

Original Article

# Optimizing the Performance and Evaluation of the Investor's Technical Supervision Activities During the Realization of Transport Constructions

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**Abstract** - The aim and purpose of the research are to analyse the performance of the technical supervision of the investor within the Czech construction Civil Engineering during the construction, particularly focused on transport line structures. It is about clarifying the meaning and role of technical supervision in the public sector in transport structures. By analysing the activity of the technical supervision, it will be possible to find the space, if and how this service can be automated, or how it can be made more efficient. A questionnaire was conducted among workers who perform technical supervision to analyse the time-consuming nature of individual technical supervision activities. The obtained data were then analysed according to various categorizations, including the BIM model, and possible streamlining forms were proposed.

**Keywords** - Technical supervision of the investor, Construction manager, Scope of work of technical supervision, Evaluation of technical supervision, The Engineer.

## 1. Introduction

The article deals with the role and importance of supervision in the Czech construction industry. It accentuates its role in public procurement and provides a comprehensive view of its activities. The article also clarifies the function, content and duties of supervision or the importance of supervision for the construction life cycle.

Currently, the Czech construction industry is almost at the peak of its staff and material capacities; the main topic between the employer and the Contractor is the ratio of quality and construction price. This ratio can never be determined exactly, but it can be checked and monitored during the actual course of construction. Among other things, the position of technical supervision is included between these two entities. Emphasis should be placed on independence, technical expertise and competence in supervision performance. If these requirements are to be fulfilled, it is mainly external supervision, i.e. supervision by external persons (legal entity).

## 2. The Position of Technical Supervision

### 2.1. The Position of Technical Supervision in the Czech Republic

The public contracting authority of the Directorate of Roads and Highways currently exclusively uses business Conditions of Contract for Construction that are standardized by the International Federation of Consulting Engineers FIDIC [1, 2]. It is necessary to note that the employer has the right to choose the type of Conditions of the Contract for

Construction when awarding procurement procedures. At the same time, it can freely change individual provisions in the special business terms and Conditions of the contract at its discretion. According to the Conditions of Contract for Construction the FIDIC, the engineer has two main roles:

1. Role – acts and represents The Employer. He does not have the authority to change the contract for the work, but he is the bearer of most of the approval and approval processes within the construction.
2. Role – to be a neutral expert determining a fair solution.

It is also evident that the overall content of the performance of technical supervision and the engineer is not only about the performance of one individual. Therefore, a team of Engineers needs to be defined. This is a multi-member team of experts, where the powers, competencies and overall performance of supervision (The Engineer) will be divided among several people, ensuring proper service performance. Determining the exact number of members of the Engineer teams is entirely up to the employer, which the Engineer team defines during the preparation of the selection procedure for the supervision service [3]. At the same time, the employer must reflect the complexity and technical parameters of the given building. In the case of large-scale transport constructions, it is possible to list some positions more than once. On the contrary, for example, if the planned construction does not include, e.g. bridge structures, there is no need to consider the specialist position for bridge structures. For the overall determination of the members of the Engineer team, it is necessary to reflect on the following:



- expected financial volume of the construction,
- defined type of construction – new construction/reconstruction under existing operation,
- list of construction objects,
- technical specification of the building.

## 2.2. The Position of Technical Supervision Worldwide

It is evident from the conducted global research that even if a country has its own contractual standards that correspond to the laws of the given country and the appropriate customs in the given country, the world-recognized standards of FIDIC, ICE [4] or AIA [5] are still the most commonly used. Furthermore, it is necessary to reflect that not only in Europe but also in the world, contractual forms of a different type are often used, e.g. EPC [6] and Turnkey. When analysing the performance of technical supervision worldwide, it is also necessary to consider its supervision terminology and scope. A great variety of terms and their interpretations, including different contents of the activity, was found:

- The engineer – this is the performance of The Engineer as stated in the FIDIC Conditions of Contract for Construction. [ 1 ]
- Engineer representative – this is a representative of The Engineer according to FIDIC Conditions of Contract for Construction, and we can consider him a permanent supervisor. [ 1 ]
- Site inspector - usually appointed for larger projects, is supposed to inspect construction works and represents The Employer. The construction inspector provides an independent assessment of the works and usually provides appropriate information to The Employer. It is advisable to elect several building inspectors for the largest projects according to their focus and fields. In this context, building inspectors do not take over construction work and are not responsible; they only inspect the work and provide an independent view. [ 2 ]
- Technical supervision - monitors public construction projects, such as highway construction, airport and bridge construction. The activity of the technical supervisor is directly related to the implementation of construction works. At the same time, he is familiar with all aspects and contractual relationships on the project. The technical supervisor checks and monitors that all construction stakeholders are working as they should and performs a visual inspection of the work performed. Technical supervisors can provide monitoring reports and construction reports. [ 8 ]
- Resident engineer - is responsible for ensuring that the construction work on the project is carried out in accordance with the contractual requirements for quality, time and cost. He is responsible to the Project Engineer and is often the intermediary between him and the Contractor. The exact responsibilities of the Resident Engineer will vary according to the extent of authority delegated to The Engineer. He must keep The Engineer

informed of current work on the site and keep detailed records of all matters that may affect The Engineer's instructions. Under the terms of the contract, The Engineer may choose to delegate additional duties and responsibilities to the Resident engineer. [ 9, 10 ] This term is mainly used in the Institution of Civil Engineers (ICE) terms and conditions, which are the most widely used worldwide. [ 11 ]

- Consulting engineers - provides engineering services and expertise for public and private sectors. Consulting engineers act as independent workers and representatives of their clients. They are responsible for finding solutions to technical problems and providing management consulting services. [ 12 ]
- Project manager – this is a person other than The Engineer; in particular, he is not independent. He can perform many similar duties as The Engineer, and the Contractor understands his actions as those of the Client. [ 11 ]

## 3. Research Methodology

The research methodology includes three phases. The first phase focuses on the state of technical supervision in the Czech Republic and abroad. Its work content will be determined, including its valuation method within the framework of a public contract in the Czech Republic.

Phase two deals with data collection and analysis processes, which include the real-time requirement of activities during the performance of technical supervision. At the same time, the tools used in the performance will be examined. The last phase is analysing the data found from the questionnaire research, and new measures will be proposed, which will be evaluated and commented on. Theoretical methods are mainly used for research, such as analysis, induction, deduction or comparison. Furthermore, basic scientific, mathematical and statistical methods are used in the work. As part of the research, a questionnaire survey was conducted among workers performing technical supervision in the Czech Republic and Slovakia. This is an anonymous questionnaire among independent technical workers who hold various functions of technical supervision and, at the same time, work on different construction sites. The questionnaire contains a list of 28 supervisory activities (see Figure 4) that a properly qualified technical supervisor should perform. This list of activities corresponds to the scope of services according to standardized contractual relations for providing technical supervision services in the Czech Republic [ 13, 14]. The persons carrying out technical supervision then added time data to the individual activities, how long they performed the given activity per week, and also indicated what tools they needed and used for this activity. The persons addressed work on various detailed and large-scale transport constructions, i.e. some of the filled-in data relating to activities on the construction of a highway

section with an investment value of over 40 million EUR, and this is the position of permanent supervisor, another person, on the other hand, supervises smaller constructions and takes into account, that he is in charge of more of these buildings. Therefore it is a type of occasional supervision. At the same time, the persons addressed work in various positions performing technical supervision. They were included in the questionnaire both the head of a multi-member Engineer team and, for example, the position of Quality Manager, the position assistant to the engineer for bridge structures or, as mentioned earlier, the technical supervisor for smaller-scale constructions, which is in charge of the entire range of these activities, were approached. This division was chosen on purpose, as it is intended to be a summary overview of the position of technical supervisor. Individuals filled out the survey independently of other individuals, and it was recommended that the interviewed person monitor (ideally measure) the time spent on the given activity during the working week and then fill in the data. The weekly interval was chosen as sufficiently representative time data, which can also be converted to a monthly interval.

## **4. Performance of Technical Supervision**

### ***4.1. Performance of Technical Supervision in the Czech Republic***

In the Czech Republic, the performance of technical supervision on procurement procedures public contracts assigned and legally obliged to be ensured by The Employer of the public contract. Among other things, two forms of supervision are distinguished in the case of public procurement, i.e. permanent supervision or occasional supervision. [ 15 ] At the same time, it is necessary to reflect on the fact that the employer's capacities can also perform technical supervision. Therefore, it is also necessary to distinguish 3 basic technical supervision performance types from this point of view.

- The engineer and his entire team are composed only of the employer's employees => the employer completely ensures the performance of supervision himself.
- The engineer and dedicated assistants are employees of the employer, but part of the assistants are from an external consulting firm => supervision is handled by the employer and, at the same time, by external workers based on a contractual relationship.
- The engineer and his entire team are composed only of external employees, i.e. an external consulting firm => supervision is performed only by external workers based on a contractual relationship.

### ***4.2. Determination of the Optimal Price for the Performance of Technical Supervision***

The Determining optimal and adequate price for the technical supervision service cannot be determined exactly. The unit price for the performance of technical supervision is a numerical evaluation of complex performance, including

adequate technical expertise and is not only about direct profit and labour costs. Especially if it is a person in an employment relationship, a considerable part of the unit price for services falls to the employer, who has other costs, which, on the other hand, must include these costs in these unit prices. The unit price then corresponds to the company's overall approach to performance, e.g. further professional growth of employees, adequate IT equipment, company innovation, competitiveness, etc. The unit price must possibly include the costs associated with housing at the construction site and the costs of travel expenses, which is pointed out by the contracting authority during when procurement procedure. In the case of a physical person who has the appropriate authorization to perform and is the holder of a trade license to perform supervision, the side costs that must be included in the total performance price are diametrically different.

On the other hand, it is very difficult for these persons to obtain reference sheets from large construction projects and thus to meet the qualification requirements in the selection procedure for more significant constructions. The invoicing of the performance of supervision corresponds to the actual performance of services and is determined according to the implementation contract, where the terms of payment and the price for the services are stated based on the public contract that took place. Usually, the total price for a public contract is determined based on the financial rate and the time interval. The choice of a unit of measure that will be fully optimized for the performance of technical supervision cannot be determined exactly. The time interval as a unit of measurement does not fully describe the performance itself; on the other hand, the performance of technical supervision does not describe the number of performed actions either. E.g. during supervisory activity, when checking the variation sheet, performance cannot be measured only according to the supervisor's opinion submitted – whether they agree/disagree with the variation/claim. The performance of supervision is not defined only by the normative side of the submitted opinion; this action includes many other activities, such as the study of documentation and documents (project documentation, construction diary, the financial drawdown of items, etc.). The approach that the unit of measure for the performance of supervision will be the directly given activity or task evaluation would be possible provided that it was clearly defined how exactly this activity should take place, including clearly defined input parameters, E.g. in the laborer profession, when digging the soil, it is possible to clearly determine what kind of soil will be the subject of the activity, how much of the activity there will be, and what tools the worker should use for it. Therefore, the measurement unit EUR/m<sup>3</sup> or only the monetary evaluation of EUR can be determined.

In the case of professional activity, which includes the performance of technical supervision, the input parameters of the activity are not clearly defined, and the primary activity itself is conditioned by another activity that must be performed to fulfill the primary activity. It is also a matter of course that the worker in question has professional knowledge and skills that he uses for the given activity. On a sample of 70 transport constructions of the public employer Directorate of Roads and Highways [ 9 ], it is also possible to trace the contractual relationship to the performance of technical supervision or The Engineer. From the value of the contractual relationship for the performance of technical supervision, the percentage ratio of the costs of the performance of supervision to the contractual value of the construction activities is calculated. From the values found, it can be stated that if it is necessary to flat-rate the price of technical supervision, the average cost of technical supervision amounts to 3.69 % of construction costs. A proportional percentage determination was carried out for the flat-rate evaluation of the performance of supervision on 70 transport constructions of the public employer Directorate of Roads and Highways. It can be observed that even if the performance of technical supervision can be flat-rate and averaged from a financial point of view, an individual approach to each construction as such must still be maintained. From these data, it is also possible to observe the trend that the higher investment construction costs of the building are not directly proportional to the assessment of the performance of technical supervision. The relationship does not apply. The more expensive the building, the more expensive the performance of supervision; on the contrary, according to the data found, it is possible to observe a downward trend in the valuation of the performance of technical supervision from buildings worth 28 million to 40 million EUR. This observed trend can be attributed to the fact that for the performance of the technical supervision and the entire team, it no longer makes a fundamental difference whether the investment costs are 40 or over 120 million EUR. The variable is only on the Contractor's side for the volume of work performed, i.e. in a certain volume of supervised and controlled work, the volume of work ceases to be decisive for the performance of technical supervision.

#### 4.3. The Importance and Role of Technical Supervision

As part of the performance of technical supervision, one of the main tasks is to control the quality of the work performed by the Contractor, as the Contractor is fully responsible for the construction work as such. Technical supervision enters the construction process itself before its implementation. Before starting the construction activity, it is necessary to assess the technological process of work chosen by the Contractor and its compliance with the project documentation. All subcontracting, products, building

materials and mixtures that will be incorporated or used in the performance of the work are also subject to assessment. The Contractor is obliged to submit them to the Employer / the engineer for approval.

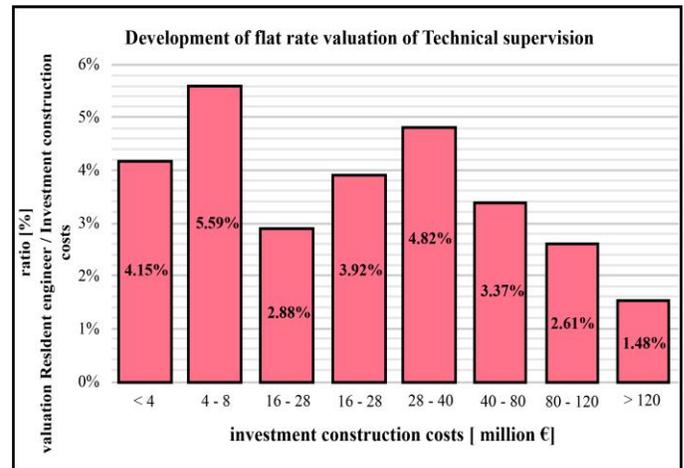


Fig. 1 Flat rate valuation of Technical supervision

As part of verifying compliance with the resulting parameters, a control test plan is used, containing the tests and measurements required by the documentation, technical quality conditions or special technical quality conditions. Its production and evaluation are the conditions for achieving the final quality requirements of the Works. Through its presence on the construction site, technical supervision controls and assesses the fulfillment of the approved technological procedure of works and control test plan of the Contractor, including using only approved materials by the engineer. At the same time, the technical supervisor agrees and takes over the work already performed. In the event of a discrepancy - whether in the progress of the Contractor's work in the implementation or use/installation of non-compliant products, the technical supervision, according to FIDIC, has the authority to request corrective work, or in extreme cases, the work may be rejected. However, it is possible to largely prevent such situations due to the physical inspection by the technical supervisor directly on the construction site during the implementation of the work. Even a mere visual inspection often reveals defects or deviations from the project. At the same time, timely notification to the Contractor minimizes possible consequences that would otherwise occur, and their impact could manifest itself only when the work is after the warranty period. The beginning of the warranty period is given by a Taking-Over Certificate of the performed work issued by the employer. However, this activity is preceded by the technical supervisor's final inspection of all collected documents, such as test reports, geodetic surveys and evaluations of defects and unfinished work that prevent or impede the use of the Works.

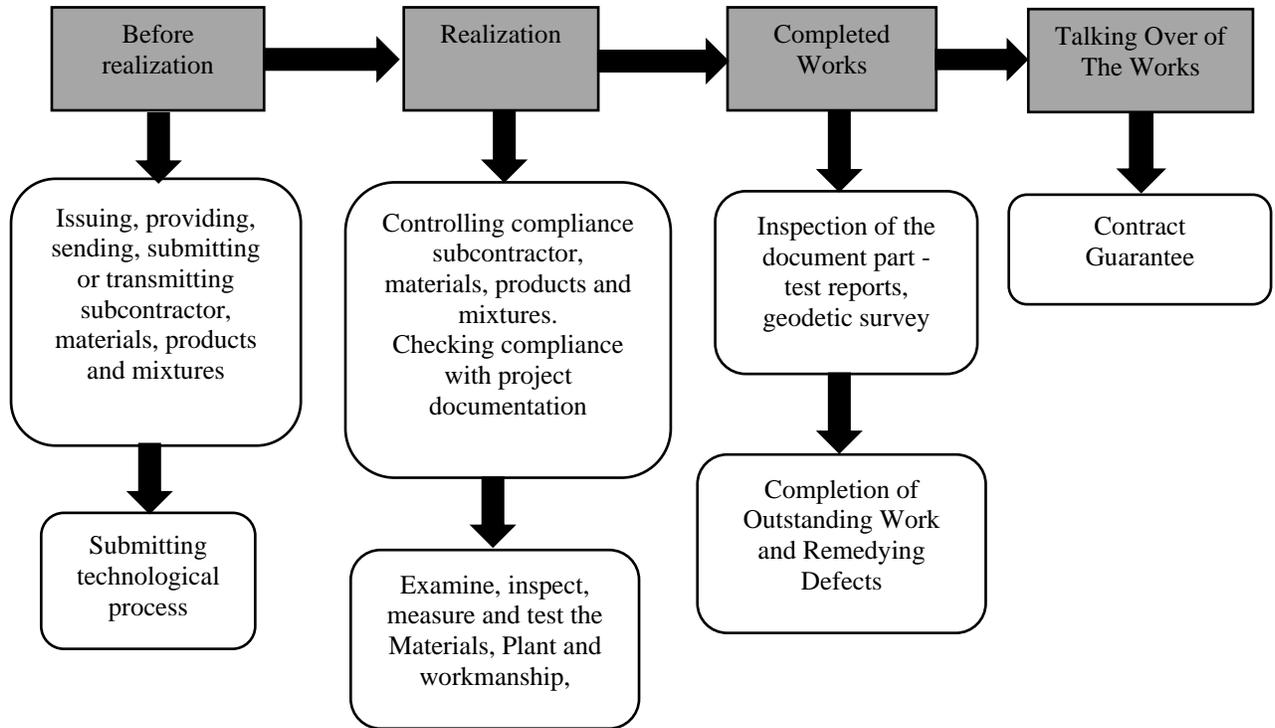


Fig. 2 Illustrative scheme of performance of technical supervision within the whole realization

### 5. Quality of Performance of Technical Supervision

Even though the quality of services nowadays can also be defined numerically, i.e. measurable data, it is still a matter of sensory perception and a subjective view. [17] A distinction must be made between product quality, which can be clearly defined by meeting a certain parameter, and service quality, which cannot be quantified by a person alone. Currently, service quality is commonly evaluated using a reference point of view communicated by the customer. [18] Another perspective that can be used to look at the technical supervision service is based on the division of work tasks into the categories of routine activities and knowledge activities. [19]

	<b>Routine</b>	<b>non-routine</b>
<b>manual</b>	<ul style="list-style-type: none"> <li>- machine operation</li> <li>- packing and palletizing</li> <li>- dosage</li> </ul>	<ul style="list-style-type: none"> <li>- repair and renovation</li> <li>- services and personal care</li> <li>- driving means of transport</li> </ul>
<b>knowledge</b>	<ul style="list-style-type: none"> <li>- counting and billing</li> <li>- data collection and processing</li> <li>- text and data proofreading</li> <li>- measurement</li> <li>- quality control</li> </ul>	<ul style="list-style-type: none"> <li>- research and analysis</li> <li>- evaluation and planning</li> <li>- construction of rules and procedures</li> <li>- learning, training</li> <li>- leadership</li> </ul>

Fig. 3 Categorization of work tasks [ 19 ]

From this categorization, presented in Figure 3, it clearly follows that the easiest activity to automate and robotize is a routine and, at the same time, manual activity. It is based on simple manual tasks in a predefined environment. The second possibility resulting from this categorization is a non-routine and, at the same time, manual activity, which is already more difficult to automate. These are predictable manual skills, but the action itself is unpredictable and requires adaptability and visual and verbal contact to specify the action further. Hairdressing is an example, it is a manual service, but every customer wants a haircut differently. Another example is a bus driver; even if he drives a predefined route and always uses the wheel, there will always be a different flow of traffic, etc. The third category is routine and, at the same time, knowledge-based, which means that even if it is always the same action and activity, it must be performed by a qualified person. This group could mainly include office work for corporate companies, etc. The last category is non-routine and current knowledge activities. These activities require flexibility, creativity, organizational skills, use of judgment and decision-making skills. The performance of the technical supervision of the investor fully meets the knowledge category. At the same time, some actions could be classified as routine, but a significant part is still non-routine. Precisely routine actions can be considered an opportunity to digitize and automate the performance of supervision using, for example, BIM (Building Information Modeling) or other applications, which then perform the given activity. [20, 21, 22]

I. Categorization		Description of technical supervision activities	II. Categorization routine / non-routine manual / knowledge	III. Categorization CDE distribution
Physical inspection of the construction	1	Physical inspection of construction work - a general overview of the construction process	routine/knowledge	Construction activities
	2	Physical inspection of construction work - the requirement for inspection of partial units (acceptance of reinforcement, acceptance of backfill)	routine/knowledge	Construction activities
	3	Physical inspection of construction work - presence during the fulfillment of the inspection test plan (compaction test, concreting tests)	routine/knowledge	Construction activities
Administrative inspection activity	4	Photo documentation processing	routine/knowledge	Processes
	5	Registration in the construction diary	routine/knowledge	Processes
	6	Approval of the amount of work performed by the Contractor - measuring diary or other methods	non-routine / knowledge	Processes
	7	Control of the financial performance of the construction - financial schedule of the Contractor and invoicing of the Contractor	non-routine / knowledge	Processes
	8	Checking the time performance of the construction - the time schedule of the Contractor	non-routine / knowledge	Processes
	9	Quality control - approval process of newly issued technological regulations and control test plans	routine/knowledge	Documents
	10	Quality control - approval process of embedded materials	routine/knowledge	Documents
	11	Review and approval process Project documentation	routine/knowledge	Documents
	12	Control of project documentation with respect to the detected condition on site	routine/knowledge	Documents
	13	Checking the documentary part of already completed construction works	non-routine / knowledge	Documents
	14	Inspection of the documentary part of already completed construction objects - acceptance procedure	routine/knowledge	Documents
	15	Checking the incorporation of comments on documents already submitted	routine/knowledge	Documents
	16	Coordination meetings - physical presence	routine/knowledge	Documents
	17	Coordination meetings - video conferencing	routine/knowledge	Documents
	18	Coordination meetings - the creation of records, preparation, etc.	routine/knowledge	Communication
	19	Processing of statements, technical supervision, and others	routine/knowledge	Communication
	20	Control of the correctness of Variation and Claim during construction	routine/knowledge	Communication
	21	Internal meetings - physical presence	non-routine / knowledge	Communication
	22	Internal meetings - video conferencing	non-routine / knowledge	Communication
	23	Internal management or other internal agenda	routine/knowledge	Communication
	24	Email communication - Contractor / Client	non-routine / knowledge	Communication
	25	Email communication - internal	non-routine / knowledge	Communication
	26	Telephone communication - Contractor / Client	non-routine / knowledge	Communication
	27	Telephone communication - internal	non-routine / knowledge	Communication
	28	other activity	various	various

Fig. 4 List of activities during the performance of technical supervision and their categorization

**5.1 Actual performance of technical supervision activities in the Czech Republic**

As part of the research, a tabulation of the display of individual activities that were listed in the questionnaire is processed, and these are activities carried out during the performance of supervision. It is possible to carry out a categorization with regard to the method of performance, i.e. whether it is a physical inspection of the building or, on the other hand, whether it is an administrative control activity of the building. Physical control of the construction is understood as a direct presence on the construction site, and administrative control activities are office activities outside the construction site. Categorizing and breaking down these activities can also be done, which are routine / non-routine and which are manual / knowledge. Further categorization of actions during the current performance of technical supervision can be done from the point of view of the future introduction of BIM and CDE (Common Data Environment). The common data environment has 4 main parts – 3D model/communication/processes/documents. [23,24,25]

From the first categorization, it is quite clear that the activity of performing technical supervision is 90% administrative control activity, and only 10 % of its actions are directly connected with control on the construction site. In other words, the activity of technical supervision is mainly carried out in the office, on the equipment of the construction site and outside of direct contact with real construction activity. This statement also corresponds to the fact that the Contractor carries out direct construction work, and the supervision performance is mainly a control activity. It follows from the second categorization that the activity of performing technical supervision is, in all its parts, a knowledge activity. At the same time, only 1/3 of the activities can be defined as non-routine. The remaining activities can be characterized as routine and can be considered activities that could be optimized and solved more effectively.

**6. Results and Discussion**

The time point of view of individual technical supervision actions was monitored as part of the research. At the same time, a categorization was carried out with regard to the method of performance, i.e. whether it is a physical inspection of the construction or, on the other hand, whether it is an administrative control activity.

- Physical inspection of the construction - The technical supervisor spends an average of 25.0 % of the working time on these activities
- Administrative control activities of the construction - The technical supervisor spends an average of 75.0 % of the working time on these activities.

Another possible categorization of activities in the performance of technical supervision activities is carried out within the framework of the four main parts of the BIM

method. This categorization aims to demonstrate that the assumed BIM and CDE model is completely based on already current procedures and processes.

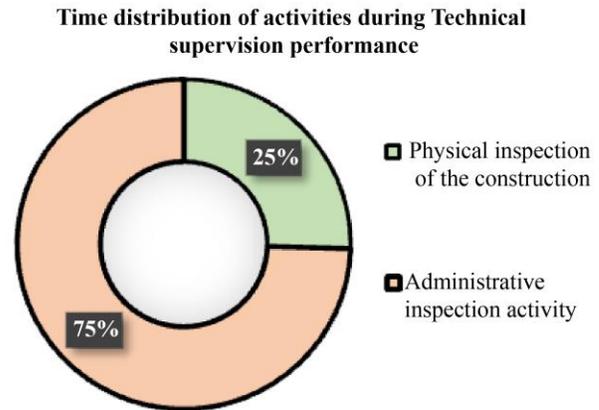


Fig. 5 Time distribution during the performance of technical supervision

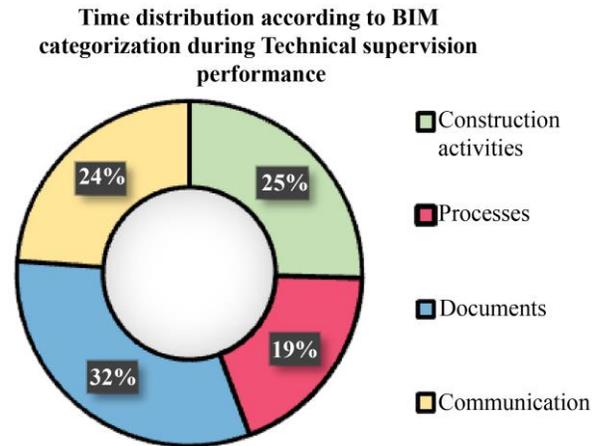


Fig. 6 BIM time distribution during technical supervision

- 3D Model (Construction) can be assigned to 3 activities out of a total of 28. The technical supervisor spends 25 % of his working time on these activities.
- Communication can be assigned to 10 activities out of a total of 28. The technical supervisor spends 24 % of his working time on these activities.
- Processes can be assigned to 5 activities out of a total of 28. The technical supervisor spends 19 % of his working time on these activities.
- Documents can be assigned to 9 activities out of a total of 28. The technical supervisor spends 32 % of his working time on these activities.

From the above, it follows that the main benefit of the possible introduction of digitization and BIM will affect the performance of supervision, especially in the way of communication, work with documents and mutual interaction between subjects (processes). On the contrary, it can be stated that the application of drawing models in 3D format will not fundamentally affect the performance of technical

supervision. As part of the research, an analysis of the advantages and disadvantages of the time intervals used was carried out, and at the same time, the overall non-systematic solution is pointed out since the performance of technical supervision is also carried out outside the time intervals that are not invoiced financially, but this is the period when the performance is contracted. There is also a situation where technical supervisors are appointed on construction sites and reported at the same time. Still, they also work on other construction sites simultaneously, so they cannot be invoiced; thus, the supervision performance cannot be carried out fully.

In another case, there is a situation where the supervisor on the construction site is listed in the form of a Permanent supervisor, i.e. every working day throughout the construction period, but his actual workload does not correspond to this. It can cause either an incorrect balance sheet during public procurement when the position is requested full-time or caused by the construction's progress. The progress of the work itself is under the responsibility of the Contractor, i.e. the position of specialist supervisor for bridge structures will be possible to perform when the Contractor proceeds with the implementation of the bridge objects, which may be when the re-laying of engineering networks and other conflicting elements of the construction are completed. In this case, when the supervisory position is fully occupied, it is not used effectively. This fundamental contradiction leads to the newly proposed concept of financial performance, i.e. flat-rate performance of technical supervision. As part of the survey, the percentage ratio between construction investment costs and the costs of performing technical supervision is determined. The Directorate of Roads and Highways can use this ratio to determine the expected price for the supervision service. The accepted contract price itself is determined by tender, but this price should now be paid by the employer as a flat rate (monthly/quarterly) regardless of the actual number of persons performing supervision in the given period. The public contracting authority of the Directorate of Roads and Highways should emphasize the fulfillment of all supervision activities as defined by the scope of services in the given contract, not monitoring how long and with what tools the person performing the supervision performs the action. Clients should completely abandon the opinion that the performance of technical supervision is mainly carried out by physical presence on the construction site. The mere existence of a supervisor at the construction site without appropriate actions is an inappropriate and uninformative act that does not mean much. Another important part of pricing surveillance performance is using an appropriate time interval. The current model, where the public contracting authority Directorate of Roads and Highways uses invoicing time intervals - hour/day/week - is not fully indicative of technical supervision's performance. The chosen model of the Directorate of Roads and Highways is also approached

with regard to compliance with the methodological instruction, where technical supervision is divided into Permanent and Occasional supervision.

The solution is to make the performance itself flat-rate, and the unit of measurement of the technical supervision activity should be a set or a flat-rate valuation. With this solution, both the contracting authority and the provider of supervision services must be aware of the procurement parameters, study them very thoroughly, and define what is included in the lump sum assessment and what is not.

## **7. Conclusion**

The real quantification of the performance of technical supervision is always dependent on the implementation contract and, at the same time, is determined by the technical structure of the construction work. Therefore, the performance of technical supervision was categorized from several perspectives. The main categorization of the performance of technical supervision and its quantification was carried out with regard to the type of activity, i.e. it was analyzed that 3 activities out of 28 are connected with physical control directly on the construction site, and at the same time technical supervision spends 25% of the working time on these activities.

The second part of activities is collectively called administrative control activities, which is 25 activities out of 28, and technical supervision spends 75% of the working time on these activities.

The second categorization and quantification of the content of technical supervision activities are based on the impending introduction of the BIM model in the Czech construction industry. According to the BIM division, administrative control activity can be further divided into documents, processes and communication. Conversely, the last part of BIM, i.e. the 3D model, can be considered an activity corresponding to physical inspection.

By summarizing the activities during the performance of supervision and its time frame for performance, it is possible to determine the optimal time interface between individual activities, which the technical supervision of the investor should carry out. The timing interface considered in this way should be considered only as an example, i.e. it is necessary to respect the fact that in normal practice, not all activities take place at one moment or in one short time interval (working week). The determined values define the time frame for us when the technical supervision performs all the prescribed activities in the optimal time. Then it should be a quality performance of the investor's technical supervision. Contractual agreements are fulfilled that the performance is performed comprehensively, i.e. in the entire range of services. There is no situation where one activity is prioritized over another, and that one is not completely neglected.

The resulting product, which every Client wishes for, is a quality management-controlled building, which will be implemented according to the work contract. Of course, almost every construction work undergoes changes not only in technical nature but in terms of finances and time during the implementation. However, these changes cannot be understood as a negative circumstance on the part of the Contractor, the Customer or the technical supervisor. In the ideal case, the highest quality performance of technical supervision could be considered to be one where the construction work is monitored and controlled, carried out according to the contract for the work in the prescribed quality and without any changes. Unfortunately, in construction practice, this state is very difficult to achieve, so it is more appropriate to think that all unforeseen circumstances that arise during construction will be resolved or are in the process of being resolved. A building that will, as a result, contain dozens of financial changes, as well as a possible time shift in the completion date, can be considered a high-quality performance of technical supervision. The quality of supervision consists of the process of solving the events and circumstances that have arisen, and it also consists of the correct and independent assessment of these situations, not least in checking compliance with all prescribed quality parameters of the building. Situations such as the stoppage of construction work, lawsuits, withdrawal from contractual performance, etc., should always be avoided.

At the same time, the quality performance of technical supervision must also be viewed from a control and preventive point of view. Regular inspection of the work carried out by the Contractor prevents possible defects in the work and thus claims procedures that could arise. By independent control of the quality parameters of the work performed, it is possible to achieve maximum values within the life cycle of the building, of course, assuming proper management and maintenance of the work in the operational phase. Ensuring the independent control of the financial aspect of the construction is achieved so that public finances are used in accordance with laws and regulations. The research found that the historical view of the technical supervision service when the performance of technical supervision is only carried out on the assumption that the person in question is directly on the construction site is wrong. The performance of supervision is always technically linked to physical presence on the construction site, but physical presence on the construction site is not the only main activity of supervision.

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## 8. Research Implications and Future Recommendation

In conclusion, there are implications from the results obtained that according to the BIM division, the main areas where it would be possible to streamline the performance of technical supervision are Processes, Documents and Communication. The streamlining of these activities does not need to be conditioned by the introduction of the BIM method. Adequate IT tools can be used even nowadays, which can be very beneficial and simplify activities. And it is not only about IT tools but also about the mutual agreement between all interested parties. It is necessary to contractually ensure the acceptance of pre-agreed procedures and the use of IT tools, and at the same time to resolve their operation, responsibility and the subsequent management of data and information. Optimizing and streamlining the performance of technical supervision alone should not lead to a situation where the supervisor will have more time within the given construction because part of the existing documents and processes will be carried out more efficiently than before. At the same time, this saved time can be devoted to other constructions. This procedure would lead to time overload for the workers themselves. It would not be motivated in any way, as the time saved by streamlining performance on one construction site would lead to technical supervision performance activity on another construction site. Streamlining the performance of technical supervision should lead to the fact that, while maintaining the range of services, this service would be improved and the time saved can be devoted to activities that are neglected at the expense of the previous one. When performing technical supervision and the time-consuming nature of individual activities, there are still activities that cannot and will never be made more efficient. It is precisely these activities that must be taken into account and given adequate time.

Efficiency in the performance of technical supervision should also have the consequence that the performance of technical supervision itself and the entire range of its activities will be flat-rate not only from the point of view of valuation but also from the point of view of the time scale of individual activities.

## Conflicts of Interest

The author declares that he has no conflicts of interest to report regarding the present study. Data generated or analyzed during the study are available from the corresponding author by request.

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