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COLLABORATION STRATEGIES FOR INFRASTRUCTURE PROJECTS OF GERMANY'S FEDERAL WATERWAYS AND SHIPPING ADMINISTRATION

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ABSTRACT

The improvement of collaboration in construction projects can lead to a more stable and efficient project delivery. Nevertheless, Germany's Federal Waterways and Shipping Administration (WSV) has limited experience with strategically implementing elements to promote collaboration in construction projects. Therefore, initial steps have been taken in the WSV by identifying major infrastructure projects along Germany's waterways to initiate the implementation of collaborative elements, such as Lean Construction methods. The aim thereby is to make experiences to improve future projects. This article describes a research project which was set up to systematically record and document experiences with collaboration elements in selected pilot projects. Also, the outcomes of an initial survey which gives insights into the pilot projects are presented. Furthermore, the results of a survey regarding experiences during the procurement phase of one chosen pilot project are presented. The results show that there is no clear definition of collaboration within construction projects in the WSV and that there is a need for further research to develop solutions and recommendations for the improvement in future projects by utilizing collaboration elements.

KEYWORDS

Collaboration strategies, infrastructure projects, waterway construction, system change.

INTRODUCTION

Collaboration between the participants of construction projects promotes the achievement of objectives and increases efficiency in planning and building services. Therefore, the implementation of elements to improve collaboration in projects is recommended in the Reform Commission for Major Construction Projects, the Planning Acceleration Strategy, as well as in the Major Projects Guideline by the German Federal Ministry for Digital and Transport (BMDV 2015, 2017, 2018).

Especially, large and complex construction projects are not usually accomplished within the intended time frame and budget. This also applies to projects of the Federal

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Waterways and Shipping Administration (WSV). For example, in some projects of the WSV the prescribed budget was exceeded by more than 30 %, and the construction time was doubled. In various water lock projects along Germany's waterways, it even has been observed that both the construction time and costs have quadrupled. (Schwarzweller et. al 2023) For example, these problems can be addressed by the utilization of methods that promote collaboration in construction projects, such as Lean Construction methods or Building Information Modeling.

Up to this point, there are only limited experiences within the WSV of implementing collaboration elements that potentially lead to more stable and efficient project deliveries. With this background, initial steps have been taken by the Federal Waterways and Shipping Agency (GDWS) to gather experiences with a strategic promoting of collaboration elements in the delivery of construction projects along Germany's waterways. Therefore, several infrastructure projects were identified throughout the WSV. Additionally, in 2022, a 'Charter for Collaboration on Construction Sites along Federal Waterways' was created and signed between the Association of the German Construction Industry (HDB) and the WSV. (WSV 2022)

The Institute of Technology and Management in Construction (TMB) of the Karlsruhe Institute of Technology (KIT) supports the GDWS, as organization unit of the WSV, with a systemized recording and documentation of the experiences in the selected projects. The aim hereby is to develop solution approaches and recommendations for the strategic implementation of collaboration elements to improve project deliveries of future projects along Germany's waterways. This paper presents the first results of the systemized recording and documentation of experiences up to this point.

COLLABORATION ELEMENTS IN CONSTRUCTION PROJECTS

In construction projects, the terms collaboration and cooperation are commonly used interchangeably in literature as well as intentionally distinguished from each other (Camarinha-Matos et al., 2009, p. 47). Therefore, it is not consistently possible to precisely delineate what is meant by these terms. Below are exemplary definitions for collaboration and cooperation.

Cooperation can be defined as "the authentic pursuit of the goals of the respective contracting partner or a goal alignment of the partners, in order to achieve a 'win/win' situation" (Schlabach, 2013, p. 50). Furthermore, according to Camarinha-Matos et al. (2009, p. 48), cooperation can also be understood as communication, information exchange, mutual activity adjustments, and shared resource utilization aimed at achieving common goals.

In contrast to cooperation, collaboration can be understood as a more enduring and comprehensive form of cooperation, where previously separate organizations work intensively on a common mission within a new structure (Mattessich & Monsey, 1992, p. 42). Additionally, collaboration is also perceived as a more communicative, intensive, and holistic form of cooperation, where the shared commitment to achieving project success and the establishment of a communal project culture are essential (Ibrom, 2022, p. 46).

Based on a literature review of various definitions of cooperation and collaboration, Schöttle et al. (2014, p. 1274) have developed an overview that allows differentiation based on various factors. The resulting definition of collaboration is meant when using the term within this study:

> *Collaboration is 'an interorganizational relationship with a shared vision to create a joint project organization with a collectively defined structure and a new and*

> *collaboratively developed project culture based on trust and transparency, aiming to maximize customer value collaboratively by solving problems through interactive processes that are jointly planned, and by sharing responsibilities, risks, and rewards among the key stakeholders'*
>
> (Schöttle et al., 2014, p. 1275).

There are various elements to promote collaboration in construction projects. These can be categorized into project culture and conflict management, organizational and procurement models, incentive systems within the compensation model, as well as methods to promote collaboration.

In many countries the necessity to improve collaboration in construction projects has been identified. Therefore, the implementation and utilization of work methods as well as project delivery models that promote collaboration are intensively discussed, e. g. in France (Attouri et al. 2023), Norway, Denmark (Paulsen et al. 2023), Peru (Prado Lujan & Murguia 2022), India (Pal & Nassarudin 2020), Lebanon (Abou Dargham et al. 2019), China (Li & Ma 2017), Saudi Arabia (Alsaggaf & Parrish 2016) or Colombia (Forero et. al 2015).

ANALYSIS AND EVALUATION OF COLLABORATION ELEMENTS IN WATERWAY INFRASTRUCTURE PROJECTS

OBJECTIVES AND STEPS OF THE RESEARCH PROJECT

Based on the assumption that successful implementation of construction projects is facilitated, among other factors, by the utilization of collaboration elements, the GDWS has developed a procurement strategy for major projects. Within this strategy, pilot projects were identified to initiate the implementation of collaborative elements and to gather experiences. Table 1 contains the 8 selected infrastructure projects in the field of waterway construction for this purpose.

Table 1: Overview of selected pilot projects

No.	Type of structure	Location	Brief description of undertaking
1	Weir	Wieblingen at River Neckar	Replacement construction
2	6 Weirs	Erlabrunn, Harrbach, Steinbach, Rothenfels, Faulbach and Freudenberg at River Main	Complete maintenance
3	Water lock	Oberesslingen at River Neckar	Maintenance during operation
4	Water lock	Hessigheim at River Neckar	Landside soil improvement
5	Water lock	Kriegenbrunn at Main-Danube Canal	Replacement construction
6	Water lock	Herbrum at Dortmund-Ems Canal	Demolition of old lock & new construction
7	2 Water locks (small)	Kiel at Kiel Canal	Replacement construction
8	Dry dock & gate berths	Brunsbüttel at Kiel Canal	New construction

The Institute of Technology and Management in Construction (TMB) of the Karlsruhe Institute of Technology (KIT) supports the GDWS with a systemized recording and documentation of the experiences in the selected projects. In the course of the scientific support, the following overarching goals are pursued in particular:

- Development of common terms and systematic approach of the diverse elements to promote collaboration in waterway construction projects.
- Elaboration of a systematic approach ('Roadmap') and an overview ('Project Map') for testing relevant elements, considering already initiated experiences.
- Project-accompanying systematic recording and documentation of experiences within the projects.
- Development of recommendations for implementation of elements within the structure and processes of the WSV based on the evaluation of projects.

All the selected projects share a high level of complexity. Furthermore, all projects are of great relevance for ensuring the operational functionality of waterways in Germany. However, table 1 indicates that the projects not only differ in terms of the type of structure but also in terms of the respective undertaking (e. g. new construction, complete maintenance). In addition, the chosen project delivery models differ, as well as the current stages of completed phases in each project. Due to this variety and complexity, a suitable systematization of data becomes necessary to enable a proper capture of experiences.

A high number of project participants must be involved when it comes to the collection and evaluation of experiences within the projects. To improve the exchange of experiences among project participants a platform called Soundingboard was established in the WSV. It takes place semi-annually in person and facilitates feedback with those responsible for the procurement strategy of GDWS, as well as with the scientific support of TMB. Additionally, a so-called ‘Online-Board’ takes place digitally in shorter cycles to keep the project participants up to date about relevant topics, e. g. Lean Construction methods.

To systematically collect experiences, methods of empirical social research are being utilized. At first, structural and general correlations as well as the measurement of social

incidents need to be examined within the pilot projects. Therefore, a quantitative research method has to be used. As a second step, a qualitative research method has to be used to explain the reasons for the outcome of quantitative research methods. (Raithel 2008)

The first quantitative approach to collect experiences within the pilot projects is described in the following chapter 'data collection with project questionnaires'. The second quantitative approach to collect experiences in the procurement phase of a chosen pilot project is described in chapter 'experiences during the procurement phase'. In both cases the qualitative approaches are in progress and will be part of further research. For example, expert interviews can lead to a deeper understanding of the participants' statements in the foregoing surveys (Marotzki 2006).

DATA COLLECTION WITH PROJECT QUESTIONNAIRES

For the data collection in the pilot projects, a questionnaire was designed to be filled out semi-annually by the respective project managers. This questionnaire will be continuously adjusted to fit the projects' development. In the following, the segments of the questionnaire for the first data collection are presented:

- brief project description
- alternative organization and procurement model
- incentivized compensation structure
- further approaches to improve collaboration
- involvement of external support
- insights and suggestions for further development

The segment *'brief project description'* contains the project's title, a summary of content and tasks, volume, duration, and necessity of the project. These details enable a quick overview of the selected projects and are intended to be incorporated into a project map which can be used as a control tool in the future by the GDWS.

Originally, the procurement strategy for major projects mainly focused on testing procurement models which were utilized rarely in the WSV up to this point. However, within the scientific support a holistic approach is being pursued, amongst others including organizational and compensation-related approaches.

Therefore, in the segment *'alternative organization and procurement model'* the questionnaire contains the procurement model for planning services, the procurement model for construction services, the utilization of a 2-phase-model, and the type of performance specifications. Additionally, the current label of the project's alternative strategy, costs for the procurement phase and the reasons for choosing an alternative strategy are requested. The segment *'incentivized compensation structure'* currently focuses on the compensation system for building services and requests the existence of a bonus malus system.

The alternative organization and procurement model as well as the incentivized compensation structure themselves are considered as elements that can improve collaboration within a project. Hence, the questionnaire contains *'further approaches to improve collaboration'*, such as a project kick-off, team reflections, conflict-solving mechanisms and other collaborative project management and work methods.

With a view to future projects, it is also of high relevance to the GDWS to estimate the costs and necessity of external services. That is why the segment *'involvement of external support'* was included. It contains the information about the support of legal advisors, support of technical advisors, services of coaches (e. g. Lean Coaches), costs for external support and special experiences made with the external support.

Furthermore, an additional segment *'insights and suggestions for further development'* was added. This segment enables an open collection of additional findings and can be used to share suggestions for further development.

INSIGHT IN ANALYSIS OF QUESTIONNAIRES

In the following, a selection of the data given in the first questionnaires is presented and discussed. The data show that the project volumes range from 16.7 million (project No. 4) to 650 million (project No. 7) euros. However, these numbers should be questioned critically because the included costs are interpreted differently for each project. A similar issue appears for project durations. For example, in some projects the start is interpreted as the project's approval whereas in others as the beginning of the planning phase.

A clearer picture is drawn by the utilized type of procurement model in each project. As shown in table 2, in 7 projects a negotiated procedure with prior competition was chosen. Only in 1 project no information is provided due to the project's early status. In 5 projects a functional specification is utilized and in 2 projects a detailed specification is utilized. Moreover, in two projects a 2-phase model is established. In 5 of the projects a general contractor is contracted for the building services. Moreover, there is 1 project with a total contractor and 1 project using a multi-party-agreement within an Integrated Project Delivery. The compensation models are distributed to 3 projects using a fixed price, 1 using direct costs, 1 using a mixed model, 1 using unit prices and 2 have no information provided yet. In 3 projects an incentive system is established and in 2 projects the utilization of an incentive system is currently discussed. In 2 projects no information is provided yet and 1 project replied that no incentive system is utilized.

Table 2: Elements: procurement model, 2-phase model, organization, and incentivized compensation

Project Element	**No. 1**	**No. 2**	**No. 3**	**No. 4**	**No. 5**	**No. 6**	**No. 7**	**No. 8**
Procurement model	neg. wpc.*	neg. wpc.	neg. wpc.	neg. wpc.	neg. wpc.	neg. wpc.	neg. wpc.	neg. wpc.
Service specification	func.**	func.	func.	detailed	detailed	-	func.	func.
2-phase model	yes	no	yes	no	no	-	no	no
Organization model (build)	general contr.***	general contr.	total contr.	general contr.	general contr.	-	general contr.	multi-party
Compensation model	-	fixed price	fixed price	mixed forms	unit prices	-	fixed price	direct costs
Incentive system	-	perhaps	perhaps	yes	no	-	yes	yes

*negotiation with prior competition; **functional; ***contractor

The combination of the organization and procurement model, and the type of performance specifications, together with the incentivized compensation structure will lead to specific terms to describe each project's delivery model. This is necessary to address the lack of commonly used terms in the WSV.

Besides the elements mentioned above the projects implement further approaches to improve collaboration, as shown in table 3. In 6 projects a project kick-off is or will be utilized, 5 projects include team-reflections. Conflict-solving mechanisms are included in

5 projects. Additionally, Lean methods and/or Building Information Modeling are named as further approaches to improve collaboration in 5 projects.

Table 3: Elements of further improvement of collaboration

Project Element	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Project kick-off	-	yes	yes	yes	yes	-	yes	yes
Team reflections	-	yes	yes	yes	yes	-	no	yes
Conflict-solving	-	yes	yes	no	yes	-	yes	yes
Collaborative methods	-	no	yes (Lean)	yes (BIM)	yes (BIM, Lean)	-	yes (BIM)	yes (Lean)

A lack of information in the filled-out questionnaires can generally be explained by a project's early status. Additionally, it can be mentioned that after the first data is collected the questionnaires must be partly specified to avoid room for interpretation for any following data collections to ensure a better comparability between projects.

COMPREHENSIVE INSIGHTS INTO A R&D WATERWAY INFRASTRUCTURE PROJECT

PROJECT DESCRIPTION

In a second quantitative approach the experiences in the procurement phase of one particular pilot project are examined. The project 'Component Tests Oberesslingen' (Project No. 3, table 1) is an R&D project and aims to gain practical experiences in several methods for maintaining water locks under continuous operation. This means that the maintenance is alternating with the locking of ships. The definition of the duration for the maintenance per day is project specific. (Westendarp 2017) The maintenance of the 'Component Tests Oberesslingen' on River Neckar must be performed within 12 h per day.

Generally, to maintain a complete water lock can take up to 3 or more years. During this time, the water lock is out of operation, which is unacceptable considering the consequence of shifting freight transportation to alternative traffic carriers, like streets and railways. The significance of this circumstance becomes even clearer when looking at a high demand for maintenance and a lack of redundancy, with a total amount of circa 260 water locks in Germany that only have one chamber. To bypass this problem, the only alternative to conventional maintenance currently is to construct a replacement lock, which generally comes with high costs and needs significant space. Therefore, maintenance under continuous operation can be a meaningful alternative for the WSV in future. (Westendarp 2017)

The component tests include amongst others: a mobile inspection closure, the installation of dam boards in guide rails, the demolition of chamber walls by milling and high-pressure water jetting, reprofiling chamber walls with pre-cast segments, in-situ concrete, bulkheads, and shotcrete. The different methods will be tested on different blocks of the chamber while the filling and draining within the 12 h closure will be simulated. Adding to this, the reprofiling of chamber walls with pre-cast segments and in-situ concrete containing micro-hollow spheres will be tested during a full closure.

Due to the high complexity in planning and construction, a project specific so called ‘Partnering Package Model’ was chosen for the delivery of the project. In this context, the term ‘Package’ means that planning and construction services are awarded to a total contractor through a negotiated procedure with prior competition. This allows the expertise of construction companies to be already incorporated during the preparation of bids before the award of the contract. (HKLW 2020) Regarding the term ‘Partnering ’, the preamble of the contract between the client and the contractor notes that the parties intend to shape a project collaboration based on the ‘Charter for Collaboration on Construction Sites along Federal Waterways’ (WSV 2022).

Furthermore, the contract includes a section related to the implementation of a collaborative decision-making process. Additionally, other project documents, such as the functional performance specification, contain expressions like ‘collaborative coordination’, ‘collaborative processing’, or ‘collaboratively decided’. However, the specific implementation of this collaboration is not conclusively defined, allowing a level of creativity for the project participants.

EXPERIENCES DURING THE PROCUREMENT PHASE

For this particular project a survey was used to save the experiences made in the procurement phase, including a foregoing market study, the prior competition, and the negotiated procedure including two negotiation rounds, as shown in Figure 1.

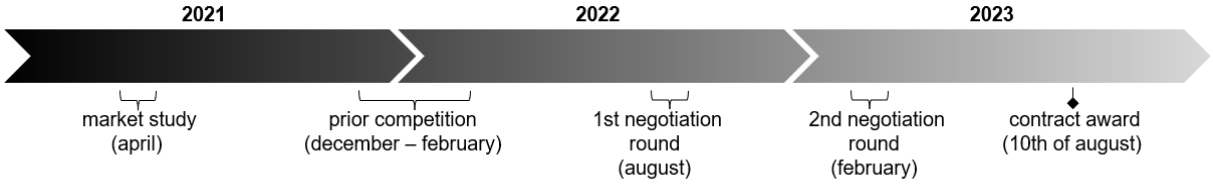

Figure 1: Procurement phase of the project 'Component Test Oberesslingen'

Both perspectives, of the client and the bidders, were taken into account. The condition to be contacted as a participant of the survey was the participation in least one of the procurement phase’s steps (market study, prior competition and negotiated procedure). This includes in total 64 persons on the bidders’ side and 17 persons on the client’s side who received a survey link via email. 19 of 64 persons on the bidders’ side and 10 of 17 persons on the client’s side filled out the survey. A higher number of participants might have been achieved by sending the survey earlier. However, the survey was sent 2 months after the contract had been awarded. The effect may have been enhanced for bidders that had not been awarded due to a loss of interest in the procurement phase.

Due to the number of participants and the fact that this survey concentrates on a project-specific procurement phase the data cannot be generalized. Nevertheless, it shows tendencies and gives ideas for further research. In the following, a selection of data focusing on the negotiated procedure is presented and discussed. The examples in Figures 2 through 7 give an insight of the different perspectives on client’s and bidders’ point of view in the procurement phase of the ‘Component Test Oberesslingen’.

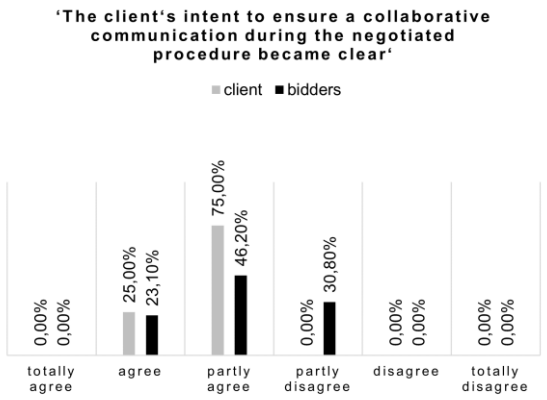

Figure 2: communication with bidders

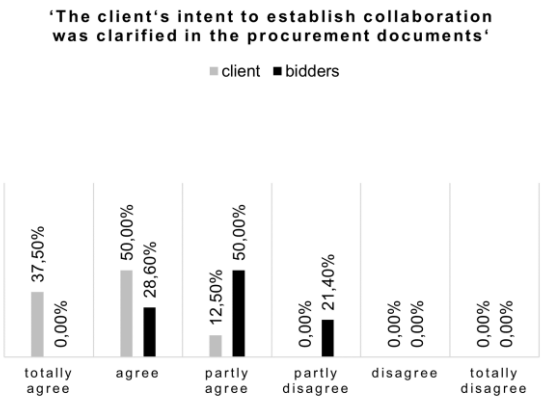

Figure 3: procurement documents

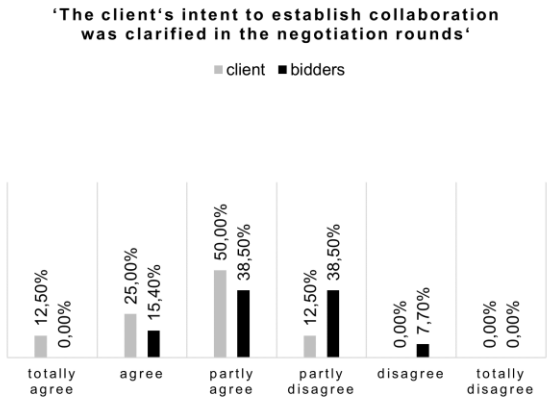

Figure 4: negotiation rounds

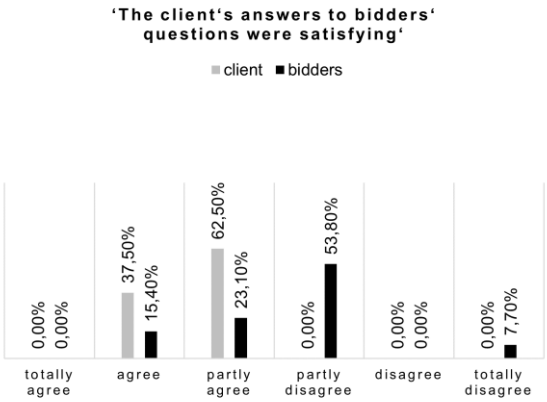

Figure 5: bidders' questions

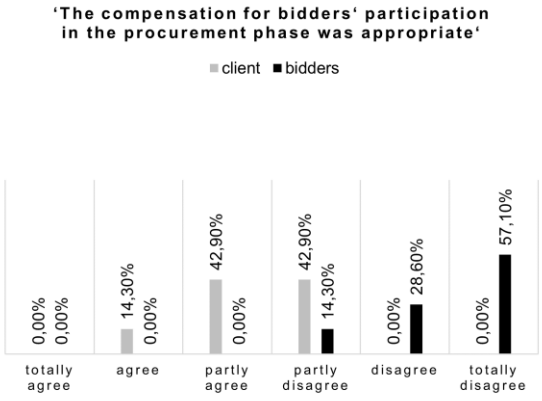

Figure 6: procurement phase compensation

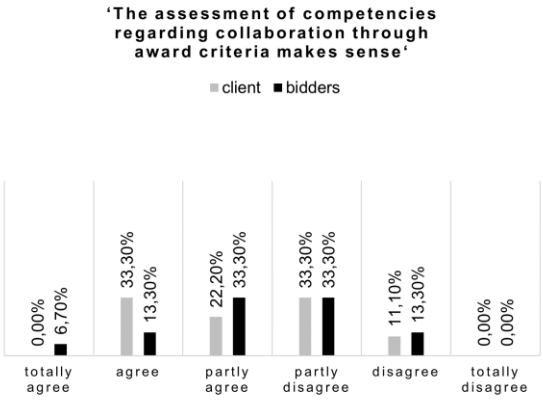

Figure 7: collaboration in award criteria

On the client's side as well as on the bidders' side 0,0 % of the participants disagreed or totally disagreed on the statements 'the client's intent to ensure a collaborative communication during the negotiated procedure became clear' (Figure 2) and 'the client's intent to establish collaboration was clarified in the procurement documents' (Figure 3). Nevertheless, it is noticeable that the tendency to agree to both of the statements is higher on the client's side. This tendency is also visible in the answers regarding the statement 'the client's intent to establish collaboration was clarified in the negotiation rounds' (Figure

4). A possible reason for the discrepancies between both perspectives could be a different understanding of the term collaboration. Even though the client had developed an understanding about collaboration on his side, the term might not have been defined and communicated clearly enough and by this also left room for interpretation in the procurement documents.

During the negotiated procedure bidders' questions were answered by the client via a digital platform. The tendency to agree with the statement 'the client's answers to bidders' questions were satisfying' (Figure 5) again is higher on the client's side. A possible reason for the discrepancies could be that the client answered bidders' questions as detailed as possible but could not address each question as needed to remain equal treatment of each bidder. On bidders' side this could have led to confusion or to unsolved problems during the work on their offers.

In the end of the procurement phase all bidders providing a final offer received a compensation of 75,000 euros. A majority of 57,1 % on bidders' side totally disagreed with the statement that 'the compensation for bidders' participation in the procurement phase was appropriate' (Figure 6). Participants on client's side tend to respond more favorably to this statement. Possible reasons for this distribution of answers could be that the client might have underestimated the required work on bidders' side to fulfill the requirements for the final offers. Also, the procurement phase lasted longer than expected. On the other hand, the required work described in the procurement documents might have been underestimated by the bidders as well.

The award criteria in the procurement phase of the 'Component Test Oberesslingen' did not include any criteria regarding collaborative competencies of the bidders. Nevertheless, in a general question the participants were asked about their opinion on the assessment of these criteria. Besides others, this question was included in the survey to receive an insight into the motivation to participate in future procurement procedures including award criteria regarding collaborative competencies. As shown in Figure 7 there is no clear tendency shown in the distribution of answers on the bidders' and on the client's side.

Currently, experts on bidders' and client's side are interviewed to find out more about the possible reasons for the discrepancies in the survey's outcome. It is intended to take the same steps (survey and following expert interviews) within the other 7 pilot projects to ensure a better comparability between projects.

CONCLUSION

In the WSV, first steps have been taken to establish and promote collaboration in construction projects. This includes, for example, the 'Charter for Collaboration on Construction Sites along Federal Waterways' with the HDB. Additionally, another charter is currently being developed between the WSV and design offices. Nevertheless, there are limited experiences with the strategic promoting of collaboration in projects along Germany's waterways, such as the implementation of Lean Construction methods. Therefore, major infrastructure projects were identified throughout the WSV to initiate the implementation of collaborative elements and to gather experiences.

The strategic implementation of collaboration elements in the WSV as a public client in Germany is a new use case for academia. Furthermore, the upcoming changes require the adaptation of the construction industry to new forms of project deliveries in projects along Germany's waterways.

This contribution hereby focuses on 8 selected infrastructure projects and discusses first outcomes of a data collection. This data is intended to be systematized and analyzed to develop solution approaches and recommendations for future projects. The first results

show that there is no clear definition of collaboration within construction projects in the WSV and that there is a need for further research because it is not possible to make sound recommendations for future projects yet. The need for further research can also be emphasized by the current lack of qualitative research results. Adding to this, more quantitative research results are needed to deduce general conclusions from the first gathered tendencies.

Major projects within the WSV tend to significantly exceed cost and time frames. The solution approaches and recommendations made in further research potentially have a meaningful influence on the stability and efficiency of future project deliveries of projects along Germany's waterways.

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