

Development of a Project Objective and Requirement System (PORS) for major infrastructure projects to align the interests of all the stakeholders

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ABSTRACT: Major infrastructure projects often exceed estimated costs and schedule. Therefore, they do not achieve the desired quality. The difference in objective interests of the project participants is a major problem. Based on the difficult contractual relationship and the late involvement of all contractors, there is a lack of information for all those involved. This gap of information can be described by the principal agency theory from the new institutional economics. One way to reduce this information deficit is to use other delivery models, contracts and methods. Delivery models like Integrated Project Delivery (IPD) with the contractual relationship and the early involvement of all the participants creates a sooner understanding of the project. This can reduce information losses. However, the current project execution models do not have a smart objective system which records the interests of the client from start to the end of the project. They are not documented with the start of the project, neither adapted iteratively. Also, these objectives don't get used to define the requirement and specify that. With the help of the recently created project objective requirement system (PORS), the objectives of all project stakeholders can be selected, checked and compared. Followed by the transfer to the requirement management. With the PORS an incentive contract can be created and thus an incentive mechanism implemented. In addition, the project delivery on time and within the budget is strongly supported.

1 INTRODUCTION

Major infrastructure projects often exceed the budget as well as the schedule and do not achieve the desired quality. This is often caused by the complexity of the construction project and the long building process (Kostka & Fiedler, 2016, p. 2). A factor for missing the planned aims is an inadequate ascertainment of demand (Warda, 2020, p. 23). Ascertainment of demand takes place at an early stage, during the initiation phase. Project goals and objectives are defined and set in terms of time and budget (Lindahl & Ryd, 2007, p. 150). Often - even before planners are involved - incomplete or unsustainable requirements are stated/defined by the principal. The planning phase must be preceded by a definition of the initial project goals of the principal (BMDV, 2018, p. 5). This usually leads to further mistakes in the planning phase. These are later followed by wrong decisions and disruptions. Furthermore, the principal's project objectives are often incompletely and incorrectly assessed. So, the ideas of the principal cannot be addressed. The increasing number of interfaces in major infrastructure projects also makes it difficult to work in a common direction towards a project goal (Püstow, May, & Peitsch, 2015, p. 15). In this context, the traditional project delivery models lead to further conflicts of objectives between the project partners. The construction company will pursue its interest to maximize profit and to complete the project as cost-effectively as

possible. This divergence of goals can be described with the principal agency theory (PA-theory), of the economics. One solution to aligning the interests of all participants is an incentive contract. Integrated Project Delivery (IPD) regularly contains those solution mechanisms as well as further ones.

A new project objective requirement system (PORS) that records the goals and objectives, checks their relationship to each other. It helps to find the clear the requirements. After that it also help the investor to find the right project delivery model for his project. With an analyze of the goals (later on the objectives) and the requirement can be choose. This decision will be made by a qualitative and quantitative analyze in an Software tool. This tool with be development in the Research project Digital Performance Contracting Competence Center (DigiPeC). The focus of this Software is to support public clients to make complex infrastructure projects like tunnels to perform successfully. Also the PORS, monitors, reports and adjusts them according to the project dynamics. The PORS can contribute to achieve a project successfully on time and within the budget.

2 PROJECT GOALS AND OBJECTIVES

2.1 *Definition of project goals and objectives*

With the start in the project initiation phase the owner must define a determination of needs. At this stage the owner also has to set the project goals and later on the objectives (Simon, p. 30).

There are many definitions of the term “project goal and objective”. In the following discussion, the definition of the International Project Management Association (IPMA) Competence Baseline (ICB 3.0) can be used as a reference (International Project Management Association, 2006, p. 44):

“The project goal is to provide value to the interested parties. A Project strategy is a high-level view of how to attain the project goal. The project objective is to produce the agreed end results, especially the deliverables, in the time-frame required, within budget and within acceptable parameters of risk. The project objectives are the set of targets that the project, program and portfolio managers should attain to provide the expected project benefits to the interested parties.”

So, a project goal is an achievable outcome that is broad and long-term. The project objective is a specific and smaller task that serves a broader goal.

Since project goals and objectives are defined at the initiation stage, they are an important instance of making project success or failure measurable. For this reason, the goals and objectives should be formulated clearly and unambiguously. The project goals and objectives also serve to create a common understanding of the project content and to give all participants an idea of their intentions. So the typical project goals in tunnel projects are: Time, Cost and Quality. That also can especially extend at tunnel projects where the public perception has a big impact. The objectives of a goal as example for time: a milestone of a construction section. The project objectives can be identified and defined by the following method.

2.2 *Methods to find the goals and objectives of a project*

In literature project objectives are often identified using the S.M.A.R.T method. The method does mean Specific, Measurable, Achievable, Relevant and Time.

A consideration of objective relationships and objective compatibility does not take place in the S.M.A.R.T method (Schelle, Ottmann, & Pfeiffer, 2006, p. 133). The literature points out that the objectives should be described in great detail. In addition to the method mentioned above, there are further methods like Management by Objectives (MBO) (Dinesh & Palmer, 1998, p. 363) and Objectives and Key Results (OKR) (Niven & Lamorte, 2017, p. 6). The S.M.A.R.T method is presupposed as known. The MBO and OKR for determining objectives

are not dealt with in this article and are mentioned for the sake of completeness. They are mainly used in corporate management.

2.3 *Finding of goals and objectives in the PORS*

In the software application there is implanted a list of goals and objectives to support the user. In a workshop with a project manager, they will also interview the public clients to add specific goals and objectives for their project. Later on, every identify and chosen goal and objective get a priority. With an interdependency analysis the conflict of the objectives will be checked. After that there will be an event tree analysis (ETA) with a probabilistic approach to judge the risk to reach the project goal.

2.4 *Requirement management*

Requirement describes attributes, functionality and quality, which the product might have (Grande, 2014, p. 5). It's the same in construction industry. The increasing demand of quality and complexity results in the requirement management getting more attention. It is part of the management discipline to identify, describe, documented, verify, realize and control the requirements. Furthermore, there are several participants in a tunnel construction involved. So first of all, the owner has to implement the requirement management. After identifying his goals and objectives. The complete process from inception, design and production of the requirement management must be implemented. It also brings a better understanding of the project for all stakeholders (Miron, Luciana, I., G. & Formoso, Carlos, T., 2003, p. 4). From the goals to the objectives there can be a deduction of the requirements. These will be find by questionnaire and interviews (Miron, Luciana, I., G. & Formoso, Carlos, T., 2003, p. 4) of the participants. A matching method for this is the delphi method. But it's important to benchmark these information's with the prior goals and objectives. This review can be done by Plan-Do-Check-Act (PDCA) from quality management in the industrial sector (Isniah, Hardi Purba, & Debora, 2020, p. 72). To understand better the high relevance of the project goals and requirements the principal agency theory will be described.

3 NEW INSTITUTIONAL ECONOMICS (NIE)

3.1 *Main approaches of the NIE*

The new institutional economics (NIE) is a collective term from economics. It summaries various sub-approaches, and gains in importance in joint consideration with business administration (BA) (Ménard & Shirley, 2008, pp. 1–2).

There is no uniform agreement within the NIE regarding the scope of the theory, but three main approaches can be assigned (Obińska-Wajda, 2016, p. 79): transaction cost theory, property rights theory and the principal agency theory (PA theory).

Only the principal agency theory will be discussed. With this theory the problem of self-interest and information asymmetry in construction can be describe.

3.1.1 *Principal Agency theory (PA theory)*

The PA theory encompasses all relations between individuals, who are in mutual influence. In the PA theory, there is an economic relation between two parties (contractual partners). In this relation, the party's agent and the principal act together. One party (agent) and also the other party (principal) act separately (Werkl, 2013, p. 47) (Ceric, 2012, pp. 767–769) (see Figure 1). The principal represents the instructing party and the agent represents the contractor. The assignment of the agent is usually regulated by a written contract. As an approach of the NIE, the PA-theory indicates the behavioral model of Homo Economicus. This behavioral model means, that both parties are to be understood as rational utility maximisers, pursuing different goals (Rodriguez-Sickert, 2009, p. 223). The parties each pursue their own interests

without taking the interests of the other party into account. This action creates a conflict of interest between the parties, which is shown in Figure 1. Another characteristic of the PA theory is the information asymmetry. This is also called hidden characteristic. This information asymmetry is an advantage for the agent, since he has industry-specific knowledge, which he could use to maximize his profits. The PA theory will be transferred to the construction industry and the contractual relationship between the client (principal) and the building contractor (agent) will be described. The conflict of interest between the two contracting parties can be deduced from the basic principle of economic activity in a much more general way. While the client tries to maximize his benefit with the lowest possible remuneration, the contractor will try to maximize the remuneration with the least possible effort. The contractor is not interested in maximizing the resulting benefits. He is interested in minimizing his effort with a fixed expectation of remuneration. In their own interest, the contractor will try to use the knowledge advantage in his favor as much as possible. Then again, the principal cannot understand or check all the operations of the agent, meaning the principal could achieve a lower economic yield (Werkl, 2013, p. 47).

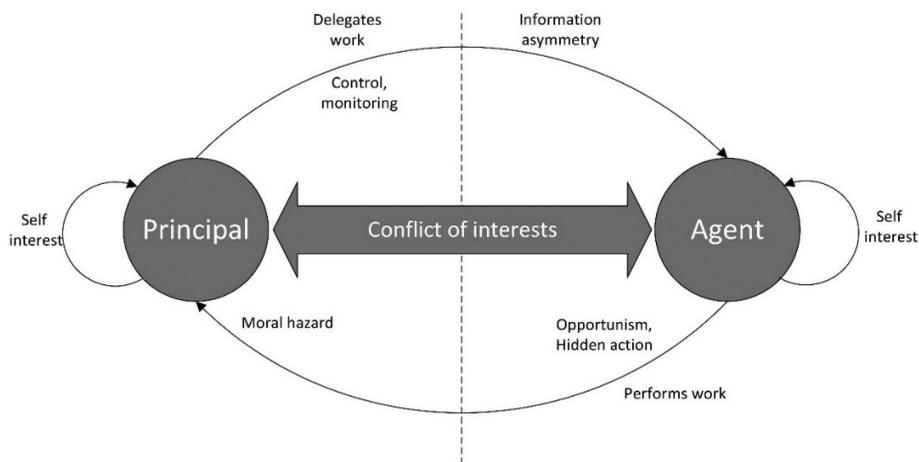


Figure 1. Visualization of the basic idea of PA theory (Snippert, Witteveen, Boes, & Voordijk, 2015, p. 572).

3.1.2 Possibilities to reduce the conflicts from the PA relationship

The relation between principal and agent has two essential characteristics (Hartmann-Wendels, 1993, p. 143): asymmetric distribution of information and Divergent benefits or objectives.

Building on this, the PA theory provides various approaches to reduce information asymmetry, to harmonize and align the goals between the parties. A chance to weaken the information asymmetry is to launch a monitoring system (Strausz, 1997, p. 354). The actions of the agent (construction company) are observed by the principal (client) in order to avoid hidden actions. The second option is to introduce a reporting system. Reporting is a form of delivery of information from the contractor to the client (Guston, 1996, 231). Another approach from the PA-theory is the implementation of incentive contracts. Incentive contracts avoid conflicts originating from the diverging objectives. This is primarily intended to mesh the goals of the principal and the agent. As a result, opportunistic behavior and an asymmetric distribution of information should no longer pose a threat to the achievement of his goals from the principal's point of view (Stukhart, 1984, p. 34). Provided that the principal and the agent are aware the consideration of incentives. So that the contract can ensure that the goals of both are considered.

Overall, it can be assumed that a favorable situation always arises for the principal when the agent has much to lose (positive incentive) and little to gain (e.g. little work suffering, saved resources) (Suprpto, Bakker, Mooi, & Hertogh, 2016, p. 1072).

3.2 Conclusion of the PA-theory for the software development an the PORS

Due to the preceding text, the PA theory can also be applied according to the construction sector. It is a fact, that the principal and the agent pursue different goals. In order to align these interests, an incentive contract is beneficial. Furthermore, the emerging conflict of the PA-theory can be further reduced through monitoring and reporting. But first at all the project goals must first be determined by the principal, then aligned with the agent by means of an incentive contract. The contract is the main element to align the interests of all the participants (Becker, 2022, p. 20). In the course of the project, appropriate monitoring must be set up on the principal's side and a controlling system function on the part of the agent to reduce information deficits. The possibility to create an incentive mechanism, to manage the goals and objectives and the other important results from the PA-theory will be implement in the PORS and the Software Application.

4 DEVELOPMENT OF THE PROJECT OBJECTIVE AND REQUIREMENT SYSTEM (PORS)

The previous chapters started that the project goals have to be defined (Figure 2, Step 1). This can be done with a project manager in a workshop and the Delphi method. Figure 2 shows the three typical goals based on the magic triangle. There can be more goals including the section of sustainability. Later on in the software tool will be a list of project goals. The project owner will define the objectives of the specific goals (Step 2). For example: to be in budget, get high position accuracy of the tubing, using environmentally friendly machines and low carbon development. This information can be obtained by project manager through workshops or interviews. However, at the end of this the software makes an interdependent analysis of the objectives.

Then the ETA will start. After that, the goals and objective will be transferred to the requirements (Step 3). This should be done in the normal requirement management flow. First to identify analyze, document and verify. Secondly it needs to be checked, if the goals and objectives fit to the requirements (Step 4). If it doesn't the process has to start again and the requirements and objectives had to be defined new. If it is at step five the delivery model and contract can be chosen. Which Delivery model and contract to should be chosen is firstly defined by the requirements and secondly by the complexity. Two other factors are the risk level and the level of design (Sander, Spiegl, Reilly, & Whyte, 2019, 4595). Later on in the application there will be more factors to choose the right delivery model. For example, the complexity of the tunnel project is high, the risk and also the of geological risks are high but the level of design is low. The PORS would choose as Delivery Model the Integrated Project Delivery. The contract could be a cost-plus incentive fee contract. Project delivery models consist of the allocation, the form of delivery and the contract (Sander et al., 2022, p. 12). In particular the delivery models differ in the transfer of information and the type of allocation. The distinction can be made between traditional project delivery (TPD) and IPD models. A TPD model has a sole contractor (SG) or general contractor (GC) and a unit price or a lump sum price contract. Integrated Project Delivery has an integrated form of delivery, all parties being involved. It is linked to a multi-party contract which includes an incentive contract (Fischer, Ashcraft, Reed, & Khanzode, 2017, p. 47; Sander, Spiegl, & Reilly, 2019, p. 36). The basic idea of IPD is to enable better handling of major projects. The aim is to achieve a faster and cheaper construction process, while increasing quality. With this form of execution, an integrated execution team consisting of at least the client, planners and building contractors or engineers is formed. They are working cooperatively and project-related. Therefore, they can

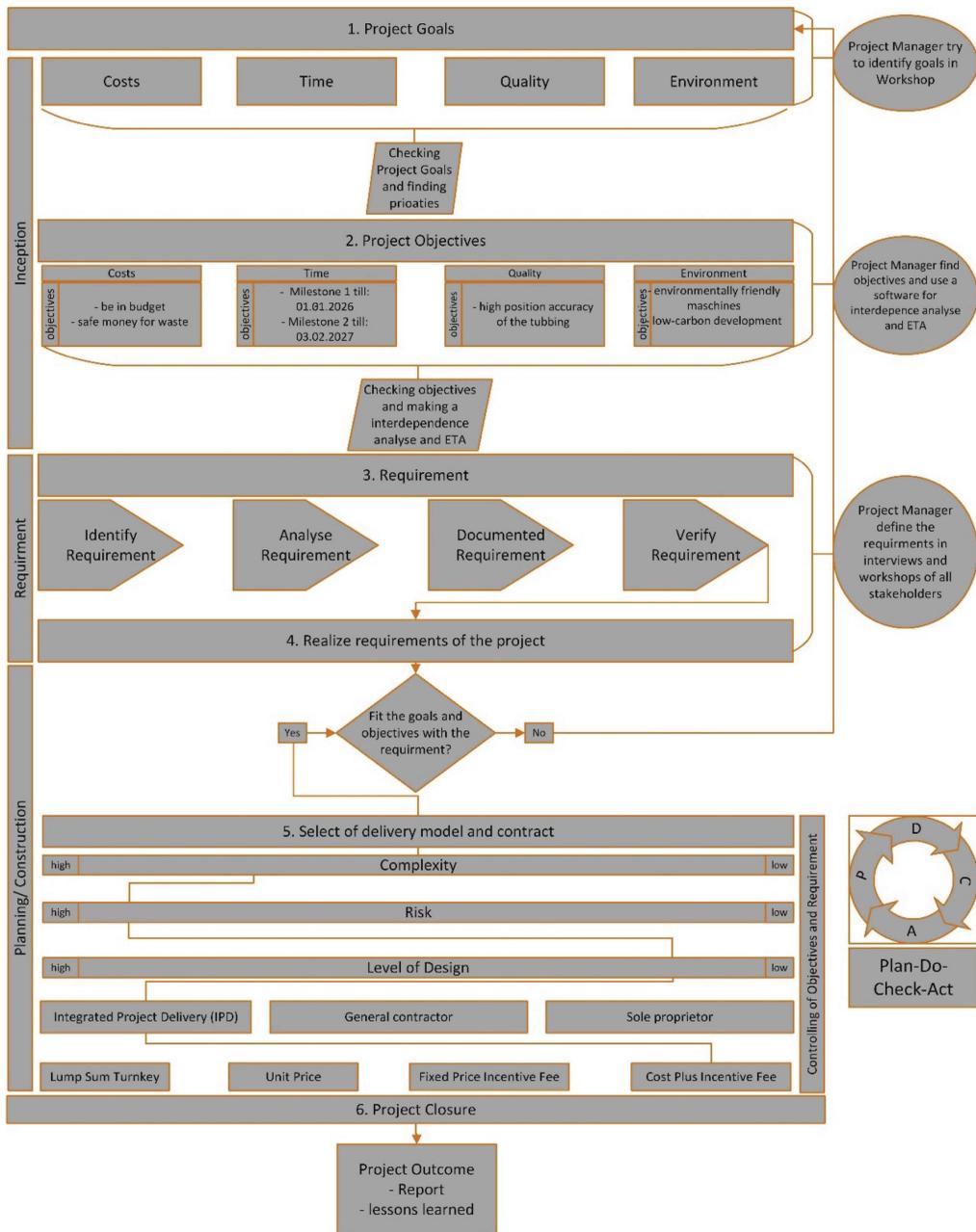


Figure 2. Steps of the process from the PORs.

execute complex, large-scale construction projects faster and more cost-effectively. All those involved in the project should be aware of the client's objectives from the outset and jointly develop project goals so that everyone involved is aware of the project requirements and the best possible solutions to achieve the set objectives (Warda, 2020, pp. 124–125) (AIA, 2007, p. 5; Cheng, Osburn, & Lee, 2019, p. 115). Through this whole process of planning and construction a controlling system for objectives and requirement must be implemented a. At step six, the end of the construction there a project report should be generated. Which shows how

fulfilled the requirements are, how many goals were achieved and which lessons can learn from this. To make these process more useable for the project manager, it will be implemented in a software tool. Which can support the project manager throughout the process from inception till the end of construction.

5 CONCLUSION AND OUTLOOK

The needs assessment for a major infrastructure project has a high priority, but usually gains too little attention. In this phase, the project goals and objectives are already defined by the client. Setting the project goals is an important milestone for major projects. After setting the goals it is important to define the objectives. This makes the status quo of the project better visible. After that the requirements should be defined. Using the PA-theory the importance of finding common goals and reducing information deficits are elementary components for the execution of a construction project. Currently, the project goal determination is only carried out at the beginning of the project. Projects are subject to high dynamics, which is why the project goals, objectives and requirements have to be adjusted ongoingly. A PORS that evaluates the goal and objective relationship among each other and brings together the objectives of the participants, which currently does not exist. This PORS would have to be applied to each project phase and provided with appropriate reporting. It has to be monitored whether the objectives have been achieved or have changed. The PORS in connection with an incentive contract could further support the cooperation and increase the success of the project. The development of the PORS is not completed. So there will be more criteria. In the next steps the software toll will be coded, tested and validate to make the PORS usable for the practice partner.

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