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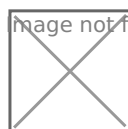
Performance Management in Czech Construction: Public Investors' Perspective

Tomáš Hanák*, Ivan Marović

Abstract: Performance management belongs to crucial managerial activities. This study aims to address how performance management in construction is applied among Czech public organizations on the project level. In order to address this issue, qualitative data has been collected by semi-structured interviews of experienced experts representing organizations owning/operating important facilities and infrastructure (road and rail infrastructure, water and sewage systems, education facilities and collectors). Findings revealed that the level of performance management adoption is rather low, organizations mostly focus on supplier performance evaluation as a response to the ISO 9001 requirements. The practical use of BIM or life-cycle costing is rather in the reflection and preparation phase, on the other hand, a progressive approach is applied in terms of deployment of modern equipment for monitoring of structural defects or the use of robots for maintenance and repairs.

Keywords: construction industry; facility; investor; performance management; project management

1 INTRODUCTION

Achieving high performance is the subject of attention of both researchers and practitioners for decades. In the construction industry, the core of the performance inextricably relates to the so-called "iron triangle" taking into account cost, time and quality components [1]. Nevertheless, many authors argue that the iron triangle model of three constraints is not enough to capture all relevant aspects resulting from the complexity and specificity of construction projects and to determine the level of project success [2,3].

Since the construction is often criticized for its lower performance when compared to other industries (e.g. due to the high number of stakeholders involved and different sub-processes [4], various innovative approaches have been adopted. In this sense, performance management in construction (PMiC) is often based on one of the following frameworks: Balanced Scorecard (BSC), European Foundation for Quality Management (EFQM) model and Key Performance Indicators (KPI) based models [5–7]. As each framework has its own pros and cons, the key question of what to actually measure still remains open especially if we follow the premise that PMiC can be seen from various perspectives. The need to use appropriate metrics is essential in order to cover all relevant areas of measurement as well as from the fact, that it affects the overall efficiency of the performance management system.

The issue of finding meaningful metrics is only one side of the matter, in addition, there is a need to look for causes that affect the achievement of the required performance, and to follow recent trends related e.g. to Construction 4.0 and Construction 5.0 initiatives. Despite the fact that a broad body of knowledge exists on construction performance management, this paper aims to contribute to available literature by addressing how Czech public investors perceive the current attitude to PMiC and its potential development in future.

The paper is organised as follows. Firstly, an overview of common performance management areas is provided, in the next section, mainstream initiatives in the construction industry are presented in the light of PMiC. Then, the data and methods are provided. After the analysis of findings and discussion, the conclusions drawn from this study are given in the final section.

2 OVERVIEW OF COMMON PERFORMANCE MANAGEMENT AREAS IN CONSTRUCTION

Yang et al. [6] have pointed out that performance management studies can be assigned to three levels: project, organizational and stakeholder. However, in practice, the stakeholder's aspect cannot be separated from the project perspective. It has been argued, that the objectives of all stakeholders have to be considered when measuring project success [2] as the project's performance depends, among others, also on the effective coordination of multiple actors [8]. Accordingly, more appropriate structuring of the main areas should be just among the project and organizational level, when organizations can basically be considered as main stakeholders involved in the project.

On the project level, no consensus is reached on the range of metrics that should be monitored. E.g., a set of six highly significant indicators has been proposed for reporting performance [9], whereas it is suggested to supplement these key indicators with additional depending on the type of works or experience level. As it can be seen in Tab. 1, the stakeholder's perspective is omitted among the top six indicators. In another approach [4], the stakeholder aspect is already included as client satisfaction is considered a component of project performance. The stakeholder's point of view is crucial as individual objectives might be different or even conflicting. As highlighted in the example of the PPP project [10], three major stakeholders have significantly different views on performance goals; while the public sector highlights whole life cycle efficiency, building long-term relationships and safety are in the focus of private sectors and users respectively. A more comprehensive approach defining 27 indicators added additional measurement areas such as environment, risk or security [11]. From these defect frequencies, cost efficiency and construction schedule predictability were evaluated as the top three most important. These findings suggest that the scope of the performance

measurement should be quite extensive in terms of the number of monitored areas, but still based on the iron triangle approach.

Table 1 Examples of PMiC on project level metrics

Ref.	Recommended performance areas/metrics
[9]	Quality Control, On-Time Completion, Cost, Safety, $/Unit, and Units/MHR
[4]	Time, cost, quality, safety, client satisfaction
[2]	Budget performance, schedule performance, client satisfaction, functionality, contractor satisfaction, project manager/team satisfaction
[11]	Cost, time, quality, safety, environment, productivity, risk containment, security
[12]	Cost deviation, schedule deviation, accident frequency, accident gravity, planning effectiveness, constraint release, quality, productivity, contract bid change
[13]	Construction cost, construction time, predictability of cost and time and client satisfaction
[14]	Integration, scope, time, cost, quality, human resource, communications, risk, procurement, stakeholder, safety, environmental, financial, and claim management

Much of the traditional construction management literature recognizes the importance of cost and time overruns. In this relation, the predictability of cost and time as proposed by [13] becomes crucial and therefore this aspect should be considered within the performance. The predictability can be viewed as a challenging issue due to the fact that time/cost overruns might be caused by numerous variables such as inadequate planning, design changes, an increase of material costs, poor supervision, lack of skilled professionals, unforeseen ground conditions or poor contract administration [15–17]. Obviously, more precise cost estimations (in terms of the bill of costs) are at disposal when detailed project documentation is available [18], whereas preliminary estimations in the design phase are quite inaccurate if no advanced approach tools are used [19–21]. Furthermore, costs issues related to the project can be improved by the use of cost-optimal construction scheduling approaches [22].

On the organizational level, the focus does not lie on individual projects, but the company/institution as a whole. Apart from profit, iron triangle organizational performance metrics have been proposed [23], assessing e.g. percentage of the projects being delivered on/under budget in a given period. Performance management framework based on Balance Scorecard perspectives (financial, customer, internal business process and learning and growth) has been proposed by [24] with an accent to the periodical estimation of the performance score. This approach has been further developed into particular indicators [25]. While [13] reports safety, profitability and productivity being company performance indicators, a more comprehensive set of 20 performance attributes and related measurement methods was designed [26]. The authors of this study argue that the rapidly changing environment of the construction industry requires the use of non-traditional performance criteria because high financial performance alone is not enough to achieve the required overall organizational performance.

Generally used performance management frameworks, such as EFQM Excellence Model (EFQM) and Balance

Scorecard (BSC) cannot be overlooked, of course. Despite their wide use, such frameworks have significant limitations resulting from their basic concepts. A critique of their deficiencies has been presented by [5, 27, 28] and in this line [5] proposed integrated BSC with EFQM to be applied in an advanced way.

Table 2 Examples of PMiC on organizational level metrics

Ref.	Recommended performance areas/metrics
[23]	Schedule performance, cost performance, safety performance, customer satisfaction, profit
[24]	Financial, customer, internal business process and learning and growth
[26]	Set of 20 performance attributes (time, satisfaction, cot performance, health and safety, …)
[5]	BCS integrated with EFQM

3 PMiC: GOING BEYOND ITS TRADITIONAL CAPABILITIES

Implementation of construction projects faces several risks. Eight risk classes have been identified in relation to large-scale projects, namely sponsorship/development, market, social acceptability, regulatory and political, financial, execution, and operation classes [29]. The problem with the successful use of risk management lies in the fact that while some risks can be foreseen in the early stages of the project, other risks are hard to predict [30]. Expected risk can be well managed and allocated among the project stakeholders (to the one who can handle it best, e.g. in the case of natural risks such as flood or windstorm, that is insurance company [31]), for other risks it is advisable to use the proposed risk models/registers. The general methodology enabling the development of risk register has been suggested by [32], on the other hand, models designed directly for specific types of buildings are also available, e.g. for wastewater treatment plants [33] or offshore wind power facilities [34].

Accordingly, [35] argue that performance management systems should be related to risk factors with the aim to estimate their influence on the project. For this purpose, risk performance indexes have been developed. However, such an approach might be applicable for mega (large-scale) projects), for smaller projects usually there is not enough ability or willingness to apply such a time and knowledge demanding approach. Therefore, it can be suggested to apply key performance indicators in such a way that they will measure relative deviations from set targets.

Furthermore, risks may vary across the entire project life-cycle. In the early stages, projects face the problem of not being able to pinpoint the future costs not only of the execution stage but also operational costs. This significantly affects the achievement of the required financial performance of investors. Many studies in recent years have focused on the development of models that will help to predict future construction costs or overhead costs [21, 35–38], however, their application by construction practitioners is highly limited. Preliminary cost estimations may also be based on the use of technical-economic indicators that may provide users misleading economic information [39].

As highlighted by [40], each stage of the project is equally important; that is why cost and time overruns, improper design and/or construction might be caused by carelessness during any stage. Therefore, performance management should not focus solely on the construction phase but should be involved in the project earlier, e.g. in order to monitor the ability to predict cost or time issues [11] on the required level.

The importance of the early stages of the project can be demonstrated e.g. on the procurement stage, as highlighted by [14]. This stage aims to award the contract to a capable contractor at favourable conditions inclusive of the award price. To select a capable contractor, prequalification plays an important role, however, also other aspects should be considered such as the procurement method to foster achieving project goals [41–44]. Achieving the financial performance of the project can be supported in the procurement stage by promoting the level of competition in the tender [45] as well as by considerations to use electronic reverse auctions [46–48].

Improving the ability to work better with data and make better predictions closely relates to the Construction 4.0 initiative. Applying Construction 4.0 visions to a full extent requires a significant transformation of the industry and its essence includes revolutionary approaches of digitalization and automation [49]. In this line, the development, adoption and application of Building Information Modelling (BIM) technology represent practical achievements for the industry. It should be stressed that the level of BIM adoption varies across the world, e.g. report on the UK construction industry from 2017 shows an increasing rate of 4D BIM adoption for planning projects while pointing out a time lag of 2.38-3.00 years between awareness and first use [50].

The comparison of BIM adoption rates among ten selected countries has been provided by [51] indicating that while the rate of adoption in the US, Canada and the UK is relatively high (79%, 78% and 74% respectively), for other countries such as the Czech Republic or Poland the rate of adoption is lagging behind (25% and 23% respectively). Such a smaller rate of adoption might be caused by various factors, e.g. by higher resistance to change caused by the use of national classification/cost estimation systems/software that are not fully compatible with the software used worldwide. As pointed by [52], BIM adoption is often driven by government or public agencies mandating its use. If adopted, users may benefit most from better cost estimation and control, efficient construction planning and management, and improvement in design and project quality [53].

Performance improvement should also be viewed in terms of a new concept called the Internet of Things (IoT); based on connecting devices, acquiring data and performing computational processes [54]. As an example of improvement, Aste et al. [54] state bridging the gap between predicted and measured energy performance. It is believed that the application of IoT will bring several benefits, not just time and money savings, but also improved safety and security and enhanced waste management [55]. Recent trends also push performance management systems to cope with the Construction 5.0 dimension by adding social aspects and commitment to sustainable development goals [56].

The aspect of sustainability is recently also accented by the Covid-19 crisis in terms of ensuring sustainable supply chains providing uninterrupted supplies of construction materials to avoid unnecessary material price escalations [57]. It should be stressed that the Covid-19 pandemic has affected the construction industry to a considerable extent in many directions (e.g. immobility of the workforce, demanding requirements related to work safety, etc.) and therefore increased the uncertainty during the execution of construction projects [58, 59].

4 DATA AND METHODS

In order to achieve the objectives of this paper, it was necessary to collect viewpoints of public investors on the PMiC topic regarding their opinions, practical experiences, current knowledge and future visions and expectations. Semi-structured interviews with experienced personnel of relevant public organizations in the Czech Republic have been conducted to achieve that. The semi-structured design of the interview has been judged as the most effective one because it allows to address core areas relating to the PMiC as well as to investigate prospective issues based on the experience of interviewees and the development of every single interview. In order to guide the interview properly, a set of predetermined basic questions has been created.

In total, five interviews were realized during autumn 2021, the interviewees are representing organizations operating important facilities/infrastructure such as road constructions, educational facilities, water and sewage systems, collectors and rail infrastructure. The details about respondents and organizations are given in Tab. 3.

Table 3 Description of respondents

Organization	Position	Years of experience	Main agenda
Technical networks	Head of department	8	Management of collectors
Road infrastructure	Administrative director	15	Road management and maintenance
Waterworks and sewerage	Technical director	13	Water supply and sewerage networks
Public transport company	Deputy technical director	16	Rail infrastructure
University	Head of investment department	8	Educational facilities

Careful selection of appropriate respondents with long-term experience in the field (see data in Tab. 3) creates the necessary precondition for obtaining valid and representative qualitative data, its consequent analysis and finally drawing adequate conclusions. The years of interviewees' experience varies between 8 and 16 years. Furthermore, respondents represent organizations with a varied spectrum of different types of facilities/structures which makes it possible to reveal their possible specifics and on the other hand look for matching points across them.

5 RESULTS AND DISCUSSION

5.1 General View on Performance Management, Procurement and Project Success

With regard to the general view on the performance, all of the respondents reported that no comprehensive performance management system is used in their organizations. More specifically, there are no strict requirements how to evaluate the performance of particular projects. Therefore, if a project is completed approximately within the set targets, there is no action from the investor's side. Only if a project fails in terms of its predefined targets, a more detailed response to such a case is required. As an exception, one organization applies KPIs to estimate the performance of the labour force.

The only issue that enjoys more attention is supplier evaluation usually performed due to the ISO 9001 requirements. Accordingly, metrics such as satisfaction with the delivered quality or the number of claims is evaluated. In this way, suppliers can be classified into predefined classes according to their performance. This activity usually aims to stabilize the number of suppliers and establish long-term buyer-supplier relationships, if applicable.

One respondent mentioned, that informal sharing of information and experience exists within the organization among persons responsible for construction project management. Similar sharing of information about project outputs and experiences with suppliers has been stated at the level of the association of municipal transport companies. Such informal sharing of information, experience, problem-solving and best practices represents a significant contribution to the performance improvements, however is not applied in an organized or official mode.

Regarding the awarding the contract within tenders, investors strive to ensure the selection of a capable supplier by sound qualification requirements, e.g. having licence or authorization for specific works such as mining licence, traffic construction and surveying authorization, list of reference projects or professional level of the supplier's employees (e.g. site manager or responsible project manager). Interviewees emphasized proper check of compliance with a qualification in order to exclude ineligible suppliers.

The evaluation process is based just on the lowest bid price criterion or as a combination of the lowest bid price and the duration of works (i.e. multicriteria evaluation [60]). For certain types of contracts investors prefer fast delivery, for example in the case of water supply or transport infrastructure, as longer construction time ensures related costs, e.g., for water supply replacement or ensuring and implementation of detours and alternative public transportation services). In such cases, contractors with faster delivery might be preferred even with a bit higher bid price (the weight of duration of works criterion is usually about 20% - 30%).

One investor has adopted an innovative and proliferating procurement method of Best Value Approach (BVA), highlighting the price/value ratio [61]. Supplier is selected based on performance and price, furthermore, BVA minimizes the level of risk during the execution of the project. This investor noted time-consuming tender preparation within BVA and weight of price criterion being about 30% while the quality aspect is evaluated with the total weight 70% (price criterion weight is in contrast with traditional public procurement). Such an approach appears to be highly suitable from a performance management perspective, in addition, it enables to filter inexperienced tenderers well.

Regarding the project success, provided answers suggest that no consensus is reached in terms of what determines the success. While one respondent considers "all internal processes related to the project were well managed" is crucial for project success, others emphasize "no occurrence of complications during the project execution", "meeting the deadlines", "shortening the delivery period and well managed and realized coordination with other investors", "smooth handover of the executed works", and "satisfaction of the final owner or user". The list of project success criteria contains a wide spectrum of diverse items, sometimes very poorly defined, which seems to be, among other things, one of the reasons why organizations did not establish a clear performance management system.

5.2 Specifics to Construction Projects, LCC & BIM

As for the actual execution of construction works, experts stress the importance of quality tender documentation. Fewer errors in the documentation will subsequently have a positive effect on reducing the number and severity of problems during the implementation of works. Accordingly, some investors apply detailed consultation and comment on the documentation already in the phase of its creation. Such an approach contributes to the achievement of project targets both in terms of costs and time, e.g. by reducing the extent of extra-works, and thus consequently to better performance. All of the experts pointed out the need for proper supervision in order to observe the delivered quality during the execution of works (extremely important for structures to be hidden, e.g. groundworks or foundations) as well as during the takeover of the work.

Specific problems can be attributed to particular types of structures. For example, in the case of collectors, extra-works are common, as despite the thorough exploration in the form of test wells the actual condition of the subsoil is not exactly known. It is therefore essential for performance management that accurate records of the purchase and actual consumption of grouting are provided. Another challenging issue is the efficient coordination with other investors, e.g. when repairing the water supply network, it is necessary to coordinate the works, for example, with the road administrator or with the municipal transport company.

One interviewee has also mentioned the issue of slow response to changes in the project and an insufficient level of communication from the supplier's side. As such issues might negatively affect the meeting the deadline, also these kinds of "soft" aspects should be observed and evaluated. The

site supervision is carried out by own experienced employees and/or external experts or as a combination.

The interviewed organizations are aware of the Life-Cycle Cost (LLC) importance. However, the real application of LCC approach is very limited. Generally speaking, accurate LCC values are not estimated/monitored. One interviewee mentioned, that LCC could be indirectly positively affected by BVA (higher quality of the delivery will positively result in lower repair and maintenance costs), another stated that selected technical elements with a specific service life are required when preparing tender documentation. The most comprehensive approach applies to Waterworks and Sewerage Company, as the financing plan for the renewal of this infrastructure is required by law. In this case, LCC planning is facilitated as the legislation indicates recommended values of service life of particular materials. The company applies the strategy to use materials with long service life (in order to minimize future repairs and related excavation works), that is e.g., the use of chemically resistant earthenware or concrete pipes with basalt lining in the case of sewage system.

For road infrastructure, it should be mentioned that LCC planning is well applicable in rural areas, while in urban areas is aggravated by objective facts, such as emergency interventions into the road structure in the event of a failure of the networks stored under them. Road operators set repair plans; however, these plans are usually based on limited financial conditions rather than on objective needs or LCC view. This results from the long-term underfunding of not only road infrastructure but also water infrastructure.

The attitude to the performance of completed and operated facilities/infrastructure varies according to its basic features. In the case of collectors, real-time monitoring of the conditions in the underground is needed, therefore, a system of dispatching, sensors (temperature, humidity, motion and end sensors) and regular inspections have been established. Advanced repair and maintenance services are applied by Waterworks and Sewerage Company, e.g., by the use of modern monitoring kits with satellite cameras, revision cycle every 12 years (around 100 km annually) or sewer robots. Trenchless technology allows detection of minor defects on time, therefore, repairs made by sewer robots has the character of preventing emergencies and will bring a more significant economic effect later.

The road administrator also uses modern technologies, such as identification of road defects using CCTV vehicles with systems for precise positioning or mobile application "Brňáci pro Brno", an effective tool for online reporting local defects on devices, objects and communication areas by its users. As mentioned by one interviewee, "it is not important how we get the information on road defects, it is just important to have such importation in time to create efficient repair plan". The potential for maintenance planning and evaluation is certainly not fully exploited. In the case of rail infrastructure, it applies to the frequency of grinding vehicle wheels, which is more based on financial limitations rather than economic analysis.

BIM technology is considered to be a necessity in the future, nevertheless, the current approach of individual organizations varies. One organization already have trained employees, another organization currently performs an analysis from which the concept of BIM implementation should be derived. Most of the respondents consider providing trained staff as the main challenge and at the same time expect that BIM will help them not only during the implementation of projects but especially during subsequent operation of facilities/infrastructure. Operators of the critical infrastructure tend to interconnect BIM with their current platforms, such as GIS data or dispatching visualization in future.

Sustainability issues are addressed by all the respondents at a different level with respect to their main agenda. Typically, these involve recycling requirements of the waste, ecological disposal, use of environmentally friendly materials or noise reduction. Sustainable agenda predominantly relates to the ISO 14001 adoption which can be considered and major motivating factor for environmental considerations in analyzed organizations.

6   CONCLUSIONS

This study has addressed various issues related to performance management in the Czech construction industry. In particular, it analysed the public investor's point of view and revealed to which extent the performance management is actually adopted. In-depth semi-structured interviews with representatives of five important owners/operators of municipal facilities/infrastructure (water and sewage systems, collector infrastructure, road and rail network and educational facilities) have pointed to the relatively low level of performance management.

Notwithstanding the organizations making certain efforts to increase the performance, these activities are rather locally focused on the particular specifics of particular project and lack a more comprehensive and holistic approach. A positive finding resulting from this study is the use of modern equipment for monitoring structural defects or the use of robots for maintenance and repairs, however significant progress is needed especially in the LCC and BIM perspectives. Czech legislative requirements demanding the adoption of LCC for the above-the-threshold public contracts in near future as well as BIM pilot studies realization will certainly contribute to their forthcoming expansion in practice.

The main limitation of this study relates to the low number of interviewees. In order to allow the generalization of presented findings and conclusions relating to the Czech construction sector, a larger dataset is required. Further research might also extend this study to compare the level of performance management adoption and use at an international level in order to reveal progress in this area from a wider geographical perspective.

Acknowledgment

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