

# Tailoring a Project Risk Management Tool through Co-Design: Managing Risk in the Fuzzy Front-End of Construction Project Design

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## Abstract

The objectives and scope of a construction project is defined in the early design stage, the fuzzy front-end. This stage is crucial for project risk management and success, but traditional risk management tend to focus on operational risk in later design stages. This action research study leverages co-design methodology and the project management actuality perspective to tailor a risk management process for the fuzzy front-end of construction projects in a large client organization. The co-design process help enhance stakeholder value perception of the designed solution.

*Keywords: co-design, risk management, design process, actuality perspective, action research*

## 1. Introduction

The construction sector is plagued by reoccurring cost overruns in large-scale construction projects (Agarwal *et al.*, 2016; Flyvbjerg *et al.*, 2003). Some of the extreme and well known examples of projects spinning out of control, include the Channel Tunnel in UK, the Sydney Opera House, or more recently the Brandenburg Airport in Berlin, Germany. For years the traditional generic best practice methods have been applied to project and risk management and still the problems persist. There is a need to improve these management practices, including risk management in the early project phases (Ahlemann *et al.*, 2013; Kutsch *et al.*, 2014). For public sector projects, the cost overruns lead to increases in the public financial burden and binds public funds (Cantarelli *et al.*, 2010). This is a global problem (Flyvbjerg *et al.*, 2003) that also reflects in the Danish context, with a history of public sector construction cost overruns (Nielsen *et al.*, 2010), where the root cause of the overruns is identified to be generic and insufficient project cost risk management from the project outset (EY, 2017; Rigsrevisionen, 2017). Construction projects generally consist of a design phase and a sequential construction execution phase. Traditional project risk management practices focus on the operational phase of projects, and this might lead to problems with actually managing risk (Atkinson *et al.*, 2006; Cantarelli *et al.*, 2012). The early phases of a project have large effects later on, yet more research is needed on how to manage risk there (Wied, 2020). The early design phase thus offers opportunities to improve risk management by co-designing risk management processes for the fuzzy front-end of construction projects.

## 2. Context of study

The earliest part of the design phase is the definition stage (Pikas *et al.*, 2018) where the project is defined with regard to e.g. goals, requirements, budget and timeframe. This can be labelled the fuzzy front-end (Sanders and Stappers, 2008) of construction project design. Formal Risk Management

processes are typically not initiated until projects are defined which means that they focus on operational risk management; making sure things are done right when the project is executed (Atkinson *et al.*, 2006). The cost risk problems are, though, not limited to execution phase, but present throughout the project lifecycle (Chen *et al.*, 2015; Ward and Chapman, 2008) from the early risk identification in design (Smith and Male, 2007). Significant cost risks are already present in the early project phases. For example, early requirements definition can introduce significant cost risk because requirements changes are a major driver of cost overruns (U.S. General Accounting Office, 2008). Several studies point to problems with effectiveness of state-of-the-art traditional risk management practices (De Carvalho and Rabechini Junior, 2015; Kutsch *et al.*, 2014; Willumsen *et al.*, 2019). Another recognized problem with risk management is, that it can easily end up disconnected from the value creation of the engineering task as a tick the box activity (Kutsch *et al.*, 2014; Olechowski *et al.*, 2012; Ward and Chapman, 1991; Willumsen *et al.*, 2019). There is no 'one size fits all' cost risk management process (Arnim and Oehmen, 2014) and risk management should be tailored to the needs of the stakeholders and the context (Xia *et al.*, 2018). However, there is a gap in the literature regarding how to tailor aka. design risk management to the stakeholder needs (Škec *et al.*, 2014; Tegeltija *et al.*, 2018; Willumsen *et al.*, 2019). Using a participatory design process is one way to include stakeholder needs. We want to investigate if a co-design process can be used to tailor a risk management process for the Fuzzy Front-end of design of construction projects. To do this we carry out action research in an organization, we utilize the Actuality perspective (Cicmil *et al.*, 2006) to gain detailed insights to use in the co-design, and we structure the co-design process according to the Double Diamond design framework. The action research takes place in a large public construction client organization in Denmark. The organization is one of the largest construction clients in the country, with a portfolio of property of more than 4 million square meters and a construction project portfolio of 5 billion DKK (670 million euro) per year on a range of medium and large-scale construction projects. During the research, we analyse the current risk management processes with a special focus on the early project stages that frames the design of the new projects. At this fuzzy front-end, customer requirements are verbalised and documented, and the project management takes the initial design considerations and decisions that shapes the rest of the design process and project execution. Through the action research, we engage the practitioners in the organization in a participatory process, that is we co-design a risk management process for the fuzzy front end of the construction projects. The aim is to extend the view of traditional standards-based and prescriptive project risk management and improve the stakeholder value perception of the early-stage project risk management by making them a vital part of the design process. Thus the novelty of this research lies in the original combination of known concepts and the application of this combination within the field of risk management.

### 3. Theoretical framework - Linking project management and design literature

#### 3.1. Actuality in project management literature

Traditional project management research and literature have had a focus on 'best practice' (Atkinson *et al.*, 2006; Barros Sampaio *et al.*, 2014; Cicmil *et al.*, 2006), that is codifying how practitioners should act through guidelines and textbooks (Blomquist *et al.*, 2010). This is a prescriptive, instrumental approach that is execution and task oriented (Svejvig and Andersen, 2015). This approach has attracted criticism about the lack of improved project performance and hence whether it actually captures the reality of projects (Barros Sampaio *et al.*, 2014; Blomquist *et al.*, 2010; Koskela and Howell, 2002; Winter *et al.*, 2006). A part of management research has chosen to focus more on actual practices of managing projects, from a more descriptive approach and with a social constructivist outset. Different sub-streams of research have explored this under varying labels, such as the Scandinavian School of Project Management, Project-as-Practice and Rethinking Project Management (Svejvig and Andersen, 2015). Within the last is advocated an 'actuality' perspective, an alternative lens, to gain new insights projects and project management practices. The perspective focus on understanding practical action (praxis) of practitioners, based on their lived experiences and social interaction, and it aims at understanding the

interrelationship and inseparability between organizational structure (policies, procedures etc.) and how individuals act (Cicmil *et al.*, 2006). The actuality perspective approach proposes pragmatic epistemology as a methodological framework. The research should be done as participative cooperative inquiry, that allows for shared understanding of praxis (Cicmil *et al.*, 2006). The foundation for being able to view project management in this new perspective is the co-production of knowledge on praxis between reflective practitioners and pragmatic researchers (Cicmil *et al.*, 2006). The actuality perspective is not discarding the traditional classic view on project management, but aim to enhance it (Svejvig and Andersen, 2015) by providing explanations of actual project behaviour (Cicmil *et al.*, 2006). Project management and project risk management is tightly linked. Risk is commonly defined as 'the effect of uncertainty on objectives' and risk management then is 'coordinated activities to direct and control an organization with regard to risk' (as in ISO31000). Project risk management is the risk management of the temporary organization that is a project (Engwall, 2003). Within project risk management similar concerns have been raised about the apparent lack of effectiveness of the classical best practice approach (De Carvalho and Rabechini Junior, 2015; Kutsch *et al.*, 2014; Willumsen *et al.*, 2019). Some empirical findings support that there is a disconnect from the practices prescribed in the standards and guides, and the actual behaviour of the risk management practitioners (Willumsen *et al.*, 2019). This is not due to lack of knowledge of the standards, but from the reality of the context in which the risk managers need to navigate, prompting the need to further explore the actuality of project risk management in particular (Willumsen *et al.*, 2019). In line with the actuality perspective the research has to be carried out as a cooperation between the practitioners and the researcher, which presupposes a co-production process of knowledge and therefore a participatory co-design process for the tailoring.

### 3.2. Co-design in design literature

Co-design is a specific instance from the area of participatory design, which emanates from an effort to increase value of production by engaging workers with the situated expertise in the development of new work systems. Co-design engages the actual users to actively participate in the design of the system (Dearden and Rizvi, 2008; Sanders and Stappers, 2008) which in our case is the risk management process. This principle of co-designing matches the basis proposition for the actuality perspective, that requires the researcher to engage with the practitioners. To use their situated expertise in the local context to create a mutual understanding of the actual actions that the practitioners do (Cicmil *et al.*, 2006). We furthermore utilize the 'Double diamond' (introduced by the British Design Counsel in 2004) in the research as a guide to structure the steps in the co-design process (Banbury *et al.*, 2021). The double diamond model has four design stages divided with the two first focusing on defining the problem and the next two defining the solution (Banbury *et al.*, 2021). This duplexity between focusing first on solving the right problem, and then solving the problem the right way, has also previously been touched upon in parts of managerial research (Atkinson, 1999; Christensen and Kreiner, 1991). The double diamond offers a way to articulate the duplexity with design concepts that can create a common understanding with the project management practitioners as advocated by the actuality perspective.

As part of the co-design process prototypes was used as boundary objects to aid in the engagement of practitioners and foster dialogue in developing solutions (Dearden and Rizvi, 2008; Vink *et al.*, 2008).

### 3.3. Research methodology and data collection

#### 3.3.1. Action Research

Action Research is the basis for doing research with an actuality perspective with its focus on collaboration between academics and practitioners (Cicmil *et al.*, 2006; Coghlan and Shani, 2014; Maestrini *et al.*, 2016). This methodological framing is also consistent with the main authors employment at the case company and in this sense the research can be categorised as an insider inquiry research (Cagney, 2015). Action research and co-design methodology furthermore share characteristics (Järvinen, 2007), which makes action research a common denominator between the design methodology and actuality perspective. Action Research is based on the assumption that involving organizational members in the learning and development generates better understanding and more valid data about a system (Coghlan and Shani, 2014) and thus has as a defining characteristic

that it involves participation (Arieli et al., 2009). The goal of action research is to solve an organizational problem through an emergent inquiry process (Maestrini et al., 2016) where iterations (Cassell and Johnson, 2006) and intervention leads to shifts in practices and thereby data that is not predictable or controllable (Coghlan and Shani, 2014). In this study the action research is utilized to study the current organizational practices and the intervention is the co-design and implementation of the revised process.

### 3.3.2. Data collection

The action research has been carried out within the context of a single-case. In this case a sampling time of 7 months was used to carry out in-depth and extensive data collection through several sources such as documents, observations (538 hours), interviews (11 hours), participating in meetings and workshops (152 hours). This approach also allows for the organizational work processes to be examined with a holistic perspective and allows for the study to be guided by the researchers sector specific pre-understanding of the industry and organizational context (Meyer, 2001). Data was collected from all relevant business areas (Meyer, 2001), and included all groups of key stakeholders within the two divisions involved in the work processes under study. It also included all hierarchical levels to identify the 'felt needs of the community' (Cassell and Johnson, 2006). Observations were done in the form of participant-as-observer, as the researcher were formally employed by the company and took part of all workdays, but at the same time also formally was articulated with the role of observing practices (Meyer, 2001). Interviews were exploratory and open-ended. In several instances interviews or workshop-type meetings evolved around prototypes developed as part of the research. This helped foster the mutual understanding that is crucial for the actuality perspective (Cicmil et al., 2006) and for defining the problem and choosing solution in the double diamond framework.

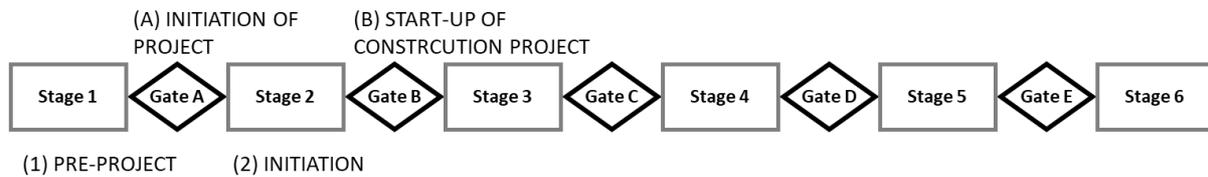
### 3.3.3. Trustworthiness and transferability

This research takes an ideographic approach (Baskerville, 1997; Thomae, 1999) in line with the interpretivist qualitative tradition (Carminati, 2018) where we seek to understand the meaning of a contingent and organizationally cultural phenomena. In the interpretivist terminology trustworthiness can be considered an alternative to the quantitative terms rigor, validity and reliability whereas transferability represents generalizability (Carminati, 2018). We have triangulated data by comparing what was written in official documents, with what we were told in interviews, with what we could observe to increase the trustworthiness of the research (Carminati, 2018; Meyer, 2001). We do not try to generalize from our specific sample to a population, but we aim to make our theoretical proposition transferable (Meyer, 2001). That co-design in combination with the actuality perspective is useful to develop tailored project risk management tools for a specific context. We are aware that for our research to be truly transferable the descriptions would need more thick detail (Carminati, 2018) than possible in this format.

## 4. Case context: The Danish Building and Property Agency

The Danish Building and Property Agency is the governmental agency with the dual role of property owner for the Danish State and the role of construction client on behalf of its customers such as the Police, Universities, Ministries and other governmental agencies. The purpose of the agency is to provide attractive and cost-efficient government workplaces and deliver this more efficient and professionally than the customers themselves would be able to. Part of their responsibilities is to manage the early project design phase, including its risk management. The initial design activities, leading to requirements definition for a refurbishment or new construction project, are handled by a 'Customer Advisor'. Only after the requirements document is accepted by the agency's client is a formal construction project started, and the process is handed over to a Project Owner and Project Manager. The Project Manager is subsequently responsible for planning and executing the construction project on behalf of the agency's customer. A support team of specialist from the Centre for Construction including a Risk Manager is appointed to the project to assist the project manager. The projects are phased according to an internal Project Model, a stage-gate phasing model for execution of projects based on the principles of Prince2 (Axelos, n.d.). As we focus on the early design stages the relevant stages are: (1)

Pre-project and (2) Initiation, after that follow (3) delivery design, (4) tendering, (5) construction, and (6) post-project. The relevant decision gates are: (A) Initiation of project, (B) Start-up of Construction Project. The stage-gate can be seen below (Figure 1).



**Figure 1. Simplified project stage-gate model**

Of particular relevance for our study are the risk management activities in the early design phases, stage (1) and (2). The status quo at the beginning of the research study was that formal risk management activities only started during the later part of the Initiation stage (2), with a mandatory 1st risk workshop to be completed before approval in gate (B). At the same gate, the project manager in a separate activity completes a complexity assessment of the project based on a generic assessment matrix provided by an external consultancy. The purpose of this assessment is that the project specific complexity characteristics should guide important managerial decisions regarding project organization, scope and budget. There was a managerial recognition that the process could be better, and management had started a revision project, to look at rephrasing the questions guiding the complexity assessment. Our research study replaced this internal project with license to look beyond just text revisions of the questions.

## 5. Research process and findings

### 5.1. Participation of stakeholders

Data from codified procedures and internal documents were used to identify stakeholder groups. We asked line managers from these groups to specify the first line of representatives within each group to be contacted for the research. Through dialogue with representatives, we identified additional relevant persons in a snowballing process and the stakeholder groups were confirmed and completed through iterations between documents and interviews. The participation of the different stakeholders was planned in accordance with theoretical guidelines from [Vink, Imada & Zink \(2008\)](#) to make sure the relevant stakeholder groups were involved in the two overall phases in Double Diamond; problem exploration and the solution design. The involvement in the different steps can be seen below (Table 1).

**Table 1. Illustration of involvement of different stakeholders. Inspired by [Vink, et al. \(2008\)](#) and adjusted for the double diamond framework**

	Step	Activity	Top management	Project Owners	Project Managers	Customer Advisors	Risk Managers	Legal advisors
Problem space	1	Discover	X	X	X	X	X	X
	2	Define	X	X	X	X	X	
Solution space	3	Develop		X		X	X	
	4	Deliver	X	X		X	X	

### 5.2. Findings in the 'problem space': Challenges of risk management in early project design phases

Following the double diamond and actuality perspective the first research step was to develop a shared understanding of the problem between the researcher and the various involved stakeholders.

#### 5.2.1. Discover: Analysis from the perspectives of traditional PM and 'actuality'

The project model and the management procedures in general follow best practice methodology and guidelines such as ISO31000. The requirement of the organization to carry out a complexity assessment for larger projects was codified in the internal procedures, and based on generic methods transferred

from other applications such as infrastructure. This means that the timing of the initial project risk management was according to standards and the content of the initial project risk management was according to requirements. An evaluation based solely on formal procedures and documentation show that the organization is doing as expected, as can be seen from the following quote from an evaluation report from the National Audit Office (Rigsrevisionen, 2020): "*The [...] improvement initiatives were fully implemented in 2018 [...] based on [procedures] being utilised successfully within the transport sector*". Turning to the 'actuality perspective', we investigated the lived experiences of the key stakeholders in the process. According to several stakeholders, the procedures were in general perceived to be 'okay' and according to standards. However, we also uncovered a feeling among the stakeholders that it was more of a mandatory task that needed to be carried out to get formal approval, than having any actual influence on the project management. The assessment of the project has become a 'tick-the-box-activity' with little perceived value among the stakeholders. One project manager expressed that it really didn't matter that the generic questions were ambiguous, as he didn't think that anybody would read it anyway. Furthermore the top management had a sense that the procedures did not give them the overview of the projects they had hoped. There were great variation in how the documents were completed, and they had experienced projects the initial assessments seemed of. A manager said: "*The project managers assess the projects based on their own experience, which means that simple projects sometimes get classified as complex, due to the lack of specific experience from the individual project manager*". With the actuality perspective, it is important to investigate the connection between organizational procedures and praxis. The complexity assessment is carried out in direct relation with gate (B) in stage (2) Initiation as part of the defined organizational procedures. In praxis we found, that the project owner and project manager already in the pre-project stage gate (A) need to define scope of engineering and architectural preliminary studies to estimate a budget for the required amount of external consultancy services. This means that there is already important project managerial decision made regarding the overall scope of the project, the overall budget, and the relevant sources of finance. This means, that there is a misalignment between the specified organizational procedures and the actual work the project managers need to do, to manage the projects. A project manager put it this way: "*The decisions can't wait, so we do, what we have to do, to make the project run*". Though the data collection it became evident that there was also a perceived lack of interaction between key stakeholders. The Customer Advisor felt alone in the initial dialogue with customers regarding project scope and limitations. Project managers filled out the complexity assessment on their own and felt they lacked important input. Risk Managers felt disconnected from the work at the initial stages.

### **5.2.2. Define: Creating a mutual understanding of the early project design risk management challenges**

Following the extensive data collection and the analysis of the situational problem the aspects of both timing, structure and value, and cooperation was articulated and discussed with the stakeholders. In this process there were identified a need to revise not only the complexity assessment document but also the work processes relating to the assessment and the documentation for the gates in the stage-gate process. The problem had shifted from one of asking the right questions in a document, to that of asking the right questions, at the right time, to the right people, and facilitating social interaction and collaboration in answering the questions.

## **5.3. Findings in the 'solution space': Improving risk management in early project design phases**

### **5.3.1. Develop: Prototyping and imagining future work**

During the development stage, several different solution methods were looked at, and discussed between the researcher and the stakeholders. To aid the discussion prototyping was used, where the researcher used practitioners input to work out examples of solutions and using them for an iterative dialogue and adjustments. In this stage the actuality perspective helped form the evaluative questions in the cooperation between the researcher and the participants. The solutions were not only judged by looking at whether they would fit into context and be useful from an organizational perspective, but also how

the practitioners believed that the solution would influence their work tasks and thereby their own actual 'everyday' situation and praxis.

### 5.3.2. Deliver: Testing and refining the solution

Through small-scale testing and refinements, the solution included the following 5 elements: 1) Removing the complexity assessment from the gate (B) documentation; 2) Reformatting the 'Request for resources' at gate (A) to include a 'Project and complexity assessment' with questions regarding the customers definition of requirements, project limitations and priorities; 3) Assigning the Project Owner to the project to perform the assessment in collaboration with the Customer Advisor; 4) Making the result of the assessment be an official part of the managerial decision regarding organization and staffing of the specific project including appointment of project manager; and finally 5) Handing over ownership of the assessment document to the Risk Management team, to make sure that results are embedded in the formal risk management process. The solution elements are shown in (Figure 2).

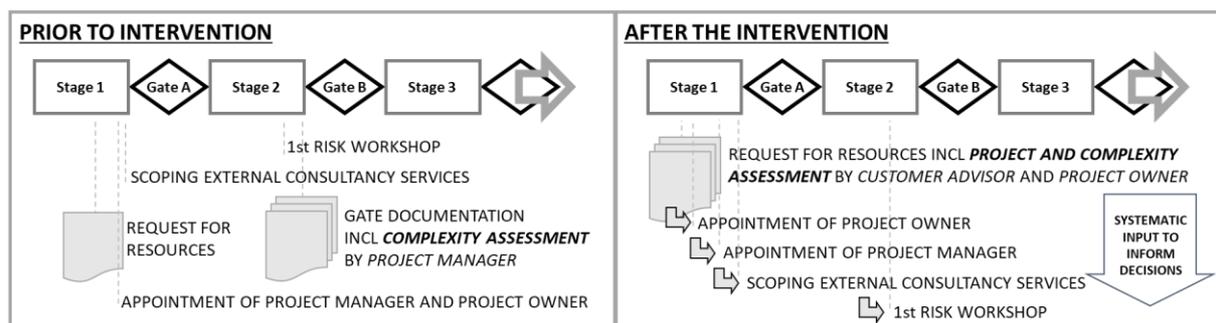


Figure 2. Illustration of solution in comparison to existing process

### 5.4. Implemented risk management improvements at the case organization

At the time of writing the solution has been 'live' in the organization for 2 months, and the preliminary organizational and process changes resulting from our research engagement are: 1) The project requirements formulation at the fuzzy front-end and the formal risk management process are tied together, to start the risk management at an earlier stage in the design process. This enables direct transfer of relevant risk from the project and complexity assessment to the 1st formal risk workshop; 2) The early appointment of the project owner gives the Customer Advisor a construction competent colleague to cooperate with and get support from in the early dialogue with the customer regarding requirements and budget. By promoting dialogue on "defining" the project and its goals, a mutual understanding is supported, increasing the likelihood of the project goals being more realistic and supporting a continued collaboration through the rest of the project. A customer advisor stated: *"The document facilitates dialogue between internal departments to explore the project and its characteristics. [The] manager assigned early in the project who together with [me] can enter a deeper dialogue with the customer regarding the project requirements and its realization"*. 3) The project owner fill out the documentation and as they are more experienced than the project managers and fewer in numbers, the variation of the completed documentation is reduced; 4) The early project assessment is done at a time, where the major decisions regarding project organization and budget is not yet taken. Therefore the results of the assessment can be used to inform these decisions.

## 6. Discussion on outcome

In our co-design process the double diamond framework offers a common language that foster mutual understanding and bridge the gap between design researcher and the practitioners even in a praxis field without familiarity with design principles or concepts. The principle of focusing on the problem before solutions give room for an actual investigation of the reality of the context and to explore the lived experiences of stakeholders through the actuality perspective. This perspective then offers the researcher valuable research questions to guide the investigation of uncovering the true nature of problems. In this

case the problem defined after this investigation was considerable broader and with larger implications than the initial framing of the problem. This fostered a solution that was more value-adding than expected, as several connected problems from different stakeholders could be addresses in common. The risk of this approach is, though, that all stakeholders value aspects of work differently, increasing complexity in defining both problem and solution when involving more stakeholders. This necessitate priorities and compromises, which worked out well with the high degree of psychological safety in the case company, but might not be equally achievable in all organizations. We have seen that the actuality perspective complements the traditional view of project and risk management by giving an alternative lens in which to seek understanding of organizational praxis; what practitioners actually do, instead of focusing solely on what procedures and regulations state they should be doing. This perspective gives new insights to formal risk procedures and the outcomes that are produces by these. It also supports a shared understanding of the barriers and problems that exist with regard to creating value though the everyday project and risk management work. Furthermore the perspective combines very well with a co-design process both theoretically and in praxis. In our case, we found, that starting the risk management early on in the fuzzy front-end of project design, makes it possible to use risk management to address the framing of project, and push for better and more coherent requirements for the project. Thereby improving the foundation for risk management in the remainder of the project lifecycle. In this way project risk management can evolve from only addressing whether the project is 'doing things right' to also incorporating aspect of whether the project is 'doing the right things'. This is in line with the theoretical proposition of [Atkinson et al. \(2006\)](#). We have furthermore found that the stakeholder value perception of the risk management process is enhanced and the co-design has fostered a positive view of the changes. As stated by a customer advisor: *"The [new] process will strengthen the cooperation and dialogue between the internal departments on the projects"* and *"[The new process] will bring a larger degree of ownership for the work and recognition that we need to work together in all phases"*.

## 7. Conclusion

The aim of the research was to bridge design research and project management research and to make a 'prove of concept' for tailoring risk management procedure in the fuzzy front-end of construction project design by utilizing co-design methodology. We have shown the application of the actuality perspective from project management research gives new insights and understanding regarding risk management processes and their value as perceived by the practitioners in an organization. Through the actuality perspective the connection between organizational structure and procedures and actual action is addressed as well as the influence of social interaction. By using theses insights and by engaging the organizational practitioners in a co-design process, we empower the practitioners to incorporate their lived experience in the re-designed organizational work process. This combined approach allows their experiences to be taken serious and into account, widens the understanding of the problem, and facilitates the co-design of a solution where organizational structure and praxis can realign and where the social interaction will be facilitated. In our case the combination of the actuality perspective and co-design methodology enabled the co-development of improved risk management processes tailored for the specific organizational context and resulting in a higher perceived value by the key stakeholders.

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