changes and refinements of project documentation. Poor communication and a bad atmosphere among clients, contractors, and consultants significantly affected the resolution of project problems. Moreover, the availability of materials was impaired by the COVID-19 pandemic, and there were significant changes in the prices of construction products and services during the project. The stakeholders concluded that the cohesion of project participants could have been higher, and some project participants were considered insufficiently expert for the positions they held. Overall, the project faced significant challenges, but despite these difficulties, it was completed within the contractual deadline, and all stakeholders were satisfied with the final outcome.

#### 4.1.3. Case C—Clinical Hospital Facility

Case C is a public investment project worth 22.7 million EUR, aimed at constructing a clinical hospital facility. The project commenced in September 2019, and the anticipated completion date was December 2021. The construction was completed on time, and the costs were regulated with annexes on several occasions, resulting in an increase of 13% in construction costs compared to the original contract.

One of the primary issues encountered during the project was the fluctuation in construction product and service prices due to the COVID-19 pandemic. However, the contract does not provide for a sliding scale to accommodate such changes. Therefore, the contractor was not able to charge the difference or seek compensation for this unforeseen challenge.

During the interviews, the stakeholders revealed that the project documentation was frequently problematic, resulting in poor cost estimates due to the discrepancies between the contracted and actual quantities of work. The design and contracting of unnecessary items that were not consumed resulted in additional and unforeseen works, thereby increasing the project's cost. The challenge of the project was certainly the location and space constraints. Strong gusts of wind occasionally limited or stopped working on site. Since other facilities bounded the construction site, the spatial organization of works, ware–houses, and construction site communications was challenging. Despite the space constraints, a large number of workers, and the necessary performance methods, monitoring occupational safety regulations was also highlighted as very demanding.

#### 4.1.4. Case D—Road Infrastructure (Highway)

The project, Case D—road infrastructure (highway), is a public investment of 19.5 million EUR. Construction started in April 2019, with a planned completion date in March 2021. From the contractor's POV, the project was completed within the contractual deadline that was regulated by annexes on several occasions. From a time perspective, the project was completed in August 2021 (time over-run approx. 22%), with construction costs 19% higher compared to the original contract.

The client has signed a contract with a consortium of two companies. The interviewed representatives of the contractors were only from one company of the consortium (7 examinees). They mentioned that communication within the consortium was a big problem throughout the whole construction phase. As the other company did not follow the dynamic plans satisfactorily, the client requested a redistribution of works. The problem was in their productivity, or better to say, stress in productivity, as they bear equal responsibilities and high penalties for non-compliance towards the client. Since the time frame remained the same, the contractor found himself in a situation wherein such a short period, they had to do additional major construction work (e.g., contracted work from consortium partner) to meet the agreed percentage of work to be done, and face the potential loss of income. The examinees from the contractor group highlighted these challenges and assigned them to a "turnkey" type of contract. Several survey participants from various stakeholder groups complained about the incompetence of the other participants and the inadequate atmosphere among the teams of clients, contractors, and consultants. Also, all stakeholders highlighted that the commitment and demands of the client in monitoring safety at work and the quality of work were significantly higher than usual.

#### 4.1.5. Case E—Road Infrastructure (State Road)

The project, Case E—road infrastructure (state road), is a public investment of 14.95 million EUR. Construction started in October 2020, with a planned completion date in March 2023. From the contractor's POV, the project will be completed with several annexes as they build their assumption based on already made changes and signed annexes.

At the very beginning of the execution phase, historically valuable remains were discovered on the construction site, which slowed down the works according to the base-plan for at least two months. Also, some additional and unforeseen works occur that comprise geomorphological characteristics of the terrain and the need for updating the initial designs. Additionally, the project documentation did not correspond to the actual situation on-site in several places, so among others, in the position of the future road viaduct, the existing buildings still existed (the private house that needed to be demolished) thus becoming part of the works needed to be done but was not part of the project. This and similar problems resulted in additional time overruns. Interviewed stakeholders also commented on the state of the project in which they are currently engaged. They agreed that communication in the project has been solid, so far, but that cohesion between teams of clients, contractors, and consultants is only partially satisfactory. They highlighted that the problems are solved extremely slowly and that something needs to be changed in this regard as soon as possible to meet project deadlines. The project's performance and potential overruns will need to be calculated once the project is finished, but, at the moment, it is evident that they will be present in both time and cost.

### 4.2. Cross-Case Analysis and Discussion

The "Conclude phase" of the protocol starts with a cross-case conclusion and modifying the theory, followed by implications. By analyzing the data collected from each case and performing analysis throughout the protocol, it is possible to conclude that the time over-run was on average 38%, and the cost over-run on average 32% for all finished projects. As the set theory is found adequate, the changes that occur during the analysis can be seen as driving fine-tuning factors. Although most of the interviewed experts answered that the projects were completed successfully in the end, the problems that occurred during the projects can be seen in more detail through the conducted case study analysis. Table 3 gives an overview of the time and cost overruns of five cases based on their detailed project documentation, contracts, drafts, S-curves, etc. On the other hand, the conducted analysis gives insight into each project throughout the time of execution, and the drivers for the overruns are mostly paced in unforeseen works and, sometimes, in additional work as a result of clients' changes.

**Table 3.** Overview of cases regarding their time and cost overruns.

| Project | Status of Completion | Time Over-Run | Cost Over-Run |
|---|---|---|---|
| Case A | Completed | 94% | 88% |
| Case B | Completed | 37% | 5% |
| Case C | Completed | 0% | 13% |
| Case D | Completed | 22% | 19% |
| Case E | At the very end | N/A | N/A |

Although the aforementioned time–cost overruns, calculated by MacDonald's equation [128], give insight into the past performance of the projects it is interesting to overlap information from each previously analyzed case (Section 4.1). Overlaying data from stakeholders' POV of defined PAs regarding projects' successful performance (Table 4) with time–cost overruns (Table 3) provides an additional level of information, not only how stakeholders see PAs to measure for project performance, but also how the performance measurement and project performance is interdependent.

From the data presented in Table 4, it is possible to draw up several interesting insights. For instance, for Case A, even though stakeholders mostly took into consideration "cost" as a vital PA, similarly to "time" and "quality" (i.e., iron triangle), actual results were achieved in terms of cost and time overruns are not satisfactory at all. Therefore, the cause of the problems must be hidden elsewhere, that is, in another PA and their interferences. In Case A, we attribute the occurrence cost and time overruns predominantly to the "team satisfaction" PA, as the realization has been planned in a consortium of contractors. Thus, the structure of stakeholders was even more complex than usual, and, therefore, neglecting team satisfaction has a high potential to negatively impact the project's success. On the other hand, for Case C, resulting time and cost overruns provide relatively satisfactory outputs despite omitting the "cost" PA. Notwithstanding, stakeholders involved emphasized both "team" and "client satisfaction" PAs which contributed positively to the completion of the project close to its cost constraints and on time.

**Table 4.** Created pattern for the future prediction of project success.

| Stakeholder/Case | Performance Areas: Profitability | | | | |
|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** |
| Client | Red | Green | Green | Red | Red |
| Contractor | Green | Green | Green | Green | Yellow |
| Consultant | Green | Green | Green | Red | Green |
| Results (over-run) Time | Black | Grey | White | Grey | - |
| Results (over-run) Cost | Black | Light grey | Light grey | Grey | - |

| Stakeholder/Case | Performance Areas: Productivity | | | | |
|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** |
| Client | Yellow | Yellow | Red | Green | Yellow |
| Contractor | Yellow | Yellow | Red | Green | Red |
| Consultant | Yellow | Yellow | Yellow | Green | Green |
| Results (over-run) Time | Black | Grey | White | Grey | - |
| Results (over-run) Cost | Black | Light grey | Light grey | Grey | - |

| Stakeholder/Case | Performance Areas: Quality | | | | |
|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** |
| Client | Green | Green | Yellow | Green | Green |
| Contractor | Green | Yellow | Yellow | Yellow | Green |
| Consultant | Green | Green | Green | Green | Green |
| Results (over-run) Time | Black | Grey | White | Grey | - |
| Results (over-run) Cost | Black | Light grey | Light grey | Grey | - |

| Stakeholder/Case | Performance Areas: Time/Schedule | | | | |
|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** |
| Client | Green | Green | Yellow | Green | Yellow |
| Contractor | Yellow | Yellow | Yellow | Green | Red |
| Consultant | Yellow | Yellow | Red | Yellow | Yellow |
| Results (over-run) Time | Black | Grey | White | Grey | - |
| Results (over-run) Cost | Black | Light grey | Light grey | Grey | - |

| Stakeholder/Case | Performance Areas: Cost | | | | |
|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** |
| Client | Green | Yellow | Red | Green | Green |
| Contractor | Yellow | Green | Red | Green | Yellow |
| Consultant | Yellow | Yellow | Red | Red | Yellow |
| Results (over-run) Time | Black | Grey | White | Grey | - |
| Results (over-run) Cost | Black | Light grey | Light grey | Grey | - |

| Stakeholder/Case | Performance Areas: Safety | | | | |
|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** |
| Client | Yellow | Red | Red | Red | Green |
| Contractor | Green | Green | Green | Yellow | Green |
| Consultant | Green | Green | Green | Green | Red |
| Results (over-run) Time | Black | Grey | White | Grey | - |
| Results (over-run) Cost | Black | Light grey | Light grey | Grey | - |

| Stakeholder/Case | Performance Areas: Team Satisfaction | | | | |
|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** |
| Client | Yellow | Red | Green | Yellow | Red |
| Contractor | Red | Red | Green | Red | Yellow |
| Consultant | Red | Red | Yellow | Yellow | Red |
| Results (over-run) Time | Black | Grey | White | Grey | - |
| Results (over-run) Cost | Black | Light grey | Light grey | Grey | - |

| Stakeholder/Case | Performance Areas: Client Satisfaction | | | | |
|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** |
| Client | Red | Red | Green | Red | Red |
| Contractor | Yellow | Red | Yellow | Red | Green |
| Consultant | Red | Red | Yellow | Red | Red |
| Results (over-run) Time | Black | Grey | White | Grey | - |
| Results (over-run) Cost | Black | Light grey | Light grey | Grey | - |

Legend: green taken into account, yellow partially taken into account, red not taken into account; black color—time–cost over-run is over 75%, dark grey —time–cost over-run is between 50–75%, grey color —time–cost over-run is between 25–50%, light grey color —time–cost over-run is between 1–25%, white color—there is no time–cost over-run,—N/A.

These findings highlight that it is not desirable to limit performance measurement to selected (e.g., well-measurable) PAs and that a broader scope of performance management is necessary due to their interconnectedness. Suppose these findings are confronted with data presented in Table 1. In that case, one may suggest that preferred PAs of "quality", "time/schedule", "cost", and "safety" are more frequently addressed in the available literature, should be supplemented with other areas taking into account also the surrounding factors affecting the project success. Presented findings, therefore, reflect on the complexity of construction projects and the importance of a multi-stakeholder environment. Based on the analyzed cases, it can be concluded that the participants were moderately satisfied with the communication on the project. In general, they considered that solving problems was slow, inefficient, and unsuccessful. In addition to the professional knowledge that is necessary, and seldom highlighted by various stakeholders, co-operation between clients, contractors, and consultants is extremely important. If co-operation is improved and better business relations are established, it is expected that the problems of the construction site will be solved easier and faster. For sure, one possible direction in order to overcome the aforementioned limitation of the qualitative approach is to perform detailed quantitative assessment focusing on, among other things, correlation between the performance areas.

Participants in the analyzed cases were moderately satisfied with project communication, but considered problem solving to be slow, inefficient, and unsuccessful. Improved co-operation between clients, contractors, and consultants was identified as a key factor in resolving construction site issues more easily and quickly. Participants were also generally dissatisfied with project documentation, leading to extensions of deadlines, discussions, and financial claims from contractors. The quantities of work foreseen by the project were seen as too large and not in compliance with the foreseen deadlines, which was compounded by documentation issues. The impact of the COVID-19 pandemic was noted in terms of availability and delivery of construction products, and changes in their prices. Finally, all 56 stakeholders involved in the interviews ranked the eight PAs, and the results are shown in Table 5.

**Table 5.** Ranking of performance areas based on stakeholders' POV.

| Rank | Clients | Contractors | Consultants |
|---|---|---|---|
| 1 | quality | profitability | quality |
| 2 | productivity | safety | safety |
| 3 | time/schedule | quality | profitability |
| 4 | team satisfaction | cost | cost |
| 5 | cost | client satisfaction | productivity |
| 6 | safety | productivity | time/schedule |
| 7 | client satisfaction | team satisfaction | team satisfaction |
| 8 | profitability | time/schedule | client satisfaction |

Contractors and consultants share similar opinions on project success factors, with the top four being the same, due to their expertise and responsibility for the project's performance. However, their opinions can differ based on their specific business goals. Surprisingly, "team satisfaction" is not ranked highly, despite participants stating its importance in interviews. Clients prioritize the final product's quality, longevity, and timely delivery, rather than team satisfaction. The participants' perspectives on project success extend beyond the traditional iron triangle model but not excessively so.

## 5. Conclusions

### *5.1. Theoretical and Practical Implications*

The goal of this study was to develop a performance management framework that can be used for predicting project outcomes and facilitating advanced management. The proposed framework utilizes pattern creation through multiple case study to forecast future project success. While the framework has been adopted by academics and practitioners in the AEC industry, the results from the multiple case study have provided additional insights into different stakeholders' views on project performance and management. The qualitative approach used in this study has exposed gaps between stakeholders' expectations and realities in managing performance in construction projects.

As a key theoretical contribution to the extant project management literature, the current research demonstrates the importance of multi-stakeholders' POV on performance measurement and perception of the project success, even in a specific set of cases where the contractor is represented by the same company. The multiple case study protocol, combined with other scientific methods, has enabled the identification of performance areas and criteria for project performance, as well as the development of a performance measurement model that offers a conceptual framework for linking performance measurement and prediction of project performance. This study's significant theoretical contribution is demonstrating the importance of multi-stakeholder perspectives on performance measurement and project success, even when a single company represents the contractor. Additionally, this research provides new insights into using patterns for predicting future performance in construction projects, enriching understanding of the performance management challenges associated with a project's complexity and uniqueness.

### *5.2. Limitation and Future Research*

The findings of this study can benefit project management practices by proposing an innovative managerial tool that enables the prediction of future project outcomes in their early stages. Combining well-known performance areas with the proposed performance measurement framework allows a multi-stakeholder environment to be adaptive and open to different viewpoints while having a consistent process in managing project performance. However, there are some limitations to this framework, such as the influence of stakeholders' expertise on the quality of the prediction pattern and the potential for inconsistencies in defining particular performance criteria. One of the most important limitations is that the stakeholders' expertise's greatly influence the quality of the prediction pattern. Therefore, it is important, especially in public investments, to build up the pattern on a large number of past projects in order to have better predictions. Also, as the whole framework is open to stakeholders to define particular performance criteria freely, they want to use on their projects, it could bring some inconsistencies to it. Such is solved by having rigidly defined performance areas that are based on previous knowledge. Therefore, it can be seen as a benefit to the stakeholders because they are not limited with what to particularly measure but at the same time have a clear structure of performance areas.

This conceptual framework also suggests avenues for future research, such as quantifying performance areas and criteria for project performance and creating a quantitative performance measurement model that can be linked to other prediction time–cost models that serve to predict project performance. Such research could be supported by intelligent Industry 4.0 tools such as AI and big data analytics. The emergence of this evolving conceptual framework calls for further interdisciplinary collaborations.

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