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Performance indicators in the construction industry: a study with Portuguese companies

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Abstract. This paper aims to study the use of performance indicators (PIs) by business managers in the civil construction sector in a region that encompasses eight districts located in the north of Portugal. Through the literature review, it was possible to gather a list of twenty potential PIs used in this sector. Subsequently, a questionnaire was applied to a sample of construction companies from this region. A statistical analysis of the data collected allowed to identify the twelve most used and most important PIs for the companies surveyed. The results indicate that the companies involved in this study mainly use the traditional financial measures, however, recognize that non-financial measures, namely the customer satisfaction index, employee satisfaction, internal customer satisfaction index, and the training of employees, are increasingly important for the success of companies. The study also analysis the criteria to select PIs, its main benefits, and difficulties faced by companies on their usage.

1. Introduction

The growth of business competitiveness in the construction industry (CI) sector has led companies to seek performance improvements to become more competitive and to meet their stakeholders' needs [1]. However, for many companies, defining and using the most relevant performance indicators (PIs), which can support improvement initiatives, can still be a challenge [2]. Neely [3] emphasizes that companies have difficulties in determining what to measure and how to measure. Tripathi and Jha [4] add that these difficulties are aggravated when it comes to construction companies, depending on the particularities and complexity of the sector.

The main objective of this work is to identify gaps and improvement opportunities for the management processes of CI companies. To that end, this work aims to investigate: (i) the PIs used by the administrators of the CI companies; (ii) the PIs they consider more important; (iii) the criteria used to select the PIs; and (iv) the obstacles and benefits arisen from its usage. The work will focus on the sub-sector of residential construction, in a region that encompasses eight districts located in the north of Portugal.

The remaining of this paper is organised as follows. Section 2 presents a literature review on performance measurement (PM), covering PIs and PM systems in the CI sector, highlighting the obstacles and advantages of using such indicators and ending with specific research questions. Section 3 presents the research methodology, including questionnaire development. Section 4 presents the questionnaire results and analysis. The paper ends with conclusions.

2. Performance Measurement

2.1. Measurement Process

Performance measurement has been gaining increasing recognition of its important role as an element for the effective and efficient management of organizations [5]. Neely et al. [6] define PM as the process of quantifying the efficiency and effectiveness of an action. Performance measurement provides information that helps in the planning, process control, and also enables the management of strategic objectives and targets [7]. The standard ISO 9001:2015 [8] under "Performance Evaluation" addresses the need for the organization to evaluate the performance and effectiveness of the Quality Management System (QMS) and through the measurement process it is possible to identify the organization's capabilities and the expected performance, both at processes and organizational level [9]. Neely [3] adds that PIs should be considered an integral part of the planning and control process, providing a means of capturing data. According to [10], the measurement process, includes design, data collection and analysis, synthesis, and presentation (Figure 1). Thus, there is a need to design or select and use PIs, however, this task is not trivial [11].
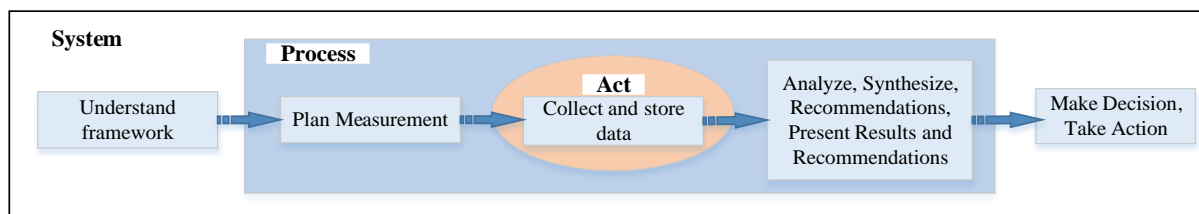

Figure 1. Measurement process (adapted from [10])

2.2. Performance Indicators

Traditionally, PM in the CI relied on financial indicators and, during the 1990s, companywide approaches to measure performance became common practice, using financial and non-financial PIs [1]. In the literature, there are several classifications of PIs, according to the company information needs and its organization and decision structure. For [12], the PIs are classified as Results Indicators, Process Indicators, and Variable Indicators. However, regardless of the type of classification adopted, the PIs must follow the changes that occur in the strategic objectives of the organization, not only be improved but also replaced if necessary.

Several authors [13, 14], have been defining criteria for the design and selection of PIs that are efficient and effective from the point of view of strategic management. These authors suggest that PIs should be transparent, useful, easy to implement, simple to understand, with visual impact, focus on improvement, low cost, and related to the organization's strategy and objectives.

Considering that PM can adversely affect performance [15], to improve overall efficiency of CI, PIs must be designed or selected, implemented and used assuming that its benefits outweigh its costs [4, 16].

2.3. Performance Measurement in the CI

2.3.1 Benefits. The CI is a very fragmented industry, in a competitive environment, in which performance improvement is a necessity and can be supported by PIs [1]. According to [17], there are two main drivers that influence successful implementation of a PM System: (1) top management commitment and (2) the perceived benefits arising from designing, implementing and using PIs. One key advantage of PM is to provide key information to support decision-making, driving company performance towards higher levels of efficiency and effectiveness [2, 18].

Overall, in the literature the following advantages of using PIs can be recognized: Increased productivity [19]; Costs reduction [18]; Support decision-making [2]; Help to implement strategies [20]; Establish targets [1]; Provide feedback [4]. Nevertheless, the existence of obstacles or barriers to the adoption of PIs may influence generalised use, hampering the development of the CI.

2.3.2 Obstacles. There are barriers to the implementation of the PM system, both structural and in the form of implementation. It can be concluded that there is a set of potential obstacles/difficulties on the adoption of PIs:

- Lack of time to do data collection [17];
- Lack of knowledge and experience of employees [15, 17, 19];
- Difficulty in selecting and choosing PIs [16];
- Time and difficulty doing data analysis [11];
- Lack of top management interest [21];
- Short-term emphasis on objectives by top management [16];
- Lack of human resources attached to this task [22];
- Some resistance from the "shop floor" personnel [17].

2.4. Performance Measurement Systems in the CI

In spite of the above-mentioned difficulties, models of PM specific for the CI were proposed, based mainly on Benchmarking systems using KPIs [1, 18].

Table 1 presents the PI proposed by some of these models used by construction companies in the world. Each PI definition is not presented and can be different from model to model. It can be concluded that by adopting different reference models and depending on specific context and objectives, PIs can be tailored to each company.

Table 1. Performance Indicators proposed by models used in the construction sector.

Initiative	Performance Indicator (category)
Key Performance Indicators (KPI) United Kingdom [23]	Cost deviation (F); Productivity (F); Cost of construction (F); Profitability (F); Deadline deviation (P); Equality and diversity (P); Defects (P); Construction time (P); Vehicle movements (P); Absenteeism (due to illness) (P); Lifetime performance (P); Weekly hours worked (P); Customer satisfaction (C); Safety (E&S); Water and energy consumption (E&S); Waste generation (E&S); Impact on the environment (E&S); Impact on biodiversity (E&S); Habitat area created/conserved (E&S); Workers Satisfaction (L&G); Staff turnover (L&G).
Danish Benchmarking System – Denmark [24]	Cost of m² (F); Productivity (F); Work intensity (P); Real-time construction versus planned (P); Actual construction time (P); Index of good practices in construction sites (P); Defects during the first year after delivery (C); Customer satisfaction during construction (C); Defects on delivery (C); Accidents frequency (E&S).
Performance and Productivity Indicators (ICBENCH) Portugal [2, 25]	Cost deviation (F); Profitability (F); Investment in technology (F); Sales growth (F); Pending Billing (F); Profitability (F); Impacts of defects in delivery (F); Defects (P); Deadline deviation (P); Successful proposals (P); Subcontracting (P); Customer satisfaction (C); Business Repetition (C); Accidents frequency (E&S); Water consumption (E&S); Permanent staff (L&G); Training (L&G); Employees satisfaction (L&G).
CI Institute Benchmarking & Metrics Programme USA [26]	Deviation from construction cost (F); Deviation from the cost per phase of the work (F); Cost of design changes during construction (F); Cost of rework (F); Cost per phase growth (F); Deviation of term by phase of the work (P); Duration of work/phase (P); Total duration of the Construction (P); Hiring rate (P); Accidents rate (E&S); Workdays lost due to accidents (E&S).

Overall, PIs can be classified in different categories, for example, according to the Balanced Scorecard [7] in internal processes (P), customer (C), financial (F) and learning and growth (L&G). However, in this specific activity sector, PIs related to environment and safety can be considered relevant. Thus, PIs in Table 1 were classified using the BSC categories (P, C, F and L&G plus Environment and Safety (E&S). As this classification depends on the specific definition of a PI its

classification can vary. For example, productivity can be considered an internal process PI, or as a financial PI. Table 1 suggests a classification, mainly to ascertain if the above categories are present in most models.

Despite the existence of several PM frameworks specifically designed to the CI [2, 4, 27, 28, 29, 30], its utilization resulted essentially in the development of benchmarking activities allowing companies to identify best practices, compare their performance with best practices identifying gaps and defining projects to reduce those gaps. To identify such gaps, the following research questions were posed:

- What are the criteria that the administrators of the CI companies use when choosing a PI?
- What are the PIs that companies can use to bridge the gap between their current status and industry best practices?
- What are the main difficulties associated with the use of PIs, and the benefits that the implementation of the PIs bring to these companies?

3. Research Methodology

3.1. Introduction
The research methodology adopted can be classified as exploratory, by using a research to organize knowledge about PI and performance evaluation. The technique used for data collection was the questionnaire, which is a systematic process of collecting observable and quantifiable data.

Regarding the problem approach, the research is characterized as quantitative, considering the use of statistical techniques in data analysis. The quantitative approach is characterized by the use of quantification, both in the modalities of collecting the information, and in the treatment of these through statistical techniques, to guarantee the accuracy of the work done. Thus, the various stages of the methodology used to carry out this study are presented in Figure 2.
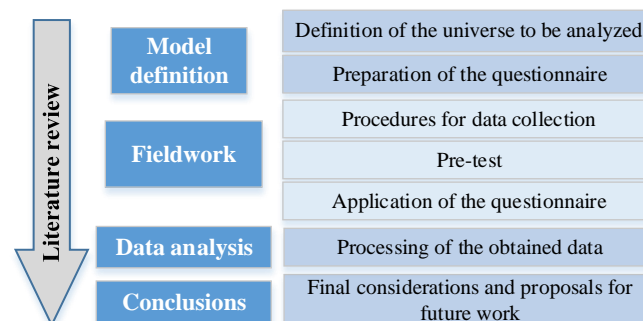

Figure 2. Stages of the research methodology.

3.2. Definition of the Study Area
This paper is an exploratory research since it seeks to organize knowledge about PM and PIs in companies in the CI sector in the northern region of Portugal. To this end, a list was obtained from the Institute of Public Markets of Real Estate and Construction with 23188 companies from the CI sector registered in this Portuguese Institute throughout the eight districts located to the north of the country, from the subsector of residential and non-residential building construction. Of these companies, 250 companies were randomly selected to constitute the sample for this study, since the means available for carrying out the work were limited. The sample was stratified by district to have the same proportion of companies as in the defined universe (see Table 2).

Table 2. Universe of study and sample size.

District	Companies		Sample	
	number	%	%	number
Aveiro	3593	15,6	15,6	39
Braga	4706	20,3	20,4	51
Bragança	692	3,0	2,8	7
Porto	7521	32,4	32,4	81
Guarda	1177	5,1	5,2	13
V. Castelo	1999	8,6	8,8	22
Vila Real	1064	4,6	4,4	11
Viseu	2436	10,5	10,4	26
Total	**23188**	**100**	**100**	**250**

3.3. Questionnaire Development

Based on the assumptions of the research developed on PIs and in the CI sector, a questionnaire was elaborated with the objective of answering the three research questions, to identify (i) the PIs used by the companies of the subsector of building construction and the criteria used to choose PIs; (ii) the degree of importance of each PI for companies, and (iii) the main difficulties and benefits related with its use. The questionnaire is structured into four sets of questions (Table 3).

Based on the literature review, 20 PIs (see Table 4) were selected for the questionnaire. These PIs span over the five groups/categories identified in the literature regarding PMS and used in this work.

Table 3. Groups of questions presented in the questionnaire.

Subject	Description
Respondents' profile	Information about the position, experience and literacy of respondents.
Company characterization	Main characteristics of the company, such as time in the market and the presence of certificates, and the use of PM systems and Benchmarking.
Use and importance of PIs	PI used and their level of importance for companies (assessed using a Likert scale (with 1 = very low, 2 = low, 3 = medium, 4 = high, and 5 = very high).
Aspects related to PIs	It addresses issues such as the criteria for choosing an indicator, the benefits and difficulties associated with PI.

Table 4. Performance indicators used in the questionnaire.

Group	Performance indicator
Financial (F)	Cost of project changes made during construction; Productivity; Cost of reworking; Cost of customer complaints; Cost of construction; Deviation from the cost of construction.
Client (C)	Customer Satisfaction Index; Internal customer satisfaction index.
Internal processes (P)	Index of good practices in construction sites; Defects detected in the delivery of the property; Evaluation of suppliers' materials; Term deviation; Number of non-conformities in audits.
Learning and Growth (L&G)	Employees' satisfaction; Training of employees; Subcontracting rate; Absenteeism.
Environment and Safety (E&S)	Water and energy consumption; Accident frequency rate; Impact on the environment.

3.4. Sample Size and Data Collection

In the first phase, a pre-test was carried out, which consisted of the face-to-face completion of the survey by five companies included in the sample, in order to observe and analyse the doubts raised by the

survey, thus preventing possible misinterpretations or even failures of the questionnaire that lead to their possible incomprehension. Thus, after the application of the pre-test, it was possible to analyse some factors, such as inconsistency or complexity of the issues, the presence of inaccessible language in some sentences, and if the application of the questionnaire was done in a timely manner.

According to the identified factors, corrections were made in the questionnaire. It was then sent by email to the companies that make up the sample. In the email sent, the purpose of the study and its methodology was explained, requesting the completion of the questionnaire by the manager or the person considered most suitable for this in the company.

After the questionnaires were sent out to the companies, it was expected that they would be completed within three weeks. In cases where it was not possible to get a response within the stipulated deadline, the company was contacted again via email in an attempt to understand, the reason for such delay or lack of collaboration. To increase the response rate, companies were contacted by telephone, requesting the completion of the questionnaire.

With this, a total of 85 questionnaires were completed and returned, resulting in a response rate of 34%. According to Dillon, Madden and Firtle [31], the response rate in scientific studies ranges from 10 to 20%, so the results obtained can be accepted as representative of the universe studied, or at least with a response rate higher than similar studies.

4. Questionnaire Results and Analysis

4.1. Respondents Profile
The majority of respondents (80%) who participated in this study are Managers. Regarding the experience of the respondents, two situations were analysed (i) the time in the current position and; (ii) the time in the construction industry sector. The results show that 24% of the respondents are in the actual position over than 10 years, 27% between 5 and 10 years, 28% between 2 and 5 years, and 21% less than 2 years. On the other hand, 60% of the respondents work in the sector for over 10 years, 19% between 5 and 10 years, 14% between 2 and 5 years, and only 7% of the respondents work in the sector less than 2 years. Thus, it can be concluded that the majority of respondents have experience in this sector. It is also noted that the majority of respondents have good academic qualifications, since 62% have higher education, being 42% undergraduate and 20% graduate.

4.2. Companies' Characterization
This work addressed the main characteristics of the companies surveyed, such as (i) time in the market, (ii) held certifications, (iii) use of PM, and (iv) use of Benchmarking.

According to this survey, more than 70% of companies have been in the market for more than five years, which allows us to conclude that the companies analysed in the research show a good consolidation in the market. As far as certification is concerned, only 28 companies (about 1/3) held some type of certification, especially the ISO 9001 certification (12 companies).

Most companies (74%) use financial reports, but this figure drops to about 54% when it comes to the use of non-financial reports. These reports are obtained, in their vast majority, without the support of a PM system since 79% of the companies do not have any PM system and only 21% have one.

Regarding the use of Benchmarking, the survey results indicate that only 25% of the companies surveyed perform Benchmarking. The main sources of information that companies use to do Benchmarking are data comparison with similar companies (12.1%) and consultants' information (9.6%). Regardless of the use of PMS companies may use PIs. Thus, the following section presents results related to PIs.

4.3. Criteria Used to Select Performance Indicators
Table 5 shows the percentage of respondents that used the presented criteria to select PIs. The main criteria in choosing a PI by the surveyed companies are "Usefulness to the company" and "Focus on improvement". The majority of respondents referred these two factors. The remaining criteria were referred by almost half of respondents.

Table 5. Criteria used to select performance indicators.

Criteria	Percentage of respondents
Usefulness to the company	76.9
Focus on improvement	59.0
Easiness to implement	43.6
Related with strategy/objectives	43.6
Low cost	41.0

4.4. Importance and Use of Indicators

This shows the PI most widely used among the surveyed companies, as well as PI that the same companies regard as most important, regardless of whether they use them or not.

Table 6 shows the 20 PIs considered in this study ordered in descending order of the frequency of use. Overall, the majority of respondents said that they use 18 of the 20 PIs. This suggests that even without a formal PM system, companies use non-financial PIs.

Table 6. Most frequent and most important indicators for the surveyed companies.

Performance Indicator	Group	Percentage of use	Importance Average	SD
Cost of construction	F	85.9	4.14	0.79
Productivity	F	83.5	4.39	0.71
Employees satisfaction	L&G	82.4	4.22	0.70
Training of employees	L&G	82.4	4.06	0.82
Customer Satisfaction Index	C	78.8	4.44	0.81
Cost of project changes made during construction	F	76.5	3.73	0.99
Term deviation	P	74.1	4.01	1.05
Deviation from the cost of construction	F	72.9	4.05	0.96
Evaluation of material suppliers	P	68.2	3.72	0.84
Defects detected in the delivery of the property	C	67.1	3.8	1.12
Cost of reworking	F	65.9	3.95	0.98
Internal customer satisfaction index	C	65.9	4.14	0.95
Index of good practices in construction sites	P	62.4	3.84	0.86
Impact on the environment	E&S	58.8	3.71	1.05
Cost of customer complaints	F	57.6	3.85	1.04
Accident frequency rate	E&S	57.6	3.62	1.30
Water and energy consumption	E&S	55.3	3.55	0.92
Absenteeism	P	51.8	3.22	1.21
Subcontracting rate	P	42.4	3.24	1.05
Number of non-conformities in audits	P	38.8	3.26	1.21

In the top ten of the most used PIs are four financial indicators (*cost of construction, productivity, cost of project changes made during construction*, and *deviation from the cost of construction*), and six non-financial indicators (*employees satisfaction, training of employees, customer satisfaction index, term deviation, evaluation of material suppliers*, and *defects detected in the delivery of the property*). Amongst these, *cost of construction* is the one most used (85.9% of surveyed companies).

Table 6 also shows the importance attributed to each of the 20 PI considered (Average column) by the companies surveyed. The shaded lines correspond to the 10 PIs considered with the highest degree of importance, distributed as follows: five are financial PIs (*productivity, cost of construction, deviation from the cost of construction, cost of reworking*, and *cost of customer complaints*) and five are non-financial PIs (*customer satisfaction index, employees satisfaction, internal customer satisfaction index, training of employees*, and *term deviation*). The *customer satisfaction index* is the most important PI for companies surveyed with an average of 4.44.

Seven of the ten most important PIs are in the top ten list of the most used by the companies. Thus, there are three PIs in the top ten list of importance that are not included in the top ten list of use: the *cost of rework, the index of internal customer satisfaction in the works,* and *the cost of customer complaints*. These data suggest that companies should be using these three PI because they consider them important, although more than 1/3 of the companies surveyed do not use them.

The assignment of high values of importance to certain PI reflects the perception that the respondents have about the advantages of their use. It turns out that the most important PI are not always the most used by companies, as this study shows. In this respect the literature refers to the advantages of adopting PIs and the obstacles to their use.

4.5. Benefits and difficulties associated with performance indicators
There are several benefits and difficulties that many companies face in making full use of a given PI. Table 7 shows the percentage of respondents that reported benefits and difficulties of using PIs.

Table 7. Benefits and difficulties associated with performance indicators

	Benefits and difficulties	Percentage of respondents
Benefits associated with PIs	Increase productivity	62.2
	Reduce costs	60.8
	Increase revenues	44.6
	Support decision-making	41.9
	Help to implement strategies	37.8
	Establish targets	36.5
	Provide feedback	27.0
Difficulties associated with PIs	Time to do data collection	64.4
	Lack of knowledge and experience of employees	32.9
	Difficulty in selecting and choosing indicators	30.1
	Time and difficulty doing data analysis	26.0
	Lack of top management interest	9.6
	Short term emphasis on objectives by top management	8.2
	Other difficulties (the lack of human resources attached to this task, some resistance from the "shop floor" personnel)	8.2

To *increase productivity* and to *reduce costs* are the main benefits reported by these companies regarding PIs use. The other listed benefits were also reported by many respondents (27%-45%).

In terms of implementation of PIs, *time to do data collection* is the main difficulty faced by companies. There are a significant number of difficulties referred in the literature that respondents did not consider relevant (<10%) such as: *lack of top management interest; short-term emphasis on objectives by top management; the lack of human resources attached to this task;* and *some resistance from the "shop floor" personnel*.

5. Conclusions
Based on a sample of 250 companies and a response rate of 34%, the conclusions apply to this sample and generalisation should be made with caution since the companies that did not answer the questionnaire could provide data that might influence these results.

The use of PMS by the reporting companies is reduced since 79% of the companies surveyed do not have one in place. However, 18 out of the 20 PIs referred to in the questionnaire were used by the majority of respondents.

In general, the participating companies have a correct understanding of the importance of PIs in the implementation of good management practices, highlighting a balanced set of PIs with a broad scope. These PIs are distributed over the groups: financial, internal processes, learning and growth and

environment and safety. With this, it can be concluded that companies in the Northern Region of Portugal use PIs.

Regarding the degree of importance of PIs, it was noticed that in the list of the top ten indicators, half of them are financial indicators. The most important PI for the companies studied is the *customer satisfaction index*. This result shows that although construction companies give more importance to financial indicators they realize that these alone are insufficient to measure organizational performance.

This study allowed to identify the most important criteria that managers of the surveyed companies use to select PIs as *the usefulness to the company* and *the focus on improvement*. The most important PIs in each of the five groups considered are: *customer satisfaction index* (C); *productivity* (F); *term deviation* (P); *employees satisfaction* (L&G) and *Impact on the environment* (E&S). The list of the most PIs is not the same as the most used. Thus, it can be suggested that the use of these most important PIs may allow companies to shorten the gap between their current status and industry best practices.

This study highlights *increasing productivity* and *reducing costs* as the main benefits resulting from the use of IPs. These advantages have been acknowledged by [18], and [20]. As the main obstacle is identified *the time to the data collection*, which may denote the inadequacy of the companies' information system to support the data collection. This obstacle has been referred to in the literature over the past two decades [17].

Acknowledgments

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