

Managing the Boundary – Discovering the Organizational Antecedents of Boundary Spanning Activity in Megaprojects

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Preface

The basis for this research originally springs from my interest in the complexity sciences. I was always fascinated, how small and often seemingly irrelevant actions and interactions can lead to emergent phenomena that fundamentally change our world. In that light, megaprojects are a bulwark of complexity in the public sector. I really wanted to figure out how the ideas and thinking of complexity science could contribute to the failure or success of these ponderous giants. With such knowledge, it would be possible to create better outcomes not only for our societies, but, given the scope of megaprojects, for mankind as a whole.

Needless to say, although it formally states that a thesis should be purely the result of an individual's work, it never really is. After all, complexity science teaches us that everything is interconnected. Hence, one must give credit, where credit is due. First of all, I would like to take this opportunity to thank my supervisor Dr. Ingmar van Meerkerk for guiding me through the process of writing a Master thesis. I am certain; I required a good portion of his time and patience, perhaps more than that of the usual aspiring master student. I always enjoyed our meetings that never felt purely professional, but like genuine and often humorous exchange between two human beings. I would also like to thank Prof. Dr. Joop Koppenjan for being the second-reader of this lengthy, but hopefully insightful document and further for creating this Master's program in the first place. When international students are made familiar with the Dutch working culture, it is always referred to the flat hierarchy and the collegial attitude of professors. You two are prime examples of this culture, undoubtedly. Naturally, I must now also thank my friend Pablo Jarvis for sparking my interest in the complexity sciences and pointing me towards the Master of Governance and Management in the Public Sector. Your advice definitely constituted a "critical junction" of my life path.

I would also like to thank my parents and my parents- in-law. Without your constant assistance and encouragement, especially in managing life outside writing the thesis, the performance of this (mega-)project would have suffered greatly in terms of schedule and quality.

Most definitely, I take my hat off to my wonderful wife Mahtab. Rotterdam was an adventure with many challenges and surprises, which we managed to overcome together.

London, June 2020

Abstract

Megaprojects are characterized by complex interactions and embeddedness in their geographical, social, technical, legal and political context. This is because their outcomes partially depend on the interests and decisions of interdependent stakeholders, who are often project external. Further, megaprojects are internally fragmented or modularized into multiple functional units, which may operate autonomously, yet remain highly interdependent. A connecting element linking the individual parts of projects and their environment is found in boundary spanners. So far only little empirical research has been conducted on the organizational antecedents and effectiveness of boundary spanning activity in the realm of megaprojects. The study identifies organizational autonomy and an open management style as two influencing factors of boundary spanning activity. Additionally, project modularization is hypothesized to suppress the effectiveness on boundary spanning activities on project performance. By using linear regression on survey data based on the inputs of 136 project professionals from 5 European megaprojects, this study found that project performance was directly improved by higher levels of autonomy, open management style and boundary spanning activity. Further, boundary spanning activity mediated the relationship between the two organizational antecedents and project performance. However, the relationship between boundary spanning activity and project performance was not significantly altered depending on the degree of project modularization.

Keywords: Megaproject, Networks, Boundary spanner, Autonomy, Management style, Project modularization, Project performance

1. Introduction

During the last decades, so called megaprojects have become an increasingly popular vehicle in delivering costly public services (Orueta & Fainstain, 2008). Flyvbjerg (2017) defines megaprojects as "large-scale, complex ventures that typically cost \$1 billion or more, take many years to develop and build, involve multiple public and private stakeholders, are transformational, and impact millions of people" (p.2). They are present in many different sectors, such as physical infrastructure (e.g. tunnels, pipelines, bridges and dams), the military (e.g. fighter jets, missiles), high-tech (e.g. 5G broadband network) or even investment-heavy scientific endeavors (e.g. CERN, fusion reactors). Yet, despite their popularity, megaprojects often come along with a string of problems. As the previous definition suggests, a large and changing number of stakeholders with different institutional backgrounds and interests are in some way involved in projects' successes or failures, if not managed properly (Bourne & Walker, 2008).

Take for instance an incident during the construction of Nord Stream 2, a gas-pipeline project in the Baltic Sea. Due to a leak in one of the operating companies' dredgers, industrial grease escaped into the waters and eventually ended up at the beaches of the nearby town of Greifswald. Naturally, citizens were angered by the pollution and demanded corrective action by the company, which was initially shrugged off. Consequently, local media outlets picked up the story, which drew politicians into the arena, who in turn prompted the construction works to stop for multiple weeks (Fett-Klumpen: Nord Stream lässt Arbeiten ruhen, 2018). This rather minor incident shows the asymmetric effect on project costs and schedule that can arise from ignoring stakeholder interests.

Yet, this is not the exception. In fact, it is a recurring issue among megaprojects to overstretch the boundaries of the iron triangle of project management (Flyvbjerg & Stewart, 2012; Lehtonen, 2014), due to unforeseen issues linked to stakeholder management. In other words, they tend to be out of budget, take way longer than the initial schedule suggested and often do not meet the required specifications that were laid down during the project planning phase (Flyvbjerg, 2014). Consequently, special emphasis needs to be put on the boundary between megaprojects and their environment as a place of interaction (Cilliers, 2001). In order to reach their objectives, megaproject managers have to look beyond their organizational boundaries and must

engage in collaboration and negotiation with other network actors (Edelenbos & Van Meerkerk, 2016). However, these actors possess different norms and values, interests and institutional logics, which pose a difficulty for smooth interactions and thus require novel forms of inter-organizational management (Williams, 2002).

Following this line of thought, stakeholder managers should increasingly become like boundary spanners (Andriof & Waddock, 2017), who are sensitive to stakeholders' interests and can resolve potentially detrimental issues throughout the several project phases (Beck, Marschollek & Gregory, 2009). Important activities of boundary spanners include, connecting different actors across organizational boundaries, selecting and translating relevant information on both sides of the boundary, as well as introducing novel cooperative arrangements between network actors (Van Meerkerk & Edelenbos, 2016).

However, the presence and effectiveness of boundary spanners is not a given, but depends on a range of individual, organizational and contextual factors as well as their mutual interactions. One such factor is identified by Verweij & Gerrits (2015), who observe a tension between an internally focused management versus an external focus in the context of large transportation infrastructure projects. The former refers to a project management style, which is primarily occupied with meeting internal deadlines and ensuring a faster project progression, which renders the overall project vulnerable to unanticipated external shocks (Flyvbjerg, 2017; Taleb, 2007). Juxtaposed to this, one finds an externally focused management style, which acknowledges the social and local embeddedness of megaprojects and therefore stresses the need for boundary spanning actors. Another factor that can either curb or facilitate their activities concerns the varying degrees of autonomy granted to individuals close to the boundary by their respective organization (Van Meerkerk & Edelenbos, 2014).

Still, boundary spanners do not possess unlimited connective capacity (Edelenbos, Bressers & Scholten, 2013) and face organizational limitations, which constraint their ability to effectively span the boundary. One such constraint can be found in the increasing tendency of megaprojects to be executed in a modular fashion (Jeffers 2016; Flyvbjerg, 2014). This increases the amount of internal departments, functional units and generally the number of actors, boundary spanners have to potentially be

aware of. Due to the plurality of different interests among these actors and the uncertain course a megaproject may take during its progression, boundary spanners may find it difficult to achieve lasting consensus or communicate with all relevant stakeholders whenever necessary.

1.1 Research goal and research questions

The focus of this thesis lies on how megaprojects conciliate the complex tension between their heterogenic internal structure and diverse external environment by employing connective management. Boundary spanners are introduced as a concept that describes actors, who deliberately carry out this sort of management. The research goal of this thesis is to understand the role of organizational antecedents for boundary spanning activity in megaprojects and to test their effects on project performance under the influence of project modularization.

Therefore, this study probes into the question “*What is the impact of autonomy, an open management style and boundary spanning activity on project performance in the context of project modularization?*”

For the sake of clarity it is helpful to segment this line of inquiry into a series of sub-questions.

1. How can megaproject performance be measured?
2. What is the relationship between boundary spanning and project performance?
3. What is the relationship between autonomy and boundary spanning activity?
4. What is the relationship between autonomy and project performance?
5. What is the relationship between management style and boundary spanning activity?
6. What is the relationship between management style and project performance?
7. Does boundary spanning mediate the relationship between autonomy, management style as organizational factors and project performance?
8. Does project modularization influence the effectiveness of boundary spanning activity on project performance?

1.2 Academic relevance

Despite being grounded in sound theoretical frameworks, empirical evidence revealing the conditions under which boundary spanning activities effectively contribute to positive project outcomes, remains scarce. In fact, many scholars make a call for deeper exploration of organizational context factors, which are able to substantiate pre-existing theories on boundary spanning (Beck, Marscholleck & Gregory, 2010; Van Meerkerk & Edelenbos, 2014; Edelenbos & van Meerkerk, 2015; Wang, Piazza & Soule, 2018). Although individual psychological characteristics are indeed a determinant of the emergence of boundary spanning activity (Williams, 2002), this study focusses on organizational explanations only. In doing so, provided research conclusions can be adequately utilized by project managers to implement adequate strategies and formulate organizational change in such a way that it benefits boundary spanners and thus ultimately improves project outcomes. In the case of autonomy, only few studies link this concept to higher levels of abstraction (team or organizational level), but rather study it on the individual level (Langfred & Moye, 2005; Hoegl & Parboteeah, 2006). Therefore, this study aims to supplement the literature on autonomy with evidence of consequences for organizational or project performance.

1.3 Societal relevance

This study contributes to an understanding of megaprojects as being deeply enmeshed in their environment, since their outcomes indiscriminately affect a number of stakeholders. On the one hand, there are reasons for concern. Due to their extreme costs, they cause systemic fragility among nations' economies (Flyvbjerg, Bruzelius & Rothengatter, 2003) and they can further create negative externalities for citizens and the natural environment (Molle & Floch, 2008). On the other hand, megaprojects can improve the quality of life for many, for example by linking previously disconnected parts of the world together (Suez Canal) or massively reducing passenger travel times (HS2). The benefits of megaprojects can even affect those, who are not direct users of the project facilities, for instance by "attracting visitors, investment, jobs and ultimately a higher quality of life for residents" (Bornstein, 2010, p1). However, as mentioned before, megaprojects are likewise affected by stakeholders' decisions to support, criticize, obstruct or even halt project progression. It is therefore vital to understand how responsible leading figures in the megaproject sector can contribute to better communication and interaction between the project sphere and stakeholders.

In studying the organizational antecedents of boundary spanning activity, this study presents a potential avenue for project managers to improve cross-boundary communication and therefore project performance. Stakeholders will also be able to benefit, as their voice is more likely to be heard by project members.

1.4 Study outline

In general, the structure of this thesis is composed in accordance with the sub-questions of section 1.1. Most sections of this paper are dedicated to assess and answer these questions in a systematic fashion. Consequently, this study will proceed as follows. First, the pre-existing theories regarding megaproject management, stakeholder management and governance networks will be used to illustrate distinguishing characteristics of megaprojects as well as the landscape in which they unfold. Further, literature on project and network performance will be used to discuss two diverging prominent notions of measuring performance, namely the objectivist and the subjectivist account. After that boundary spanners will be introduced as a useful concept, which can effectively bridge between the seemingly juxtaposed interests of megaprojects and their environment. The literature will then be employed to construe an array of testable hypotheses. The second part of this study, the methodology section, expounds on sampling choices, data collection and analytical techniques used. Next, the respective outcomes are presented and visualized in the results section. In closing, the discussion section aims to put the findings into perspective of the larger literary corpus, gives practical implications for professionals and further elaborates on the scope and limitations of this study.

2. Theoretical Framework

2.1 What makes megaprojects different?

Although there is no definite monetary boundary of what constitutes a megaproject, they have exceptionally large budgets that usually exceed 1 billion \$. They are trait makers, rather than trait takers (Hirschman, 2014), which means their successful implementation redefines how society operates, rather than fitting in with existing arrangements - e.g. the installation of a 5G mobile network. As a result, unlike normal projects, the successful implementation of megaprojects often involves strong economic and political interest (Flyvbjerg & Sunstein, 2016). Due to their enormous scale, megaprojects create a lot of jobs, build crucial public infrastructure and bind significant amounts of capital. In some cases, megaprojects function as the poster child of ambitious politicians, who want to memorialize their political legacy or rally public support for their persona. However, political interest in megaprojects generally goes beyond narcissistic sentiment. Office holders and administrations dislike public attention on cost overruns, schedule delays or other negative consequences of a project's progression, which can reduce public trust in the quality of governmental decision making (Flyvbjerg, 2012).

Drawing on the research of Head (2008), megaprojects have a lot in common with wicked problems, as they score high on all three dimensions of wickedness. First, their degree of structural complexity, that is the number and interrelatedness of systems and subsystems, is immense. On the one hand, they are comprised of many interrelated internal systems, including top management, different units concerned with construction, compliance, monitoring, and so forth. On the other hand, there are external systems, such as politics, multiple jurisdictions, global capital markets, labour markets, international supply chains or even the weather system, which can fundamentally influence megaprojects' progression. Since most of these sub-systems are interdependent to some degree, unexpected changes in one domain, may have asymmetric effects on the whole project. As an example, for the profound impact of structural complexity in large infrastructure projects, one may look at the development of the AnsaldoBredaV250, a high-speed train supposed to connect the Netherlands with Belgium. Although the project looked promising at first, unforeseen circumstances (such as a tunnel-burn in Switzerland) changed the progression of the project decisively. Due to the incident, the EU as a major legislator was committed to increase

the safety of the public train transportation systems by raising the construction standards to an extent that was not anticipated by the manufacturers. The construction company did neither predict an increase in standards, nor did it participate in the political arena resulting in the change in the first place. Ultimately, the project was not successful.

Second, as mentioned before, megaprojects involve many different actors, both internal and external, who represent a plurality of goals, values and viewpoints. This value divergence is relevant for megaprojects, as actors might differ in their perception of what constitutes a problem or solution and what does not. Imagine for instance a project management team, who deems 2m high sound barriers as sufficient to protect close communities from the noise of a to-be-build highway. Although the project team was tasked with providing a service for the good of society at large, individual citizens might disagree with the present plan as intolerable levels of noise pollution threatens their living quality and community life. In turn, these stakeholders can become tenacious adversaries for successful project implementation.

Finally, megaprojects are subject to uncertainty and are unpredictable. Together, this triumvirate of complexity makes megaprojects challenging to plan, implement and evaluate (Verweij, 2015).

To conclude, megaprojects are highly unique and widely considered as one-shot-operations. Implementing a megaproject is not simply executing a premeditated recipe, but rather an evolutionary process that requires constant adaptation and tinkering. Their embeddedness in unique and unpredictable social, political and economic systems therefore demand ongoing negotiation efforts between the project sphere and the project's environment.

2.2 Measuring performance – a Sisyphean task

The question of how project success can be described and ultimately measured has been consistently asked by researchers (Atkinson, 1999; Ika, 2009). As a result, during the past decades, multiple approaches on project evaluation emerged in the various bodies of literature. Therefore, this section will attempt to sketch the conceptual battle between two conflicted, yet popular notions: the objectivist approach and, what Ika (2009) labels the “subjectivist” approach. Each approach is then evaluated for their fit with megaprojects.

2.2.1 The objectivist approach

On the one extreme, one finds the rational or objectivist account on project performance which mostly draws from project management and business administration literature. Originally developed for smaller scale projects, it found its way into evaluating megaprojects. According to this approach, one should assume the existence of an ideal set of criteria, which are able to measure project performance (Ika, 2009). These criteria are universally applicable and thus can make projects comparable. The most prominent manifestation of the objectivist view can be found in the iron triangle (Lehtonen, 2014; Atkinson, 1999). The iron triangle evaluates projects by three factors and three factors only: time, costs and scope. Time simply refers to whether a project's progression remains in schedule and runs according to plan. Likewise, a project is deemed 'good', if its costs do not exceed precalculated expectations. Finally, the factor scope entails, whether a project meets its planned specifications and features. Together, these factors determine the quality or performance of the project. Although this approach appears to be allegedly simple and straightforward, it is a conceptual combination of efficiency and effectiveness (Belout, 1998).

Naturally, adhering to the assumption of universality has consequences for research, both theoretically and empirically. In his literature study on the history of project success and performance research, Ika (2009) remarks that studies following an objectivist approach often employ large-n survey research to extract knowledge. This can be problematic for megaproject research, as the amount of available cases is naturally limited by the low number of megaprojects running at a time (Flyvbjerg, 2014).

As mentioned before, the iron triangle only depicts an extreme variant of the objectivist approach and milder, less orthodox versions do exist. In general, these adaptations relax the universality assumption and rather rely on context-specific measures for project performance, depending on project type and their environment (Iermolenko, 2011). The original trinity of time, costs and scope is then enriched by other factors such as risk, resources or sustainability of project processes (Ebbesen & Hope, 2013). Such approaches put less emphasis on purely output based performance indicators, but also look at the efficient utilization of inputs (e.g. capital or human resources) and the way they are processed by project units. This allows project evaluators to introduce

contextual factors as explanatory constraints for project performance, giving more room to account for megaproject's uniqueness. For instance, Rezvani & Khosravi (2018) compare the differences of performance metrics in infrastructure, aerospace/defense and IT megaprojects.

However, there are shortcomings that all versions of the objectivist approach share, when heedlessly applied to megaprojects. First, there is the ex-ante selection of objective performance criteria by a few central actors, usually politicians, project owners and managers (Reynolds, 2015). Stakeholders, who may also be affected by the project's implementation and outcomes, are mostly excluded from deliberation. Their complaints are frequently perceived as a nuisance, threatening cost and time efficiency. This contradicts with the ambition of most megaprojects, which is to create tremendous societal value (Hirschman, 2014). Neglecting stakeholders' concerns may incur costs for society, which are simply not "priced in" by objectivist, yet exclusive performance criteria. In addition, stakeholders may react to protect their interests, which actually might fall back on project progression and costs. In other words, the rational approach relies on a very narrow definition of objectivity and might not be as rational as initially suggested.

This line of argument is also found with Klijn & Koppenjan (2016), who look at the pitfalls of rational-objectivist evaluation methods in governance networks. They stress that a rational approach disregards the importance of network goals in two ways. First, goals among actors can be conflicting. Managers, who rigidly adhere to their performance criteria may cause societal damage that is not being accounted for or find themselves among strong opposition. This is especially true under uncertainty, meaning that some goals that are relevant in the future of the project are not known from the beginning. In these situations, unexpected obstacles may render previously determined criteria unachievable or even obsolete (Flyvbjerg, 2013). Take for instances the construction of a German railway and urban development project in the city of Stuttgart (also known as Stuttgart 21). During the construction of a large railway station, it was discovered that a protected lizard species nested in the designated construction area (Milankovic, 2019). The goal of building the new railway station was suddenly confronted with the social (and legal) goal of natural protection. As a result, the already problem-ridden project came to a stall once again.

Second, goals are often dynamic and can change throughout the planning and implementation process. Yesterday's friends can become tomorrow's opposition or vice versa. This is also known as "goal displacement" (Klijn & Koppenjan, 2016, p. 243). Preferences of project owners or stakeholders may change over time, when new information becomes available. This is especially true in highly politicized environments, in which politicians fear low voter turnouts if dissatisfaction with a megaproject prevails. Evaluation criteria thus often need to be adapted (e.g. changing the project specifications for political reasons) and thus lose some of their external validity. Finally, from a wicked problem perspective, megaprojects are highly unique and are thus almost impossible to compare (Bruenig, 2017). Any attempt to quantitatively compare megaprojects, will only produce numbers with, again, low validity or generalizability.

On a different note, project performance evaluations are not only used to describe the general success of a project, but also create judgements on how the managerial team performed (Ika, 2009). However, objectivist approaches come along with problems of causal inference, because it is hard to ascertain the definite source of a project outcome (Klijn & Koppenjan, 2016). In fact, they provide little value in answering the question, whether it can be attributed to managerial decision making, external factors or a combination of the two that ultimately determined project success or failure.

However, despite the apparent ill-fit between the rational approach and megaproject evaluation, the former still enjoys significant popularity in practice. On the one hand, modern mass media perpetuate the use of the iron triangle's parameters, since it is more convenient to report a few numbers (and thus imply simplicity), rather than providing a holistic and contextual image of reality (Flyvbjerg, 2012). On the other hand, due to the type of projects (e.g. construction, energy, and technology) project managers often hold degrees in natural science (Ika, 2009). In general, objectivity is axiomatic to these disciplines, which results in a bias in favor of objective performance measurement tools.

2.2.2 The subjectivist approach

For these reasons, megaprojects may best be assessed by a subjectivist perspective (Ika, 2009). In this perspective project success is seen as a social construct. Success and failure are not objective judgements that can be measured universally, but depend

on the meaning others ascribe to it. What may be a success for project owners may turn out to be disappointing for users or other stakeholders. This marks an important shift in focus. Instead of perceiving megaprojects as isolated projects with a central evaluating entity, they are seen as “networks of people and organizations that work more or less coherently and purposefully to address public problems” (Benjamin & Green, 2009, p.297). Consequently, the problem of who should evaluate megaprojects should be returned to these very networks. Still, this begs the question how network success can be described.

Lehtonen (2014) is aware of this problem and offers a modified network-mapping approach, as a starting point. It consists of a series of steps. First, it is necessary to draw the boundaries of the relevant network. Megaprojects are embedded in multiple systems and the effects of their interactions are often far reaching, making it difficult to establish a clear border. Approaching a network could be based on frequently interacting members, the presence of a formal governance structure, actors involved decision making processes, mutual recognition or the presence of a common network identity (Lehtonen, 2014; Klijn & Koppenjan, 2016; Levi-Faur, 2012). Indicators that negatively impact project performance are distrust, missing actors and structural holes or dysfunctional relationships (Lehtonen, 2014). Next, one needs to explore existing accountability structures. Networks are amorphous, constantly evolving structures of actors with little to no central steering mechanisms. As a result, accountability rarely manifests vertically, but rather horizontally – between actors. This can be a problem in megaprojects, when large power asymmetries are present. Political actors can exercise their formal power over managers and other stakeholders, to push developments in a desired direction. To disentangle opaque and evolving accountability systems, it becomes crucial to develop a deep understanding of the case at hand. This resonates with Ika’s (2009) observation on the choice of research methodology among subjectivist studies, which employ comparative case studies more frequently than their objectivist counterparts. Third, as the critique on the objectivist approach suggested, one should pay special attention to individual and network goals. The exploration of project goals should focus on the inclusion and participation of network actors, who might discover common goals and shared perceptions along the way (Hertting & Vedung, 2012).

In conclusion, this approach stresses the importance of mutual learning and development of network actors. Horizontal accountability relationships are identified as a crucial requirement for effective learning under power asymmetries and diversity of interests (Klijn & Koppenjan, 2016). In general, stakeholder participation is necessary to arrive at a value judgement, on whether a project has been successful or not. Unlike the quantifiable parameters of the iron triangle, network mapping follows a logic that also includes symbolic and rhetoric success factors (Ika, 2009). Nevertheless, schedule, cost and scope do matter, as they are still required for planning and to assess project feasibility. Still, the lessons of complexity science and network evaluation are a reminder to not inflate the meaning and importance of these criteria.

Concluding from the two previous sections, this study employs a subjectivist approach for the evaluation of megaprojects. Such an approach resonates more adequately with the internal and external dynamics of megaprojects and their environment, which are rich in complexity, uncertainty and (value) divergence among a plurality of actors (Head, 2008, Lehtonen, 2014). It places strong emphasis on the successful interaction between different parties, which is necessary to avoid unexpected non-linear effects that can end in unsatisfactory outcomes for project owners, stakeholders and society as a whole (Molle & Floch, 2008). Ultimately, only the subjectivist approach can account for the high levels of granularity that is found in megaprojects.

2.3 Boundary spanning – connecting two worlds

The intrinsic complexity of megaprojects demands the pursuance of novel paths in fostering and sustaining coordination among different actors: boundary spanning. First, the following sub-section will introduce and discuss the concept of boundary spanners in the context of megaprojects. The link between boundary spanning and project performance will be further elaborated in sub-section 2.3.2.

2.3.1 What is boundary spanning?

Megaprojects are internally fragmented, as they are often made up of many functional units and hierarchical levels (Flyvbjerg, 2014). Additionally, they are embedded in complex social, political, economic and technological systems, which are comprised of an array of public, private and other societal actors (Gerrits, 2012; Klijn & Koppenjan, 2016). As outlined in section 2.1, megaprojects and their environment are

subject to high degrees of interdependency. Thus, in order to reach their objectives, megaproject managers have to overcome their organizational boundaries and must engage in collaboration and negotiation with other network actors (Edelenbos & Van Meerkerk, 2016), who often stem from diverse organizational and institutional backgrounds. However, these different norms and values, interests and institutional logics pose a difficulty for smooth interactions and thus require novel forms of inter-organizational management (Williams, 2002). According to Van Meerkerk & Edelenbos (2016), this niche is occupied by “boundary spanners”, who operate on the boundary between their organization and its environment. Important activities of boundary spanners include, (1) connecting different actors across organizational boundaries, (2) selecting and (3) translating relevant information on both sides of the boundary, as well as (4) introducing novel cooperative arrangements between network actors (Van Meerkerk & Edelenbos, 2016).

Although most organizations and project managers consciously design certain professional roles to keep in touch with their environment, this is not a necessity. In principle, every member of a megaproject can perform boundary spanning activities to some degree. Take for instance a regular construction worker, who during lunchbreak, mingles with the locals and gets to know about growing concerns with the noise levels close to the local retirement home. In theory, he then holds potentially valuable information, which could prompt his superiors to enact noise preventive measures – avoiding disconcerted citizens. This little anecdote exemplifies the transformational aspect of boundary spanners (Levina & Vaast, 2005; Van Meerkerk & Edelenbos, 2014). Due to their informational exchange, stakeholders on both sides of the boundary are able to change their course to prevent harm or even create win-win situations.

Accordingly, this study focusses on boundary spanning activity, rather than the presence of formal boundary spanning organizational roles. Following the suggestion of Van Meerkerk & Edelenbos (2014), boundary spanners are conceptualized as “boundary spanners in practice” (p.8), rather than as actors, who only fulfil representational boundary spanning functions (Levina & Vaast, 2005). The key difference between the two notions lies in the directionality of information flows (Van Meerkerk & Edelenbos, 2014). Traditional corporate or project communication roles primarily focus on broadcasting information to the project’s exterior. Boundary

spanners in practice however, absorb, translate and guide information flows bi-directionally, which enables participants on both sides of the boundary to adapt their decisions.

2.3.2 The link between boundary spanning activity and project performance

The complex interplay between the project domain and its diverse environment requires high degrees of informational exchange (Mok, Shen & Yang, 2015). Actors' goals are highly diverse, often invisible to others and may change during the course of time (Gerrits, 2012; Klijn & Koppenjan, 2016). Perceptions, underlying assumptions and vocabulary may differ and can cause misunderstandings and conflict. Boundary spanning constitutes an adequate tool in facing complexity heads on, by taking the proverbial bull by its horns. Empathy and otherness bestow boundary spanners with a better understanding of the gravitas and urgency of stakeholder interests and allows them to assess and report them, before they grow out of hand. Their connective capacity further allows them to establish new relationships between wary or unknown actors, which can contribute to joint solution finding. As a result, new resources¹ for problem solving may become available to the network. Increased stakeholder interaction can not only prevent negative effects, but also led to unexpected positive outcomes (Klijn & Koppenjan, 2016). Thus, boundary spanning activity does not only contribute to risk management, but provides connected stakeholders with potential upside. Boundary spanners can also enhance the levels of trust within a network, which in turn positively affects network performance (Van Meerkerk & Edelenbos, 2014). One concrete example is the replacement of conflict frames² with more collaborative associations.

This study employs a subjectivist approach to project performance. A study by Van Meerkerk & Edelenbos (2014) confirms the positive relationship between boundary spanning and (network) performance. Despite their different context, the similarities between networks and megaprojects and their environment suggest a similar relationship. Consequently, the following hypothesis allows to test the relationship between boundary spanning activity and project performance:

¹ Resources in the wider sense of the word, including financial resources, but also knowledge or time.

² E.g. the greedy/ruthless project managers vs the oppressed stakeholders or the never-satisfied nagging stakeholders vs the benevolent creators of public value

Hypothesis 1: *The degree of boundary spanning activity positively affects the degree of project performance.*

2.4 Organizational determinants for effective boundary spanning

The literature on boundary spanners discusses a wide range of individual, organizational and contextual factors that can limit the emergence and effectiveness of boundary spanners. The focus of this study lies on the organizational factors. The following paragraphs will look at three candidates that could influence the effectiveness of boundary spanning activity: Autonomy, managerial styles and project modularization.

2.4.1 The role of autonomy

The concept of boundary spanners originated from organizational science literature and has been recently applied in various network contexts (Van Meerkerk & Edelenbos, 2014; Van Meerkerk & Edelenbos, 2016; Bressers & Lulofs, 2010). However, so far it has been rarely applied in a megaproject context. Yet, megaprojects share important characteristics with networks, such as the number of diverse actors and complex interactions (Lehtonen, 2014). Therefore, transferring the concept of the boundary spanner may bear fruit and add explanatory power to prevailing models.

Still, the notion of connective management is not at all new to the domain of megaprojects. A similar but distinct concept to that of a boundary spanner is found in project management literature: the stakeholder manager (Roloff, 2008). However, there are differences. As mentioned before, in principle, every organizational member could play the role of a boundary spanner, regardless of their formal occupation. On the other hand, stakeholder managers are employed for the exact purpose of dealing with stakeholder issues. The role of the stakeholder manager is formalized and registered in an employment contract. The contractual relationship defines their tasks, modus operandi and goals they ought to achieve. Stakeholder managers engage with stakeholders as an ambassador of their project organization and usually communicate through official channels. One aspect of their work evolves around prioritizing and engaging with other formalized organizations, governments or financiers. As a result, relationships that form between stakeholder managers and their counterparts tend to become formalized over time.

Boundary spanners on the contrary are somewhat detached from their organization, despite being employed by it. They act as a bridging element between different actors, by assuming the role of a mediator or cultural broker (Williams, 2002). One crucial skill that is required to perform boundary spanning is addressed under the label otherness in the literature (Williams, 2002; Van Meerkerk & Edelenbos, 2016). Otherness describes an individual's tendency to value differences in mindsets, culture, perspectives or roles and to further understand their individual situation and needs. Boundary spanners in possession of this competence are thus able to translate different language codes to relevant actors, to account for institutional differences (thus providing more network predictability) and to visualize potential agreements between stakeholders that would have otherwise remained hidden. Further, otherness indicates some degree of impartiality, thus lessening the likelihood of a boundary spanner to side with a certain party. This way, actors can be made aware of interactions that are based on a mutual gains perspective, rather than a zero-sum approach.³ This argument further displays boundary spanners' required ability to respect another's values and perspectives instead imposing their own beliefs or those of their organization (Sørensen and Torfing, 2016).

In other words, the difference between the two notions is not of categorical nature, but rather gradual, as they differ in the degree of autonomy they are equipped with. Hence, stakeholder managers should be ultimately be considered as a subset of boundary spanners, however, with lesser amounts of autonomy. If all stakeholder interactions are strongly formalized and clearly delineate the communications' content and time, the impact of personal intentions or the potential of goodwill, will be crowded out. These arguments are empirically supported by findings of Perrone, Zaheer & McEvily (2003), who look at the relationship between role autonomy and trust in boundary spanning supplier representatives. They find that aspects of role autonomy, such as the absence of functional influence of other organizational departments and length of tenure significantly increase the effectiveness of boundary spanning activity, by positively contributing to trust building. In fact, a lack of autonomy can decrease actors' trust in boundary spanners, since they are anticipated to act according to their organization's agenda, rather than in good faith for the common benefit (Perrone, Zaheer & McEvily, 2003). This is a key difference to stakeholder managers, who by

³ As a result, actors are more likely to share potentially helpful information.

contract are expected to be primarily loyal to their employers' interests. Further, an organizational architecture with little to no autonomy, reduces the amount of attention external stakeholders receive (Crilly & Sloan, 2014). This strongly points at reduced activity at the boundary, with less information flowing both ways. As a result, autonomy is expected to be crucial for the effective commission of boundary spanners' activities and the following two hypotheses is derived:

Hypothesis 2: *The degree of autonomy positively affects the degree of boundary spanning activity.*

However, the potential outcomes of a more autonomous workforce in megaprojects are not limited to an increase in boundary spanning activity only. There are a number of arguments, which suggest a much larger impact on project performance as a whole. To begin with, task autonomy, that is "the degree to which an individual is given substantial freedom, independence, and discretion in carrying out a task" (Langfred & Moye, 2004, p.935), is strongly linked to individual's performance. Without the specter of an overly controlling supervisor or a meticulously detailed contract in their necks, employees are more likely to produce qualitative work. This relates back to boundary spanners, whose actions are also hampered by lesser degrees of autonomy. A similar observation on the team level was made by Hoegl & Parboteeah (2006), who studied the effect of autonomy on the performance of teams in innovative projects. When individual team members enjoyed equal opportunity to assert their influence within the team (team-internal autonomy) as well as the absence of interference in operation decisions, strategies and work processes of other organizational members (team-external autonomy), teams were often able to deliver better results, with higher degrees of creativity and innovativeness (Hoegl & Parboteeah, 2006; Langfred, 2005). Surprisingly, only few studies exist, that study autonomy as a determinant of organizational, let alone project performance. One of the rare findings is provided by Park (2016) in the context of businesses and corporations, which indeed experience an increase in performance, when employees were given sufficient task autonomy. Still, direct evidence linking employee autonomy to megaproject performance remains unfound. However, the impact of autonomy on performance on multiple levels of aggregation hints (albeit vaguely) at a general relationship between the two concepts. Therefore, a third hypothesis reads:

Hypothesis 3: *The degree of autonomy positively affects the degree of project performance.*

Synthesizing the previous two hypotheses leads to another hypothesis.

Hypothesis 4: *Boundary spanning activity partially mediates the relationship between autonomy and project performance.*

2.4.2 Boundary spanning under different management styles

As shown in section 2.2, a plethora of definitions for project performance exists. This is not only true for academic circles, but reflects in the everyday practice of megaprojects. Top managers are a vital element of megaprojects and have the ability to shape role definitions, organizational culture and employee relationships.

According to Davis, Schoorman & Donaldson (1997) manager-employee relationships can be roughly divided into two categories: principal-agent relationships and stewardship relationships. The former describes a relationship in which both parties act according to the economic rationale of utility maximization. This can become a problem, because their individual goals are juxtaposed to each other: the principle (or manager) desires to have a hard-working, value-maximizing agent (or employee), whereas the agent is assumed to provide only the minimum amount of effort required. Value for the principal is defined as their individual value only. As a result, the principal has an incentive to contractualize the employment relationship and shape employee behavior with a certain incentive structure (Laffont & Martimort, 2009).

Although boundary spanners are not necessarily employed as such, behavior that indicates such activity could be perceived as unwanted or negative by superiors, as it draws resources from serving the project and distributes them to the benefit of the network (Johlke, Stamper & Shoemaker, 2002). As a consequence, boundary spanners may become the target of blame or face other repercussions. In fact, the absence of active managerial support can stifle even the most talented boundary spanners (Johlke, Stamper & Shoemaker, 2002). This constitutes an incentive to reduce or even halt their activities and limit their executed tasks in accordance with their formal role description.

A relationship based on stewardship is different. In this case, both partners have their common success in mind. Individual sacrifice can be expected if the collective benefit exceeds the individual costs (Davis, Schoorman & Donaldson, 1997). This mindset resonates with a subjectivist account on megaproject performance, which is inherently inclusive. The success of a project is not only defined by the principal's surplus, but by the satisfaction of the network as a whole. In this view, boundary spanning activity is not seen as an unnecessary cost, but as a valuable contribution to maximize network goals. As a result, boundary spanners are likely to increase their efforts.

The literature on governance networks adds to the previous line of argument and explores the concept of managerial orientations deeper and offers an array of different concepts. A study by Edelenbos & Klijn (2009) coined the term process management, which refers to a management style, which focusses on the external environment of project organizations. This orientation places strong emphasis on stakeholders and the processes of how collaboration takes place. Interactive communication strategies are deemed important in this approach. Next, in the context of public-private-partnerships (PPP), Verweij, Klijn, Edelenbos & Van Buuren (2013) introduce the concept of an adaptive management style. Here, management uses as few ex-ante or fixed project goals as possible and engages in joint goal-searching with different stakeholders throughout the different project phases. The idea behind this approach is to remain open for the inclusion of new ideas and establish adaptive goals throughout the different project phases. Again, it remains crucial for project managers, to encourage and perform broad interaction with stakeholders. Finally, Van Meerkerk & Edelenbos (2018) describe a facilitative management style, which is geared towards the creation of commitment among network actors. This is achieved by creating an environment that enables other stakeholders to willingly engage in cross-boundary interactions and makes inter-organizational communication comfortable.

All of these management styles have a few things in common. They place strong emphasis on the organization's environment and are concerned with the establishment of collaborative processes that yield quality interactions. Naturally, these management styles resonate with the very essence of boundary spanners and are therefore expected to facilitate their connective activities. This observation is further substantiated by the fact, that all of these studies contrast the respective management style, with another, more inward facing management style, which

prioritizes the enforcement of organization-internal goals and the adherence to pre-determined schedule, feature and cost considerations.

However, these approaches almost exclusively focus on the organization's external interactions and neglect the effect of managerial orientations on employees' behaviour. Therefore, management must encourage networking activities and promote not only external, but also internal communication channels and must further create a climate, in which information sharing is rewarded (Tushman & Scanlan, 1981; Ysa, Sierra & Esteve, 2014). For instance, management-employee communication style strongly matters for boundary spanning individuals (Johlke & Duhan, 2000). By employing a two-way communication style, managers can reduce role ambiguity boundary spanners experience, which in turn makes them more comfortable in receiving and transmitting information to both sides of the boundary. As a result, this study introduces the concept of an "open management style", which supplements the external inclusiveness and adaptiveness of the abovementioned managerial orientations, with internal or inward facing-openness in the form of inclusive managerial communication.

Implementing these seemingly small changes can play out significantly on the project domain. Edelenbos & Klijn (2009) find evidence on how different management styles impact the outcomes of large infrastructural projects. As mentioned earlier, their research compares a so called "project management style", which is marked by a managerial focus on the project's content, scope, time and budget – in other words the objectivist iron triangle – to a "process management style", which emphasizes the project environment, perceived outcomes as well as collaborative processes. They find that the latter positively affects project outcomes, by employing an open and participatory communication approach labelled as "Dialogue, Decide, Deliver" (Edelenbos & Klijn, 2009, p. 6 as opposed to "Decide, Announce, Defend". Still, collaborative communication is often best executed by boundary spanning individuals. For instance, a large qualitative study by Di Maddaloni & Davis (2018) looks at how managerial perceptions on the importance of the project environment, especially the local stakeholders, impact project outcomes. Although project outcomes are often "fixed", disregarding local stakeholders can significantly drain project resources. Yet, being open to stakeholders is easier said than done and requires extensive amounts of time and availability as well as consistent messages and a commitment to things

that were agreed upon. Additionally, many of the study's informants highlighted the importance of informal ties in building and maintaining community relationships that go beyond official channels. Yet again, even with potential boundary spanners being present and willing, this inclusive approach can only be successful if backed by management. Further, some stages in the progression of megaprojects also tend to foster higher amounts of contractors, who are hired to do "the groundwork". This is an important limitation to the effectiveness of inclusive management, as contractors neither have a strong incentive, nor the capabilities to continuously engage with local stakeholders (Di Maddaloni & Davis, 2018).

To conclude, if and how effective boundary spanning activity is performed is likely dependent on the managerial orientations of project's managers (Verweij, Klijn, Edelenbos & Van Buuren, 2013). Therefore, a third and fourth hypothesis reads as follows.

Hypothesis 5: *The degree of open management style positively affects the degree of boundary spanning activity.*

Hypothesis 6: *The degree of open management style positively affects the degree of project performance.*

Again, by combining the previous two hypotheses into a full-fledged model, leads to another hypothesis.

Hypothesis 7: *Boundary spanning activity partially mediates the relationship between an open management style and project performance.*

2.4.3 Project modularization

Flyvbjerg (2014) observes a small trend away from highly centralized steering of megaprojects to more decentralized organizational forms. This is the result of a long history of poor project delivery. Learning from the costly outcomes of many megaprojects, it became more sensible to fragment or "modularize" the project. This means that megaprojects are split up into many smaller projects that are less dependent on their co-parts than in the centralized mode (Jeffers, 2016). Now, if one of these sub-project's experiences overruns in cost or time or faces other unforeseen hindrances, other parts are not necessarily affected right away. Although this mode of

governing megaprojects comes along with a reduction in efficiency, it recently has become more popular, due to its higher alleged effectiveness and lower systemic risk (Choi, 2014; Bondi, Magagnini, Macini, Micheli & Travaglini, 2016).

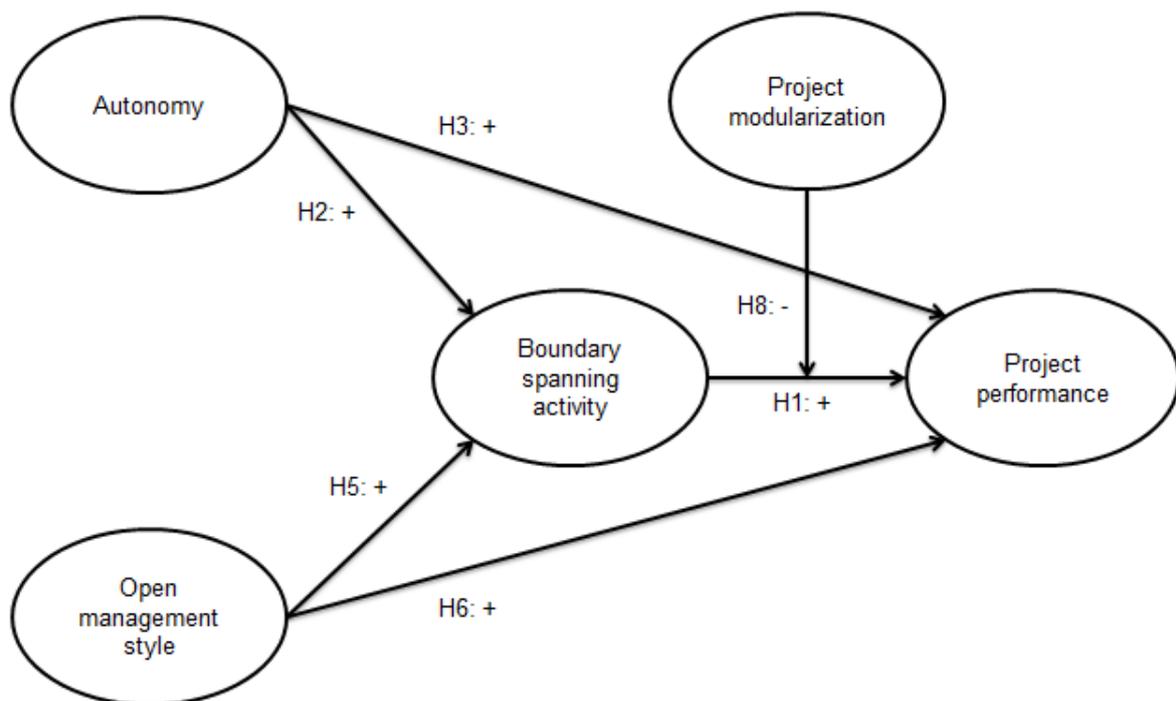
This change poses a challenge for boundary spanners, as their effectiveness is greatly determined by the number and quality of their internal and external linkages (Tushman & Scanlan, 1981). Internal linkages refer to boundary spanners' connections with others within their own unit, department or organization. External linkages point to their connections with other units, departments or organizations. Breaking down megaprojects in smaller, more independent units, naturally increases the number of departments and project related contact persons, a boundary spanner would need to keep track of. Additionally, the number of actors or organizational units in a network is positively correlated with the plurality of different goals, perceptions and strategies (Klijn & Koppenjan, 2016). Hence, larger, fragmented networks require more time and effort to manage. In addition, highly modularized projects exhibit higher degrees of employee transition (Di Maddaloni & Davis, 2018). Especially managers are likely to be transferred to a new, perhaps less related, position. Di Maddaloni & Davis (2018) surmise that in order for collaborative communication practices to work, the employee transition rate must be minimal, as otherwise trusted relationships with local stakeholders cannot be maintained.

This argument is closely aligned to the stipulations of network theory. By cutting a megaproject into many small and less dependent modules, the amount of structural holes (especially between unrelated departments) in the network is destined to drastically increase (Rodan, 2010; Kossinets, Kleinberg & Watts, 2008). For instance, it is obvious that a single boundary spanner will find it impossible to be directly connected to all relevant project or departmental managers, due to the sheer size of the project. As a result, boundary spanners may a) not be aware of all relevant changes happening within the project, b) not be aware of a suitable recipient for collected information, thus risking to not have vital information be transferred at all or c) may not be directly connected to the mentioned recipient, which would result in slowed down, indirect information flows via other network actors. In all three cases, adaptive decision making, both in the project internal and the external domain, would be impaired. Consequently, even if boundary spanners perform their connective tasks to the best of their ability, the underlying fragmented organizational structure

diminishes their actual impact. In cases, where project modularization is high, boundary spanners, despite actively engaging with stakeholders and transmitting information across the various boundaries, may find their efforts to bear less effect on the overall project performance, compared to cases in which project modularization scores low. Although this effect is to some extent expected to be prevalent in all megaprojects, increasingly modularized projects are expected to be more prone to a diminished information flow, despite the presence of boundary spanners.

As a result it is likely that the effectiveness of boundary spanning activity on project performance suffers, as boundary spanners do not possess unlimited connective capacity. One could argue that this development resembles the difficulties of an actor-rich project environment. As a result, the following hypothesis can be formulated.

Hypothesis 8: *The degree of project modularization negatively affects the relationship between boundary spanning activity and project performance.*



H4: Partial mediation of autonomy on project performance by boundary spanning activity

H7: Partial mediation of open management style on project performance by boundary spanning activity

Figure 1. Conceptual model

3. Methodology

3.1 Data collection

Data was collected via different methods, including online surveys, in-person interviews and hand-out questionnaires during a site visit. The collection process took place between 15.01.2020 and 25.05.2020. The actual respondents within the megaprojects were predominantly project managers (both junior and senior), stakeholder managers, field managers, public relations representatives and in-house management consultants. Hence, they were expected to have sufficient knowledge on the relevant aspects of the projects, which were of interest to this study. Although some respondents could be identified as relevant for their case via desk research⁴, other connections had to be established via snowball sampling. This was achieved by asking the initial respondents for a referral or further distribution of the questionnaire as they were only visible to project interns. Additionally, an on-site visit was used as an opportunity to distribute a paper version of the questionnaire to the presenting managers and staff.

Before being presented the actual survey, respondents were informed about the study's general motivation, background, and assurance that their data would be anonymized and used only for the purpose of this study. The survey questionnaire can be found in Appendix A. Respondents were then asked to give their consent in order to be forwarded to the survey questions. The survey itself consisted of five sections. Moreover, respondents were made familiar with how the study understood certain terms and concepts (e.g. the project environment or that actors actively involved in the network do not have to be necessarily titled or employed as such). In order to scrutinize the quality of the explanations and questions posed, a short interview with a project team leader from the broadcasting sector were held prior to the execution of the actual data collection. The interview revealed that respondents found such a clarification helpful. It also led to the reformulation of a few questions and adaption of scale composition. More information on this will be provided in the operationalization section.

The survey was sent out to 243 individuals. In addition to that, many respondents were asked to refer other colleagues that fit the sampling criteria to the researcher. Because of this partial snowball sampling approach and the in-person site visits, the total

⁴ This included professional social networks such as xing.com or linkedin.com.

number of approached individuals remained unknown and it was therefore difficult to produce an accurate non-response rate. Still, in total, 165 responses were collected. Before analyzing the data, incomplete responses, non-consented surveys and online surveys that exhibited an odd answering time, were excluded ($90 \text{ seconds} < X < 1200 \text{ seconds}$). After the pruning, a total number of 136 responses remained in the data set.

3.2 Sample choice

Megaprojects were selected based on desk research, working language and project progression. To reduce the confounding effect of contextual factors, such as region-specific culture, all cases had to be located in the European Union or its associated states. Although, the European Union cannot be considered as a homogenous block, significant commonalities exist. For example, most major projects and megaprojects enjoy funding of the EU commission's (a common stakeholder) various regional and development funds and therefore must comply with certain regulations (EU-Projects, 2019). Additionally, publicly launched initiatives such as the COST-Megaproject research unit (<http://www.mega-project.eu/>), suggest the emergence of a common framework of how megaprojects are perceived and operate in the EU. This is also reflected in the presence of organizations aimed at gathering and disseminating best practices (*Fédération de l'Industrie Européenne de la Construction; The European Construction Institute*). Therefore, megaprojects from other regions of the world were excluded from this study. Table 1 shows the full list of selected megaprojects, general information on the project and their respective respondent numbers.

Table 1. Megaprojects, descriptions and respondents

Project name	Description	Total responses (%)
High Speed 2 (HS2), UK	High speed train connection between London, Birmingham, Manchester and Leeds. Suitable for trains up to 360km/h. 100-115bln £ estimated costs.	24 (17,64%)
London Crossrail, UK	Latest railway line to be integrated into London's underground network (Elizabeth line). With 73miles it crosses the British capital from East to West. Current expected costs 18.6bln £, up from the initial estimate of 14.7bln £.	29 (21.32%)

Berlin Brandenburg Airport (BER), GER	Large international airport with two runways near Berlin. Original completion date: Nov. 2011. Infamous for increasing costs and delays. Currently expected to cost 7.3bln €.	34 (25.00%)
Stuttgart 21, GER	Railway development project to connect Stuttgart and Augsburg, as well as building an underground train station. As of beginning of 2020, SG21 is expected to cost 10bln €	22 (16.18%)
Nord Stream 2, RU & GER	Large international energy project. System of offshore gas pipelines, connecting Vyborg (Russia) to Greifswald (Germany) through the Baltic Sea. Politically contested. Estimated costs up to 17.2bln €	27 (19.85%)

The total of interpretable responses was n = 136

3.3 Operationalization

The following section displays the scales used to measure the key variables autonomy, management style, project modularization, boundary spanning activity and project performance. Table 3 lists all scale-items and constructs used in this study. Additionally, their respective reliability and validity are assessed.

(1) *Autonomy*. The choice of measurement items for the autonomy scale was inspired by a pre-existing scale developed by Breugh (1999). Breugh differentiates between three sub-types of (work) autonomy, namely method autonomy, scheduling autonomy and criteria autonomy. Method autonomy refers to the degree of constraint organizational rules and superiors impose on individual's choice of working methods. Scheduling autonomy refers to the individual's ability to choose the time and sequence of their tasks. Finally, criteria autonomy refers to an individual's ability to choose their objectives and influence how they are evaluated. The scale was further enriched by the findings of Perrone, Zaheer & McEvily (2003), who enlist functional influence as an important constraining factor. All items were measured using a 7-point Likert scale, ranging from (1) Strongly disagree to (7) Strongly agree. The last two items were coded negatively and had to be recoded accordingly. The final measurement of autonomy was derived by calculating the scale average ($\text{sum}(x)/n$).

(2) *Management style*. Two broader notions of management styles were identified in the literature. On the one hand, the *open management style*⁵ emphasizes joint goal-searching, the integration of novel ideas in the decision making process, an inclusive stance towards stakeholder participation (Edelenbos & Klijn, 2009; Verwij, Klijn, Edelenbos & Van Buuren, 2013) and is in general closer to a subjectivist approach to megaproject management. It is marked by unambiguous and frequent informational exchange, with relevant information flowing freely both vertically (up and down the organizational hierarchy) and horizontally (between departments or between the project and environmental domain). On the other hand, the rather objectivist *closed management style* is characterized by ex-ante goal formulation, one-way information flows, a preference for formal communication channels and a general focus on the project domain.

Considerations from both styles were used to arrive at a composite scale to measure the independent variable *open management style*. Item 1 and 2 were extracted from a communication scale developed by Johlke & Duhan (2000) to query for the way of information flows present within the project. Item 3 to 7 were adopted from Edelenbos and Klijn's (2009) scales on "identifying managerial choices" (p.328-331) and inquired on goal formulation, inclusiveness and stakeholder participation. Some items were derived from scales used to describe a closed management style and thus had to be re-coded inversely. Then, the average of 7 items measured on a 7-point Likert scale ranging from (1) Strongly Disagree to (7) Strongly agree was calculated to produce the final scale value.

(3) *Project modularization*. Naturally, the degree of how strongly a project is fragmented or modularized is a structural condition, which is not altered by individual perceptions. Therefore, each megaproject was assessed via desk research using publicly available information. The sources included media mentions, project websites, project & governmental reports, public databases and cold calling. Important data points were number of departments, levels of hierarchy, number of contractors and number of site locations for operation and manufacturing. This data was then integrated into a single digit, which represented a low, medium or high degree of

⁵ In this study, the concept of open management style serves as an umbrella term for the diversity of related, yet nuancedly different types of management styles in the literature, such as external oriented management style, inclusive management style or adaptive management style.

project modularization. Each project was subsequently assigned its respective modularization value, which can be found in Table 2. However, it is important to note that the ordinal scale of this variable does not allow making judgements based on the numerical difference between two projects. It merely reflects a category and only allows inferences, whether one project is more modularized than the other, but not by how much.

Table 2. Project Modularization

Project Name	Sector	Modularization Score	Reasoning
High Speed 2 (HS2), UK	Transport, Rail	3 - High	High number of construction sites, many independent contractors, high number of teams with different functions
London Crossrail, UK	Transport, Underground	1 - Low	Matrix organizational structure, fewer departments than other megaprojects, geographical proximity
Berlin Brandenburg Airport (BER), GER	Transport, Air	3 - High	Complex ownership structure involving several jurisdictions on multiple governmental levels, high amount of contractors
Stuttgart 21, GER	Transport, Rail + Station	2 - Medium	Multiple geographical locations, different parts of project managed by distinct subsidiaries
Nord Stream 2, RU & GER	Energy	2 - Medium	Rather centralized decision making, many functionally different departments

(4) *Boundary spanning activity.* This study conceptualized boundary spanners as boundary spanners in practice rather than as attached to a formal boundary spanning role. Additionally, one of the key aims of this study was to arrive at conclusions how boundary spanning activity impacts megaprojects as a whole. Given the informality and opaqueness of the boundary spanning role, identifying and querying individuals and their potential boundary spanning activity was deemed difficult and perceived as risking delivering results with low validity. Hence, participants were asked about the wider presence of boundary spanners (or rather the presence of individuals performing

boundary spanning tasks) in and around the megaproject. This approach is not new. Van Meerkerk & Edelenbos (2014) developed a powerful scale that measures the presence of boundary spanners. They incorporate the following aspects: inter-organizational information exchange, relationship building and maintenance, connecting internal processes and network developments, a sensitivity for important issues in the network and swift mobilization of organizational capacities to deal with network developments. Consequently, items 1 to 4 depict these aspects and were adopted from Edelenbos & Van Meerkerk's (2015) scale. An original fifth item was omitted from the scale for two reasons. First, the item was associated with the lowest factor loading (.61) of all items in the scale of the original study by Van Meerkerk & Edelenbos (2014). Second, during the trial interview, the interviewee found the question to be unclear and misleading in a megaproject context. As a result, the *boundary spanning activity* scale was comprised of four items measured on a 7-point Likert scale ranging from (1) Strongly disagree to (7) Strongly agree. Again, the average was calculated to establish a conclusive value for this scale.

(5) *Project performance*. One problem of using pre-determined objectives to measure project performance lies in the fact that megaprojects and their environments are inherently dynamic (Ysa, Sierra & Esteve, 2014). Hence, goals and objectives become subject to change over time as new challenges or specifications may emerge. Moreover, the effects of an increasing project modularization on the methods of performance measurement have yet to be assessed by academia. For instance, some parts of the project might operate smoothly, yet others may struggle with a powerful stakeholder, which slows down the whole project. This makes it difficult to pinpoint "where and when" projects succeed or underperform and assigning statistically valid weightings appears to be a thorny task. As a consequence, this study used perceived project performance as a proxy to depict project performance. This method is not new and has been successfully employed by Klijn & Koppenjan (2016) and Steijn, Klijn & Edelenbos (2011) in their research on public-private partnerships (PPP). Still, the original scale was developed by Klijn, Steijn & Edelenbos (2010) in the context of analyzing governance networks. Due to the structural and contextual similarities to PPPs and governance networks, this approach was expected to be a good fit for megaproject research. Their newly developed scale combines aspects of stakeholder inclusiveness, integrative and innovative quality of solutions as well as their efficacy.

This study drew on the familiar scales of Klijn & Koppenjan (2016) and Van Meerkerk & Edelenbos' (2014) scales and integrated them into an adapted 6-item scale that was used to measure perceived project performance. Again, each item was measured on a Likert-scale ranging from (1) Strongly disagree to (7) Strongly agree.

(6) *Controls*. To prevent interference by non-study related variables, two control variables were inserted. The most commonly utilized confounding variable was identified in *tenure*. The literature sometimes also refers to this as *length of involvement in the organization* or *years of experience*. There are arguments that this variable could be a stronger predictor of boundary spanning activity or even perceived project performance, than those examined in this study. First, respondents with many years of experience may be able to draw from experiences gained in previous project deployments, which allows them to assess the processes and outcomes of megaprojects more realistically (Klijn, Edelenbos & Steijn, 2010). Second, the length of involvement with megaprojects could teach respondents technical or interactive skills, which are important for boundary spanning, such as identifying relevant information, connecting and maintaining stakeholder relationships or managing information flows. Finally, tenure can also work as a filter. The longer someone is employed in a megaproject, the more apparent his relevant skill set and individual traits become to them and their supervising managers. As a result, individuals may be directed to suitable organizational positions and or roles.⁶ Further, *project phase* was initially deemed as a possible, popular confounding variable. As megaprojects unfold, underlying conflicting interests or other challenges, which are not present in the initial stages of the project, may emerge over the course of time. Often, developing solutions for these issues takes time itself and the degree of their success is not immediately visible. Hence, it is only in later project stages, that managers and stakeholders alike can accurately judge the success and durability of their interactions and solutions. However, these considerations aside, there are empirical studies, which show that project phase has no bearing on respondents performance perceptions (Van Meerkerk & Edelenbos, 2014).

⁶ For instance, someone with strong connective skills finds himself in a boundary spanning type role, whereas someone with low degrees of otherness ends up in the back-office.

3.4 Reliability analysis

Principal component analysis was used to assess the construct validity of the developed measures. Factor extraction by Varimax rotation resulted in five different constructs, which were congruent with the developed model. Most factor loadings scored .50 or higher, which meant that the individual items asserted a moderate to high influence on the composite construct (Dunteman, 1989). In other words, the items were considered as a defining part of the construct. In order to test, whether the developed scales showed high levels of internal consistency, reliability analysis was conducted. Its results are shown in Table 3. All scales proved to be highly reliable, with Cronbach's alpha values greater than .80. Additionally, almost all items had an inter-item-to-total correlation greater than .50. According to Nunnally (1994), this constitutes a good level for empirical studies trying to provide research based real life applications.

Table 3. Measurement items and construct reliability

Items and Constructs	Factor loading	Corrected item-to-total correlations	Cronbach's alpha	Source
Autonomy			.843	
1) In this project people are allowed to decide how to go about getting their job done (the methods they use).	.65	.67		Adapted Breugh (1999) and Perrone et al. (2003)
2) In general, people involved in this project can decide the time when to do particular activities.	.69	.70		
3) There is some control over what employees objectives are and how they are evaluated	.81	.70		
4) In general, supervisors do not have to approve people's decisions before they can take action.	.67	.65		
5) When making decisions, there are often constrains by individuals from other departments or functional units.	.54	.59		
6) Rules and regulations often restrict or slow down work unnecessarily.	.45	.46		
Open management style			.832	
1) In this project, people exchange ideas and information with their supervisors freely and easily.	.81	.69		Johlke & Duhan (2000)
	.77	.64		

2)	In this project, supervisors and employees communicate both ways.	.59	.32	Partially adapted from
3)	In this project, management strives for clearly recognizable goals and makes sure they always come first.	.63	.58	Edelenbos & Klijn (2009)
4)	In this project, the management perceives criticism as constructive and implements it into their decision making.	.71	.61	
5)	It is difficult for new parties to participate in the project's organization efforts.	.71	.61	
6)	The management actively encourages the involvement of stakeholders. Even if they are critical of the project.	.76	.63	
7)	Sometimes, decisions are pushed through, even when not all stakeholders have been involved or agree.			
Boundary spanning activity			.827	
1)	In this project there are many persons active who are able to build and maintain sustainable relationships with different stakeholders.	.56	.67	Reduced scale adopted from Van Meerkerk & Edelenbos (2014)
2)	In this project there are many persons active who have a feeling of what is important and what matters to other stakeholders.	.45	.63	
3)	In this project there are many persons active who take care of a good information exchange between the project and its environment.	.69	.70	
4)	In this project there are many persons active who make effective connections between developments in the wider network and internal work processes of their home organizations.	.66	.62	
Perceived project performance			.871	
1)	Do you think innovative ideas have been developed during the project?	.50	.58	Adapted from Klijn, Steijn & Edelenbos (2010), Van Meerkerk & Edelenbos (2014)
2)	Do you think the developed solutions effectively deal with the project's problems?	.67	.73	
3)	Do you think the developed solutions are long-lasting or durable?	.64	.73	
4)	Do you think that the various project stakeholders in the network have contributed to its results?	.51	.62	
		.61	.70	

5) Do you think that the developed solutions are generally supported by stakeholders?	.68	.68
6) Do you think the various problems were sufficiently integrated?		

All items were measured on a 7-point Likert scale.

3.5 Data Analysis

Although the present data had a nested structure, with an individual as well as project level, this study abstained from multi-level analysis for the following reasons. First, the sample size on the project level was simply too small. According to Maas & Hox (2005), the sample size on level-two (the project level), should at least reach around 50 cases. Otherwise, the results have a higher likelihood of being subject to bias, especially in terms of the produced standard errors. Second, a comparison of the between-project and within-project variance of the several variables further did not support the use of a multi-level analytical approach. For all individually measured variables the within-project variance was significantly higher, compared to the between-project variance (see Table 4.). This means that the total variance of the respective variable, was only to a small degree explained by group or project membership. For instance, in the case of open management style, only 10.45% of all observable variance could be attributed to project membership. Thus, the largest portion of variation (89.55%) remained unaccounted for and therefore could be explored by other statistical means such as linear regression. The same reasoning was applied to the other variables, which between-project variance even in the most extreme case did not exceed 28.32%. These levels were deemed insufficient for multi-level analysis.

As a result, IBM's statistical software SPSS and the PROCESS macro (Hayes, 2017) were used to perform multiple linear regressions. Appendix A shows the annotated code employed to wrangle and analyze the data. The PROCESS macro was used as it possesses some advantages over approaches, which solely rely on causal steps (Baron & Kenny, 1986) to test for mediation or moderated mediation. In general (moderated) mediation requires many individual tests, especially if the proposed moderator is not dichotomous. Each of these tests needs to be significant, in order for the whole integrated model to be pronounced significant. PROCESS overcomes this limitation by using only one single test statistic, which makes multiple steps redundant.

Additionally, PROCESS is less prone to sampling bias in comparison to other methods, as it does not require the sample's indirect effects to be normally distributed (Hayes, 2017).

Table 4. Analysis of variance (ANOVA)

Scale		Explained variance of total
Autonomy	Between-projects	28.32%
	Within-projects	71.68%
Open management style	Between-projects	10.45%
	Within-projects	89.55%
Boundary spanning activity	Between-projects	16.77%
	Within-projects	83,23%
Perceived project performance	Between-projects	21.11%
	Within-projects	78.89%

Note: All variances were significant at the $p < .01$ ** level

4. Results

4.1 Descriptives

In order to get a better understanding of the data at hand, descriptive statistics were reported in Table 5. Respondents tended to be rather experienced with megaprojects in general, with 8.02 years of average involvement in megaprojects ($\sigma = 4.75$ years). This strengthens the overall validity of this study, as it increases the likelihood of respondents having good knowledge of project parameters, as well as being able to judge them. On average, respondents evaluated their project organizations as granting their employees medium autonomy (3.99; $\sigma = 1.41$), featuring a moderately open management style (4.17; $\sigma = 1.20$) and having a moderate presence of boundary spanning actors (4.15; $\sigma = 1.43$). Further, respondents tended to view the performance of their projects as improvable and slightly below the scale mid-point (4), with an average perceived project performance of 3.88 ($\sigma = 1.34$). However, the range of project performance perceptions ranges from the lowest possible score of 1.0 to the very high score of 6.67. This amount of variance was partially expected before collecting the data. As megaproject's employees are scattered across different organizational departments, they are exposed to other, distinct bits of information, allowing them to draw individual conclusions on how the project as a whole might progress. This can be seen as beneficial for megaproject research, as perception data aggregation allows researchers to arrive at a more holistic picture of megaproject performance. Further, the presence of extreme responses could indicate a dissatisfaction or satisfaction of a project employee with the outcome of the project, based on recent or temporary events.

Table 5. Descriptive statistics of study variables

	Minimum	Maximum	Mean	Std. Deviation
1. Tenure	1	23	8.02	4.75
2. Autonomy	1.17	6.67	3.99	1.41
3. Open management style	1.71	6.43	4.17	1.20
4. Boundary spanning activity	1.0	7.0	4.15	1.43
5. Project modularization	1	3	2.19	.79

6. Perceived project performance	1	6.67	3.88	1.34
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Note: For all items n = 136

Table 6 provides a more granular view of perceived project performance, by segmenting the variable into the individual megaprojects. Respondents from the High Speed 2 and Crossrail projects, saw their projects performing well, with individual perceptions exceeding the scale's mid-point (4) by .65 ($\sigma = 1.57$) and .39 ($\sigma = 1.48$) respectively. On the other end, the two German projects came along with less favourable performance perceptions. The Berlin Brandenburg Airport megaproject was perceived to perform the worst, with an average performance of 2.96 ($\sigma = 1.14$). This is congruent with the anecdotal findings of desk research and the general public opinion of the German population and media accounts, as the project suffers from repeated delays (Fiedler & Wendler, 2016).

Table 6. Perceived project performance by individual project

Megaproject	Mean perceived project performance	Std. Deviation
High Speed 2	4.65	1.57
Crossrail	4.39	1.48
Berlin Brandenburg Airport	2.96	1.14
Stuttgart 21	3.66	.70
Nord Stream 2	3.98	.94

Note: The number of respondents per individual megaproject is not equal and varies from 22 to 34.

4.2 Correlations

The correlations of all dependent (4, 6), independent (2, 3, 5) and control variables (1) can be found in Table 7. Taking a look at correlations can be helpful to better visualize the data and establish, whether direct associations are present. Albeit these correlations do not constitute a proof for the correctness of the model developed in this study, they do provide initial support for some hypothesized effects. The table shows, that boundary spanning activity is indeed significantly positively related with both, autonomy ($r = .474$; $p < .01$) and open management style ($r = .588$; $p < .01$), which is line with hypotheses two and five. Further, perceived project performance is positively correlated with autonomy ($r = .599$; $p < 0.01$), open management style ($r =$

.511; $p < 0.01$) and boundary spanning activity ($r = .611$; $p < 0.01$), which are all hypothesized to be its predictors. Tenure constitutes the only control variable of this study. However, as Table 7 shows, there are no significant correlations between tenure and the dependent variables of this study. Only a positive correlation between tenure and autonomy ($r = .242$; $p < 0.01$) showed to be significant. This does not come as a surprise, as members of organizations often climb the organizational hierarchy over time and get awarded with more responsibility and room to carry out their own decisions (Perrone, Zaheer & McEvily, 2003). Finally, project modularization and perceived project performance feature a significant negative correlation ($r = -.195$; $p < .05$). Given the positive correlations of the other variables, this could indicate a suppressive interaction effect.

Although many correlations point towards the hypothesized relationships, regression analysis is required to see, if causality can be established.

Table 7. Correlations between model variables

	1	2	3	4	5	6
1. Tenure	1					
2. Autonomy	.242**	1				
3. Open management style	.076	.356**	1			
4. Boundary spanning activity	.082	.474**	.588**	1		
5. Project modularization	.055	-.283**	-.262**	-.331**	1	
6. Perceived project performance	.129	.599**	.511**	.611**	-.195*	1

Note: This table shows the association between the respective variables with the Pearson coefficient. For all items: $n = 136$ * $p < 0.05$; ** $p < 0.01$

4.3 Main model analysis

Table 9 presents the results of a series of linear regressions, predicting the direct effects of several variables on perceived project performance. All coefficients presented in the following paragraphs are unstandardized, as all variables are similarly based on a 7-point-Likert measuring scale. Hayes (2017, p.519) argues, that in this

case, unstandardized coefficients allow for a more simple and trivial interpretation, making standardization unnecessary.

Before assessing the fully integrated model of Figure 1, the model was gradually built up in a stepwise fashion. This was done, in order to better understand the relationships between the different variables and their interactions. As a first step, it was attempted to find a connection between the two independent variables autonomy, open management style, and the dependent variable perceived project performance (Model 1). According to this simple model, they are indeed causally related, with autonomy ($b = .454, p < .01$) and open management style ($b = .382, p < .01$) both having a direct (unstandardized) effect on project performance. Next, boundary spanning activity was introduced as a covariate, as it was hypothesized to be a possible mediator (Model 2), which asserted a significant direct unstandardized effect of $b = .302 (p < .01)$. As a result, both of the aforementioned direct effects on project performance shrunk, autonomy ($b = .362, p < .01$) and open management style ($b = .21, p < .05$). These preliminary results imply a partially mediating role of boundary spanning activity in the relationships between autonomy, open management style and network performance. Next, PROCESS macro was used to assess the strength of the indirect effect, as well as its significance. Model 3 incorporates these four variables into one single test. The overall model explains 51.94% ($p < .01$) of the total observed variance in project performance. Autonomy asserted a direct effect of $b = .3615 (p < .01)$ and a small indirect effect of $b = .0924 (p < .01)$ on project performance via its effect on boundary spanning activity ($b = .3075, p < .01$). Open management style, too, significantly affected project performance directly ($b = .2098, p < .05$) and indirectly ($b = .1724, p < .01$) via boundary spanning activity. This is a good preliminary indication for the correctness of the developed model.

Model 4 and 5 continue, by including the hypothesized interaction effect between project modularization and boundary spanning activity on project performance, as well as the control variable tenure. For the sake of simplicity, only the final model 5 will be elaborated in more detail, as the results do not differ much. Further, this model is also used for hypothesis testing. Figure 2 visualizes these results in one fully-integrated conceptual model. Again, the variables autonomy and open management style show significant, positive direct effects ($b = .3742, p < .01$; $b = .2046, p < .05$) on project performance. Hence, *hypotheses 3 and 6* can be accepted. Both variables also directly

influence boundary spanning activity, with autonomy contributing $b = .3130$ ($p < .01$) and open management style contributing $b = .5701$ ($p < .05$), leading to the confirmation of *hypotheses 2* and *4*, respectively.

Further, boundary spanning activity itself appeared to strongly affect project performance ($b = .5027$, $p < .05$). In comparison to the previous model, the coefficient increased by approximately .2. Although this relation was hypothesized and thereby confirming *hypothesis 1*, its very high effect size is surprising and is worth further discussion. One possible reason for this could be that project modularization as the recently introduced variable had an effect on boundary spanning activity, which in turn influenced project performance. However, this seems unlikely, as the two are negatively correlated ($r = -.331$; $p < .01$).

By multiplying the direct effects of the independent variables on boundary spanning activity with the direct effect of boundary spanning activity on project performance, two significant indirect effects were established. Autonomy indirectly influenced project performance via boundary spanning activity with an unstandardized coefficient of $b = .3130 * .5027 = .1573$ ($p < .01$). The total effect of autonomy on project performance therefore amounts to $.5315$ ($.3742 + .1573$). In other words, if the score of autonomy increased by the value of 1, project performance increased by the value of $.5315$. Likewise, open management style indirectly influenced project performance by $b = .2866$ ($p < .05$), amounting to a total effect of $.4912$ ($.2046 + .2866$).

Although the indirect effects of autonomy and open management style tended to decrease with higher degrees of product modularization, the interaction effect of $b = -.08$ was not significant ($p = .2796$). Even though the data hints at the hypothesized suppressing tendency of project modularization, the effect is likely to be attributed to randomness. As a result, *hypothesis 8* cannot be accepted.

Finally, tenure was included to control for the possible confounding effect of years of involvement with megaprojects on the model's variables. The only reason tenure was ultimately included in the model, was its apparent positive correlation with autonomy ($r = .242$, $p < .01$). However, its statistical influence is weak ($b = -.012$) and not significant $p = .9497$. Still, even though the last two added relationships did not prove to be significant, the previously established direct and indirect effects remained

significant, with only some changes occurring in the variable scores, which shows consistency in the main relationships.

Consequently, this study can make a confident claim in accepting the following hypotheses: 1, 2, 3, 4, 5, 6 and 7. Due, to insignificant results, hypothesis 8 could not be accepted. A summary of the hypothesis tests can be found below in Table 8.

Table 8. Summarized list of hypotheses

	Hypothesis	Status
1)	<i>The degree of boundary spanning activity positively affects the degree of project performance.</i>	Accepted
2)	<i>The degree of autonomy positively affects the degree of boundary spanning activity.</i>	Accepted
3)	<i>The degree of autonomy positively affects the degree of project performance.</i>	Accepted
4)	<i>Boundary spanning activity partially mediates the relationship between autonomy and project performance.</i>	Accepted
5)	<i>The degree of open management style positively affects the degree of boundary spanning activity.</i>	Accepted
6)	<i>The degree of open management style positively affects the degree of project performance.</i>	Accepted
7)	<i>Boundary spanning activity partially mediates the relationship between an open management style and project performance.</i>	Accepted
8)	<i>The degree of project modularization negatively affects the relationship between boundary spanning activity and project performance.</i>	Rejected

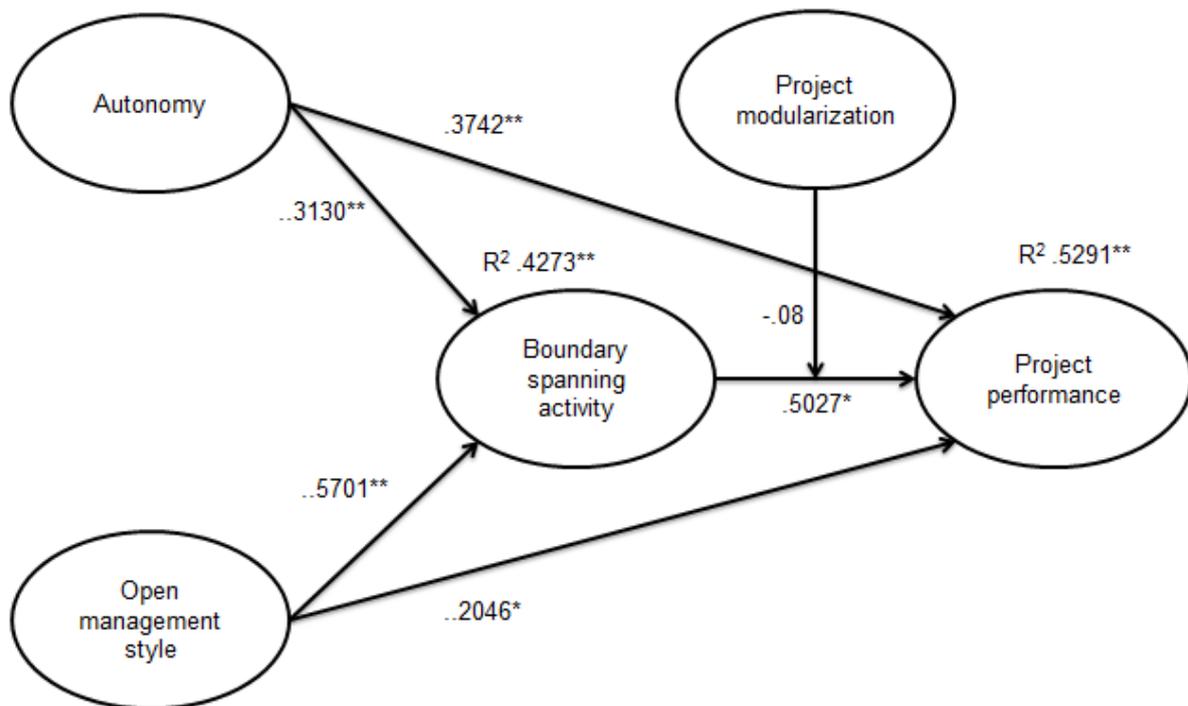


Figure 2. Unstandardized coefficients of autonomy, open management style, boundary spanning activity, project modularization and project performance

Table 9. Direct effects of five rounds of linear regression models on perceived project performance

	Model				
	1	2	3	4	5
R ²	.461**	.519**	.5194**	.5291**	.5291**
PROCESS model	-	-	4	14	14
Autonomy	.4540**	.3620**	.3615**	.3731**	.3724**
Open management style	.3820**	.2100*	.2098*	.2044*	.2046*
Boundary spanning activity		.3020**	.3022**	.5042*	.5027**
Project modularization				.4813	.4796
Project modularization x Boundary spanning activity				-.0806	-.0800
Tenure					-.0012

Note: All coefficients are given in an unstandardized format. For all items: n = 136

*p<0.05; **p<0.01

4.4 Standardized model analysis

The main model analysis of the previous section constitutes an accurate representation of all hypothesized relationships, integrated into one single model. However, the fourth and fifth rounds of linear regression did not reveal additional

significant relationships and further increased the model's explained variance by only slightly less than .1.

In order to ensure better comparability between the relationship strengths of this and other studies, this section will produce the standardized coefficients of a reduced model, which only includes the identified significant associations. This reduced model is congruent with that of model 3 of the previous section but features standardized variables instead. Table 10 show the findings of a regression analysis.

Table 10. Linear regression for direct effects with standardized coefficients

Dependent variable	Boundary spanning activity	Project performance
R ²	.4265**	.5194**
Autonomy	.3034**	.3804**
Open management style	.4802*	.1873*
Boundary spanning activity	-	.3204**

Note: All coefficients are given in a standardized format. For all items: n = 136 *p<0.05; **p<0.01

Again, the indirect effects of autonomy and open management style on project performance are calculated by multiplying their individual effect on boundary spanning activity times the effect of boundary spanning activity on project performance. This results in an indirect standardized effect of autonomy of $\beta = .972$ ($p < .01$) and open management style of $\beta = .1539$ ($p < .05$)

The standardized total effect the independent variables on project performance is computed by building the sum of their direct and indirect total effects. In the case of autonomy, the standardized total effect amounts to $\beta = 0.3804 + 0.3034 = 0.6838$ ($p < .01$), and that of open management style to $\beta = .1539 + .4802 = .6341$ This means that if ceteris paribus the respective variables increase by 1 standard deviation, project performance will increase by .6838 and .6341 standard deviations respectively.

5. Conclusion

This study attempted to examine the research question “*What is the impact of autonomy, an open management style and boundary spanning activity on project performance in the context of project modularization?*” By surveying 136 managing professionals of five European megaprojects, it was possible to collect significant perceptual data, which was subsequently examined by regression analysis. Overall, the resulting findings affirm the research question. As expected, boundary spanning activity is a strong predictor for project performance and is affected by autonomy and an open management style. Only the association between project modularization and boundary spanning activity was an exemption, as it was not significant.

Hence, the findings of this study allow drawing three major conclusions. First, boundary spanners are indeed important for the successful commission of megaprojects. By connecting actors and transmitting relevant information from both sides of internal as well as external organizational boundaries, boundary spanners contribute to project performance. Notably, boundary spanners are not required to act within the formal capacity as connective agents, but can perform bridging activities even casually or informally. With boundary spanners being present, project managers from multiple European countries felt that solutions to problems were more innovative, inclusive, durable and found generally more support by all parties involved.

Second, project managers do occupy a key role in setting the scene for boundary spanners emergence and effective operation. This study showed that organizational autonomy and an open management style are both strongly linked to the presence of boundary spanning activity within the megaproject and its surroundings. Project managers and planners possess the ability to modulate these variables, at least in the project domain. In terms of management style, this can be achieved by having managers adjust behavioral and interactive patterns with subordinates and other stakeholders as well as encouraging other organizational members to follow suit. Behavioral adaptations should generally involve the respect and inclusion of subordinates and stakeholders as well as their opinions in the decision making process, a departure from fixed and unchangeable project goal definitions and the implementation of bi-directional information pathways between different departments, managers and other actors. In terms of autonomy, managers in charge should focus on keeping the amount of constraining rules at a minimum and develop role

descriptions that do not impose overly rigid guidelines regarding when or how to accomplish individual tasks.

The third and ultimate conclusion relates to a project's degree of modularization. Since no significant relationship between modularization, boundary spanning activity and project performance could be established, this study cannot make a confident claim that boundary spanners' connective capacity is affected by an increasingly fragmented project configuration. However, this does not mean that project modularization and the model's two dependent variables are completely disassociated from each other. Albeit this study does not detect a link between the three, future research is not barred from pursuing this path with a better equipped research design and a more extensive sample.

6. Discussion

6.1 Academic impact

By building on and synthesizing the traditions of governance networks and megaproject research, this study compiled an integrated model of megaproject performance, which tried to regard megaprojects as deeply embedded and connected to their environment, rather than as monolithic, static entities. This connection is manifested in the inclusion of boundary spanning activity as a central point of performance generation. The findings of this study affirm this line of thinking, by confirming the significant relationship between boundary spanning activity and project performance.

This study contributes to the literature, by introducing the concept of boundary spanners, which is foremost found in the governance network literature, to the megaproject literature corpus. In doing so, it takes a clear position in the debate between objectivist versus subjectivist accounts of megaproject evaluation. The findings imply that megaprojects are too similar to governance networks, as to be measured solely by strictly objectivist criteria. Much like governance networks, megaprojects are abundantly complex, populated by many actors with diverging values and opinions and, perhaps more than governance networks, subject to the pitfalls of non-linear risk events (Flyvbjerg, 2017; Sanderson, 2012).

Additionally, this study enriches the literature, by contributing (rare) empirical evidence demonstrating the link between organizational characteristics, boundary spanning and project performance. First and foremost an array of hypothesis was confirmed by the data, with positive associations found between the variables as expected. The centerpiece of this study, namely the relationship between boundary spanning activity and project performance, was successfully revealed. This confirms previous research by Van Meerkerk & Edelenbos (2014), who investigate this relationship, with the addition of trust as a mediating factor. It further reaffirms the findings of previous research, which linked boundary spanning activity to performance in the context of public-private partnerships and governance networks (Van Meerkerk & Edelenbos, 2014, Noble & Jones, 2006).

Further, earlier research highlights the importance of autonomy and managerial styles as organizational antecedents of boundary spanning activity. Open management style was established as a strong organizational level predictor of boundary spanning activity and project performance itself, which is line with previous findings (Edelenbos & Klijn, 2009). The results also validate the findings of Van Meerkerk & Edelenbos (2018), who identify an equally strong relationship between facilitative project management and boundary spanning activity in governance networks. Still, this study adds to the previous literature by introducing the concept of an open management style. Already existing understandings of “stakeholder-friendly” managerial orientations, such as facilitative, process or adaptive management primarily focus on the projects’ environment and the interaction therewith (Edelenbos & Klijn, 2009; Van Meerkerk & Edelenbos, 2018; Verweij, Klijn, Edelenbos & Van Buuren, 2013). Although, an external focus of project managers was still central to an open management style, it further emphasized the simultaneous importance of inward-facing, inclusive communication practices, which was often neglected by previous conceptualizations. This is important for boundary spanners, as their connective capacity not only depends on their ability to retrieve information from external stakeholders, but also to disseminate it within their home organization. By encouraging open and bi-directional communication flows within the megaproject, both horizontally (between departments) and vertically (between supervisors and employees), project managers can increase the number and quality of boundary spanner’s internal linkages.

Next, autonomy was correctly identified to positively influence boundary activity. Individuals, who experience lower degrees of autonomy, are less comfortable or willing in performing in inter-organizational or inter-departmental communication exchange and vice versa. One argument could be that their relationship with the organization is more accurately described by a principal-agent type relationship (Davis, Schoorman & Donaldson, 1997). In these relationships, employees are incentivized to act purely according to their contract or their organizations expectations – thereby strictly prioritizing the organizations goals over that of other stakeholders. As their loyalty is more towards their own organization and securing a larger piece of the pie, they are less likely to have a higher degree of otherness, or act as boundary spanning individuals. Other than different types of work relationships, differences in autonomy

could be explained based on different hierarchical levels, varying departmental backgrounds or simply tenure (Sisodia & Das, 2013). The findings of this study hint at such a connection, as tenure was positively correlated with higher degrees of autonomy.

Although some empirical evidence linking individual autonomy to individual job performance (Langfred & Moyer, 2005) or team performance (Hoegl & Parboteeah, 2006) exists, little research has related autonomy to performance of larger organizations or even megaprojects. This study finally addresses this gap in the literature, and claims to have unearthed a causal relationship. Employees' ability to schedule their tasks themselves and making their own decisions regarding task procedures contributed to overall project performance.

Still, not all hypotheses could be confirmed. The only exception was the proposed interaction between project modularization and boundary spanning activity (Hypothesis 8), which did not prove to be significant. Still, theoretical and empirical research examining the question on how project modularization affects the processes and outcomes of megaprojects remains rare. It was attempted to close this gap by introducing project modularization, as another potentially explanatory and intervening factor. However, this study finds no significant effect on boundary spanners ability to increase project performance. The claim that boundary spanning activity suffers from an increased project modularization, could therefore not be substantiated. Still, regression analysis showed a (non-significant) negative interaction, which's direction was expected based on literature research. One explanation for this could be that the idea behind the hypothesized relationship is simply wrong.

Nevertheless, the fact that there was also no link between modularization and performance at all is surprising. According to the scarce literature, there should be at least a weak positive direct relationship between the two variables (Jeffers, 2016). The practical popularity of megaproject modularization further hints at a potential relationship, but no evidence for this claim was found.

There are other possible explanations for this outcome. First, there might be other confounding factors at play, which alter the effect of modularization. Seyoum & Lian (2018) offer physical proximity and knowledge sharing across management as influencing factors in the context of globally acting auto manufacturers. Another

explanation rests in this study's conceptualization of the modularization variable. It is possible that the three-dimensional categorization employed in this study does not represent the underlying reality adequately. Since only five megaprojects were compared and analyzed, there is a chance that these projects are in fact quite similar in terms of fragmentation and other not included megaprojects differ greatly. Of course, this would require a re-assessment of how the modularization variable is measured.

6.2 Insights for practitioners

Besides its theoretical contribution, this study also allows to hand out practical insights for megaproject professionals. In general, project managers should be aware of the beneficial effects of boundary spanners on project performance. Although the literature often emphasizes boundary spanner's ability to mitigate disaster⁷ (Pettus & Severson, 2006), this study wants to additionally highlight the win-win situations among several (network) actors, boundary spanners can help facilitate. As a result, project managers should strongly encourage boundary spanning activity.

The findings of this study suggest two avenues to do so. First, project managers should strive to bestow more autonomy to their colleagues and subordinates. The issue of increasing project employees' degrees of freedom should be attacked from multiple angles. First, contractual arrangements should not be designed in an overly specific fashion, which compels employees to perform tasks in a predefined way or according to a highly rigid schedule (Davis, Schoorman & Donaldson, 1997). Next, boundary spanners would benefit from a more flexible and non-quantitative performance evaluation. This is important, because boundary spanning efforts and outcomes are difficult to measure and attribute to the actual individual. If these activities are not rewarded, let alone recognized, the incentive for time-consuming stakeholder engagement might reduce significantly (Stamper & Johlke, 2003). On a larger scale, project managers should actively seek to clear the way for boundary spanners, as in reducing the amount of constraints arising from too many rules or inter-departmental role conflict, in which responsibilities are unclear. However, transforming an entire department or even a project can be an arduous task, especially if changes require

⁷ Boundary spanners can function as an alerting antenna and antidote that senses and resolves potential threats in their onset, before they become unruly, blown out of proportion by the media and thus difficult to manage.

interference with running procedures, the hierarchical organizational order or corporate rules and regulations (Oreg, 2006)

Hence secondly, modulating management style to become more open and inclusive could be the lower hanging fruit. Even though its total effect on project performance was a little bit smaller, it showed to be a much stronger predictor of boundary spanning activity compared to autonomy. Therefore, if project resources are scarce and the capacity for organizational change seems limited, managers should channel their efforts to improve in this category first. For instance, targeted management training or adapted guidelines for conduct could help in cultivating an organization-wide climate that increasingly resembles an open and outward facing managerial philosophy. In such an organization, project managers possess knowledge of the practices and nuances of inclusive network management and are self-aware to what extent they and others fulfil this role.

Ultimately, these adaptations are not only useful for organizations, which aim to increase the prevalence of boundary spanners, but also helpful to simply increase project performance on its own, as the two direct effects of autonomy and management style on performance display.

6.3 Limitations and future research

One of the major limitations of this study concerns the restricted explanatory power of its main dependent variable: project performance. This was a consequence of the chosen conceptual design, since one of the main goals of this study was to reveal the link between organizational antecedents and increased boundary spanning activity. Hence, only individuals, who were native to the project domain and had knowledge and exposure to these factors, were queried.⁸ However, project performance, especially according to the subjectivist account, is a far-reaching and inclusive concept, which usually requires the input of all relevant actors within the wider stakeholder network. Stakeholders in the environment are more exposed to the externalities of megaprojects and are likely to evaluate performance criteria differently than project internal staff (Gerrits, 2012). As a result, the performance related findings of this study have to be treated with caution. Future studies could mitigate this bias, by actively involving other stakeholders in their assessment of overall project

⁸ Naturally, project external stakeholders would have limited to no knowledge regarding these factors.

performance. This would allow additional observations of which types of stakeholder organizations are more actively involved in creating connective capacity within the network or “spawn” more boundary spanners.

A second limitation pertains to the similarity of the megaprojects, from which responses were collected. All five projects were dedicated to create some sort of public infrastructure, either for transportation or energy distribution purposes. However, not all megaprojects fall into this category and thus the findings of this study might not simply translate to all kinds of megaprojects. For instance, other megaprojects, such as the ones relating to large scale scientific endeavors (CERN, ISS), may be more exposed to highly professionalized environments, in which the concept of the common employee as the “stakeholder-in-practice” has little or no bite. In those cases, highly educated experts, with legal or engineering expertise or special political ties, might be required to successfully conduct boundary spanning activity (Sun, Mellahi & Wright, 2012). As a result, the strong effects of autonomy and an open management style, which were observed in this study, might not replicate in these types of projects.

Additionally, the sample of this study only includes projects from Germany and the UK, which was a choice made in order to make the cases at hand more comparable. However, this comes with the downside of a reduced generalizability of the findings. Although the megaproject sphere is rather small and populated by a highly internationalized workforce (at least on the management level), one should refrain from blindly transferring the results of this study to other megaprojects in different regions of the globe. There are several reasons for this. Some studies argue, that civil societies in Germany and the UK are more developed and often more consensus oriented, than their counterparts in e.g. Asia or Africa (Hendriks, 2017). Further, governments, as a main driving force behind megaprojects, are therefore more sensitive to citizens demands and potential rights violations by megaproject commissioners. This is also reflected in the presence of strong institutional and judicial systems to monitor and enforce stakeholders’ rights. As a result, one could assume that varying degrees of importance are placed on boundary spanners and their activities in different parts of the world, depending on the stakeholders’ relative power to become involved in project matters. Still, empirical evidence regarding governmental responses in different contexts is mixed, as a study by Li, Koppenjan &

Verweij (2016) on local governments' reaction to environmental conflicts in an authoritarian governed China, shows.

Thirdly, as with most quantitative studies in the field of megaprojects, this study would have benefitted from a larger sample size. This argument relates to both, the number of actual respondents, as well as the number of megaprojects, from which the respondents were recruited from. On the one hand, a larger number of respondents might have made the hypothesized interaction effect of project modularization with boundary spanning activity significant (Leon & Heo, 2009). This becomes even more relevant in the context of the correctly predicted directionality of the hypothesized moderation. A larger number of megaprojects on the other hand could have increased the variation in the modularization variable, creating a much more refined image of the megaproject's modularization landscape. By including more megaprojects, it would also become possible to conduct multi-level analysis, as the sample size at higher levels (here at the project level) needs to reach around 50 to prevent biased results (Maas & Hox, 2005). This would be especially interesting for future research, in regard to the increasing trend to design megaprojects in this fragmented way that Flyvbjerg (2014) describes.

Another limitation concerns the measurement and operationalization of the project modularization variable. Part of this measuring process was desk-research. Although a similar procedure was followed for each megaproject, the measuring process was not systematic enough to ensure a high reliability of the modularization variable. As a consequence, future research may arrive at different degrees of modularization for the same projects. Therefore, the findings of this study in regard to modularization might suffer from reduced replicability. Next, unlike the other variables, project modularization was measured on the group or project-level, rather than the individual level. Thus, all individual data points within a project, were assigned the same modularization score. Naturally, this erases all within-group variance of this variable, which makes it less likely to find significant effects that stem from modularization. Additionally, with only 5 megaprojects being surveyed, the variance of the variable even on the project level remains rather low, which undermines the potential explanatory power of modularization. Again, future research should include more projects and assess them with a more systematic and comparable approach.

Finally, as boundary spanning activity proved to be a strong contributor to project performance, future research, especially qualitative studies, could probe into the question of how boundary spanners achieve this outcome. In general, there are two possible notions. Are they agents of change, who stimulate win-win situations by bringing actors together, or does their ability to prevent potentially catastrophic external events outweigh?

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APPENDIX A – Questionnaire

1. Dear Sir or Madam, The following survey is part of a Master Thesis on megaprojects and the determinants of their success or failure. It will take about 3 to 4 minutes to complete. The student conducting this survey is part of Erasmus University Rotterdam (NL). Although you will not be asked to provide personal or sensitive information, all data collected will be kept anonymized and used exclusively for the purpose of this study. Hence, there is no harm to be expected from filling out this survey. Naturally, you are free to withdraw from this survey at any point without consequences. Please do not be intimidated by the apparent size of the four choice tables presented to you. Other participants from megaprojects in Germany and the UK took not long to finish this questionnaire, too. By choosing "I consent" you agree to the abovementioned conditions.

I consent.

I do not consent.

2. How many years have you been involved with megaprojects?

Indicate number of years.

**** The following section was presented in table format. Each item had a list of 7 points, ranging from 1 (I strongly disagree) to 7 (I strongly agree), from which participants could choose This method was used for both, the digital surveys as well as the paper version. ****

[Plain text] During the following questions please keep the following understanding of a megaproject's environment in mind. Megaprojects are deeply embedded and interlinked with their environment. However, this does not only refer to the immediate surrounding or local stakeholders that might be affected by the project, but extends to ties with legal, political and environmental systems as well as supplier-relationships, both up- and downstream..

3. Please indicate the extent to which you agree with the following statements.

- 1) In this project people are allowed to decide how to go about getting their job done (the methods they use).

- 2) In general, people involved in this project can decide the time when to do particular activities.
- 3) There is some control over what employees objectives are and how they are evaluated.
- 4) In general, supervisors do not have to approve people's decisions before they can take action.
- 5) When making decisions, there are often constrains by individuals from other departments or functional units.
- 6) Rules and regulations often restrict or slow down work unnecessarily.

4. Please indicate the extent to which you agree with the following statements.

- 1) In this project, people exchange ideas and information with their supervisors freely and easily.
- 2) In this project, supervisors and employees communicate both ways.
- 3) In this project, management strives for clearly recognizable goals and makes sure they always come first.
- 4) In this project, the management perceives criticism as constructive and implements it into their decision making.
- 5) It is difficult for new parties to participate in the project's organization efforts.
- 6) The management actively encourages the involvement of stakeholders. Even if they are critical of the project.
- 7) Sometimes, decisions are pushed through, even when not all stakeholders have been involved or agree.

[Plain text] The next question deals with actors performing connective tasks. Please consider, that these actors are not necessarily employed or titles as such. For instance, stakeholder managers would indeed fall into this category, yet perhaps you are aware of an engineer, manager or general worker (or others), who seems to be engaged in one of the following tasks.

5. Please indicate the extent to which you agree with the following statements.

- 1) In this project there are many persons active who are able to build and maintain sustainable relationships with different stakeholders.
- 2) In this project there are many persons active who have a feeling of what is important and what matters to other stakeholders
- 3) In this project there are many persons active who take care of a good information exchange between the project and its environment.
- 4) In this project there are many persons active who make effective connections between developments in the wider network and internal work processes of their home organizations.

6. Please indicate the extent to which you agree with the following statements.

- 1) Do you think innovative ideas have been developed during the project?
- 2) Do you think the developed solutions effectively deal with the project's problems?
- 3) Do you think the developed solutions are long-lasting or durable?
- 4) Do you think that the various project stakeholders in the network have contributed to its results?
- 5) Do you think that the developed solutions are generally supported by stakeholders?
- 6) Do you think the various problems were sufficiently integrated?

APPENDIX B – SPSS CODE

DATASET ACTIVATE DataSet1.

*Recoding negatively formulated questions

```
RECODE Auto5_neg Auto6_neg Ms3_neg Ms5_neg Ms7_neg (1=7) (2=6) (3=5)
      (4=4) (5=3) (6=2) (7=1) INTO Auto5_rec Auto6_rec
```

```
      Ms3_rec Ms5_rec Ms7_rec.
```

EXECUTE.

*Factor Analysis & Reliability Analysis & Scale Computation

RELIABILITY

```
/VARIABLES=Auto1 Auto2 Auto3 Auto4 Auto5_rec Auto6_rec
```

```
/SCALE('ALL VARIABLES') ALL
```

```
/MODEL=ALPHA
```

```
/STATISTICS=DESCRIPTIVE SCALE CORR
```

```
/SUMMARY=TOTAL MEANS.
```

```
COMPUTE AUTO=(Auto1 + Auto2 + Auto3 + Auto4 + Auto5_rec + Auto6_rec) / 6.
```

EXECUTE.

FACTOR

```
/VARIABLES Auto1 Auto2 Auto3 Auto4 Auto5_rec Auto6_rec Ms1 Ms2 Ms3_rec Ms4
      Ms5_rec Ms6 Ms7_rec
```

```
      Bs1 Bs2 Bs3 Bs4 Perf1 Perf2 Perf3 Perf4 Perf5 Perf6
```

```
/MISSING LISTWISE
```

```
/ANALYSIS Auto1 Auto2 Auto3 Auto4 Auto5_rec Auto6_rec Ms1 Ms2 Ms3_rec Ms4
      Ms5_rec Ms6 Ms7_rec Bs1
```

```
      Bs2 Bs3 Bs4 Perf1 Perf2 Perf3 Perf4 Perf5 Perf6
```

```
/PRINT INITIAL CORRELATION EXTRACTION ROTATION  
/FORMAT BLANK(.4)  
/CRITERIA MINEIGEN(1) ITERATE(25)  
/EXTRACTION PAF  
/CRITERIA ITERATE(25)  
/ROTATION VARIMAX  
/METHOD=CORRELATION.
```

RELIABILITY

```
/VARIABLES=Ms1 Ms2 Ms3_rec Ms4 Ms5_rec Ms6 Ms7_rec  
/SCALE('ALL VARIABLES') ALL  
/MODEL=ALPHA  
/STATISTICS=DESCRIPTIVE SCALE CORR  
/SUMMARY=TOTAL.
```

```
COMPUTE MS=(Ms1 + Ms2 + Ms3_rec + Ms4 + Ms5_rec + Ms6 + Ms7_rec)/7.  
EXECUTE.
```

RELIABILITY

```
/VARIABLES=Bs1 Bs2 Bs3 Bs4  
/SCALE('ALL VARIABLES') ALL  
/MODEL=ALPHA  
/STATISTICS=DESCRIPTIVE SCALE CORR  
/SUMMARY=TOTAL.
```

```
COMPUTE BS=(Bs1 + Bs2 + Bs3 + Bs4)/4.  
EXECUTE.
```

RELIABILITY

```
/VARIABLES=Perf1 Perf2 Perf3 Perf4 Perf5 Perf6  
/SCALE('ALL VARIABLES') ALL  
/MODEL=ALPHA  
/STATISTICS=DESCRIPTIVE SCALE CORR  
/SUMMARY=TOTAL.
```

```
COMPUTE PERF=(Perf1 + Perf2 + Perf3 + Perf4 + Perf5 + Perf6)/6.  
EXECUTE.
```

*Create Interaction effect variable

```
COMPUTE Int_1=MODUL * BS.  
EXECUTE.
```

*Descriptives

```
DESCRIPTIVES VARIABLES=Tenure AUTO MS BS PERF MODUL  
/STATISTICS=MEAN STDDEV MIN MAX.
```

```
SORT CASES BY Projectname.  
SPLIT FILE SEPARATE BY Projectname.
```

```
DESCRIPTIVES VARIABLES=Tenure AUTO MS BS PERF  
/STATISTICS=MEAN STDDEV MIN MAX.
```

*Correlations

```
CORRELATIONS  
/VARIABLES=Tenure AUTO MS BS PERF MODUL  
/PRINT=TWOTAIL NOSIG
```

/MISSING=PAIRWISE.

*Regression Analysis done with process macro. Model 4 used with AUTO as X, PERF as Y, BS as mediator and MS and Tenure as covariates.

*Next, model 14 was used, to include MODUL as moderating effect. Neither interaction effect, nor direct effect on performance were significant.