International Journal of Project Management 39 (2021) 581–593

Contents lists available at ScienceDirect

International Journal of Project Management

journal homepage: www.elsevier.com/locate/ijproman

Translating the invisible: Governing underground utilities in the Amsterdam airport Schiphol terminal project

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ARTICLE INFO

Keywords:
Translation process
Utilities
Risks
Infrastructure
Project governance
Underground

ABSTRACT

Governing material conditions—including physical, material subjects such as machines, build constructions, construction materials, and subsoils—is a crucial challenge within projects and is underrepresented in project governance theory. To clarify the relationship between project governance and materiality, we draw on translation theory, which is essentially about the reinterpretation, appropriation, and representation of interests related to materials. This paper studies the challenges of governing the underground during the construction of the new terminal at Amsterdam Schiphol Airport. The findings show that, during the project life cycle, the translation of the underground by project actors hampered the necessary relocation of utilities in this project. This eventually resulted in delays and unforeseen costs. This translation is explained by a combination of the governance of the project, strategic interactions of project actors, and the characteristics and context of the material conditions. We contribute to project governance studies by demonstrating the usefulness of translation theory to better understand the mechanisms at play in governing underrepresented material conditions in infrastructure projects.

1. Introduction

Project governance is an increasingly key approach to addressing and managing the complexities of infrastructure projects (Ahola, Ruuska, Artto & Kujala, 2014; Brunet & Aubry, 2016; Pitsis, Sankaran, Gudergan & Clegg, 2014). Project governance is here defined as the set of mechanisms that regulate the interaction between project participants at the various project levels to realize a certain project performance (Artto & Kujala, 2008; Biesenthal & Wilden, 2014; Brunet, 2019; Pitsis et al., 2014). In terms of dealing with the challenges and risks pertaining to project realization, the coordination of the various interests of the network of actors involved in the project is central to governing how they interact with one another (Koppenjan, Charles & Ryan, 2008). Despite its rapid development over the last 15 years, project governance studies have largely overlooked the role of the material conditions of projects, as depicted by theories of sociomateriality. Sociomaterial theory sees social and material processes and structures as mutually enacting (Dale, 2005). Material conditions include physical, material, and 'nonhuman' subjects like material artefacts such as drawings, machines, and subsoils (Floricel, Bonneau, Aubry & Sergi, 2014; Sage, Dainty & Brookes, 2014). Ninan, Mahalingam, Clegg, and Sankaran (2020) used a sociomateriality lens to demonstrate how ICT tools were used to manage external stakeholders in a metro construction project. In another example, van den Ende, van Marrewijk and Boersma (2015) showed how the sinking of historical buildings caused a crisis in the construction of the Amsterdam metro project. Notwithstanding these examples, material conditions are underrepresented in project governance studies, and, in project studies more generally (Floricel et al., 2014). This topic can advance our knowledge and understanding of the governance of complex projects, as has been called for by Pitsis et al. (2014).

The aim of this study is to clarify the relationship between project governance and materiality by using the concept of *translation* from actor-network theory, which is prominent within the field of sociomateriality (Latour, 2005). Actor-network theory sees networks in terms of associations between human and nonhuman actors, in which actors try to create and change associations in order to position themselves more centrally in the network (Callon, 1984). Gao (2005) argues that 'translation implies that an actor reinterprets or appropriates the interests of other human actors and the interests embedded in nonhumans according to one's own, and has these interests represented' (p. 257). In other words, translation is about the reinterpretation, appropriation, and representation of interests related to materiality. Analyzing translation processes reveals the mechanisms that govern the interests of nonhumans and their implications for a project. The absence of an association or an accurate translation implies that nonhumans are ignored, not seen as

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https://doi.org/10.1016/j.ijproman.2021.04.003
Received 10 August 2020; Received in revised form 20 April 2021; Accepted 21 April 2021
Available online 11 May 2021

relevant, or taken for granted, until the implications of these neglect result in these nonhumans being catapulted into existence (Latour, 1993).

In this paper we argue that the underground is a nonhuman actor, which creates uncertainty in projects (van den Ende et al., 2015). Coping with these uncertainties is a serious project governance concern (Hayes & McDermott, 2018). At least three predicaments can be discerned. First, the difficulty of governing the underground relates to its invisibility, which makes it hard to manage as well as the fact that nonhumans often present themselves only when things go wrong (Norrman et al., 2016; Parriaux, Tacher & Joliquin, 2004). Second, due to an increased scarcity, the lack of underground space makes it difficult for clients to act independently in the maintenance and construction of underground infrastructures. Coordination with other organizations is increasingly necessary for planning and executing infrastructure projects (Vilventhan & Kalidindi, 2016). Third, the underground entails high risks: (unknown) cables and networks, instability underground (van den Ende et al., 2015), archeological findings, contamination, and even animals (Tryggestad, Justesen & Mouritsen, 2013) can cause delays and budget overruns. In short, special attention must be paid to the translation of the invisible underground to anticipate these issues and to prevent unexpected manifestations of these risks from threatening the successful realization of projects. As such, the problem of the difficult translation of the underground is a crucial challenge within project governance. It exemplifies the competition for attention and centrality among associations of human and nonhuman actors in projects.

Based on the above discussion, the central question in this paper is *how does the governance of projects influence the translation of material conditions?* To answer this question, we present the case of the project governance and the translation of the underground in the pre-construction phase of the development of a new terminal in the heart of one of Europe's busiest airports, Amsterdam Airport Schiphol. As the excavation area is an operational space, 2000 km of utility networks needed to be relocated. To find a balance between practical relevance and academic rigor, we adopted an engaged scholarship approach (van Marrewijk & Dessing, 2019).

The structure of the article is as follows. First, the literature on project governance, translation theory, and translation strategies is discussed. Then we discuss the selection of the case study method, the research methods, and the operationalization of the conceptual model. In the findings section, we present the translation process across the different phases of the project, hereby showing the governance practices within the Schiphol utility relocation. In the discussion section, the findings are reflected upon using the concepts of governance and translation. Finally, conclusions are drawn, and contributions to the project governance literature are discussed.

2. Theoretical framework

2.1. Project governance

There is a large volume of published studies describing the role of project governance in the management of projects (ul Musawir, Abd-Karim & Mohd-Danuri, 2020). We make a distinction between governance as a structure and governance as a management activity (Klijn & Koppenjan, 2016). On the one hand, a governance structure refers to the presence of certain organizing instruments, systems, or organization forms that shape and constrain the behavior and activities of actors at the various levels of a project (Lowndes & Roberts, 2013; Pitsis et al., 2014). Three structural elements of governance can be distinguished. First, formal institutions like laws, regulations, and procedures shape how projects and processes are organized and the order in which activities and participation therein are structured (Müller, Zhai, Wang & Shao, 2016; Pitsis et al., 2014). Different kinds of designs and contracts may also be an important part of the governance structure because of their organizing effect. Second, there are goals, taken-for-granted norms, values, and performance agreements that direct, shape, and constrain actors' behaviors (Scott, 2013). The third structural element is consisting of workgroups, arenas, and platforms in which designs, decisions, and products (Ostrom, 1986; Zelikow & Allison, 1999).

On the other hand, governance as a management activity refers to efforts to influence project actors' behaviors by motivating, activating, and facilitating actors in contributing to the development and performance of the project (Ansell & Gash, 2008). As the realization of projects requires interaction within the network, governance is more than simply a structure; it involves ongoing management efforts during interaction processes in the various project phases (Sanderson, 2012; Warsen, Klijn & Koppenjan, 2019). Furthermore, Quinn and Cameron (1988) argue that controversies are at the center of understanding governance approaches, and so project governance will also be aimed at preventing, mediating, or overcoming controversies among actors. As the conflict of interests and the exercise of power may underlie controversies, an important aspect of governance is the balancing of competing values and interests. Creativity in finding solutions that succeed in combining various perceptions, stakes, and values is an important characteristic of good project management (Wolf & Van Dooren, 2018). Finally, management efforts may be aimed at influencing the governance structure, either at the start or during the project.

Governance is seen as an ongoing activity during all project phases to continuously interlock various sometimes competing interests (Koppenjan, Veeneman, Van der Voort, Ten Heuvelhof & Leijten, 2011; Sanderson, 2012; van Marrewijk & Smits, 2016). This tension between competing values has been acknowledged as a source of failure for construction projects (Veeneman, Dicke & De Bruijne, 2009). Because complex projects inherently provide a less clear notion of all the involved interests, certain interests might get obscured and therefore underrepresented. For instance, a full focus on safety can come at the expense of time and budget. Therefore, the core of project governance is to design a balanced arrangement of interactions between the different internal stakeholders, representing different aspects of the project (Silvius, Kampinga, Paniagua & Mooi, 2017). In these complex projects, Floricel et al. (2014) point to nonhumans, as an underexploited and underrepresented concept in project management. Although materiality might be assumed central in realizing infrastructure projects (Styre, 2017), the complexity of the various material aspects involved makes it hard for project actors to have an overarching understanding of the materiality involved. This implies that some nonhumans are more central and better understood than others, which may be more marginal or harder to rasp.

2.2. Actor-network theory and the translation process

Examining the relationship between project governance and materiality requires a theoretical lens that can identify associations between human and nonhuman actors. A lens based upon actor-network theory (ANT) and the translation concept provide is helpful for two reasons. First, within ANT, the concept of translation focuses upon the associations between actors, instead of on the actors themselves. Translation is the creation of an association between actors that did not exist before and to some degree modifies these actors. Associations between actors are not necessarily social, but can be seen as traces of associations between heterogeneous elements (Latour, 2005). It may be that they are taken for granted, not seen as problematic, or being overlooked altogether. Second, ANT depicts translation as a process. The translation process refers to a process by which actors within an actor-network try to exercise authority over one another and nonhuman actors in the network. By creating and changing the associations between human and nonhuman actors, actors actively try to position themselves more centrally in the network (Toennesen, Molloy & Jacobs, 2006). Through the translation process, an association is becoming part of social life (Law, 1992). The process thereby allows the examination of ongoing interactions between heterogeneous elements, such as interactions between different project actors and the underground.

Centrality is important in actor-network theory, as actors' strength does not stem solely from their individual characteristics; it also stems from their associations with other actors. According to Callon and Latour (1981) actors are part of an association, if they 'speak or act on behalf of another actor or force' (p. 40). Human actors, therefore, may represent the interests of nonhuman actors with which they are associated, like the underground (Callon & Latour, 1981). In the same vein, Callon (1990) argues that a project's success is dependent on the active participation of those who are determined to connect the dots to form a convergent network. For instance, actors need to address cables in the underground to avoid cable strikes during the construction phase of a project. The translation process is about how invisible nonhuman elements are translated by human actors, resulting in their representation throughout the different decision-making junctures in projects (Schweber & Harty, 2010).

Translations are exercises of power between competing associations of actors within a network. This means that existing controversies may hinder the development of a project or give a central place to certain associations and programs of action at the expense of others. These controversies need to be governed to push the project forward (Venturini, 2010).

2.3. Translation strategies

Strategic interactions are 'a series of successive decisions about the nature and content of a policy problem' (Klijn & Koppenjan, 2016: 83), or in this case a controversy over a translation. Toennesen et al. (2006) show that actors strategize to influence translation. The strategies of actors are successful if 'aligned interests are created through the enrolment of sufficient body of allies and the translation of their interests so that they are willing to participate in particular ways of thinking and acting that maintain the network' (Walsham & Sahay, 1999: 42). Actors use different translation strategies to convince others of their translation. By means of reinterpretation, appropriation, and representation, actors try to put nonhuman actors more centrally in the work.

Human actors may also associate themselves with nonhumans through boundary objects in an attempt to align previously disconnected actors. Boundary objects are here defined as artifacts that act as translation devices to associate humans and nonhumans in the absence of consensus (Allen, 2014; Leigh Star, 2010). Boundary objects are an intrinsic part of translation strategies because they traverse different social worlds through negotiation and knowledge creation (Latour, 2005).

Together, the earlier discussed studies outline that project governance is an ongoing activity during all project phases to interlock the different interests in a project. This is done by governing the interactions between actors through instruments of governance structure and governance as a management activity. This concept allows to include nonhumans in governance studies and examines the process through which nonhumans are translated: actors are strategizing to convince others to align with their interests. The conceptual model depicted in Fig. 1 was developed to explain how a nonhuman—in this case the underground—is translated during the various phases of a project. The translation is the outcome of the controversy between actors in which they formally represent the nonhuman within the project. The model suggests that the governance structure and the governance management strategies shape and constrain the strategic interactions among the actors involved in the translation and, by so doing, also influences how the controversies evolve and how nonhumans are translated.

3. Methodology

A case study approach was employed (Yin, 2017) since this approach is suitable to qualitatively analyze interactions in-depth within a complex setting (Hetemi, Jerbrant & Mere, 2020). The conceptual model which is used to analyze the case is developed through an iterative reasoning between the theory and the empirical data to capture the factors that influence the relationship of interest of the researcher (Alvesson & Kärreman, 2011). The case to be analyzed is the utility relocation project preceding the construction of a new terminal at Amsterdam Airport Schiphol.

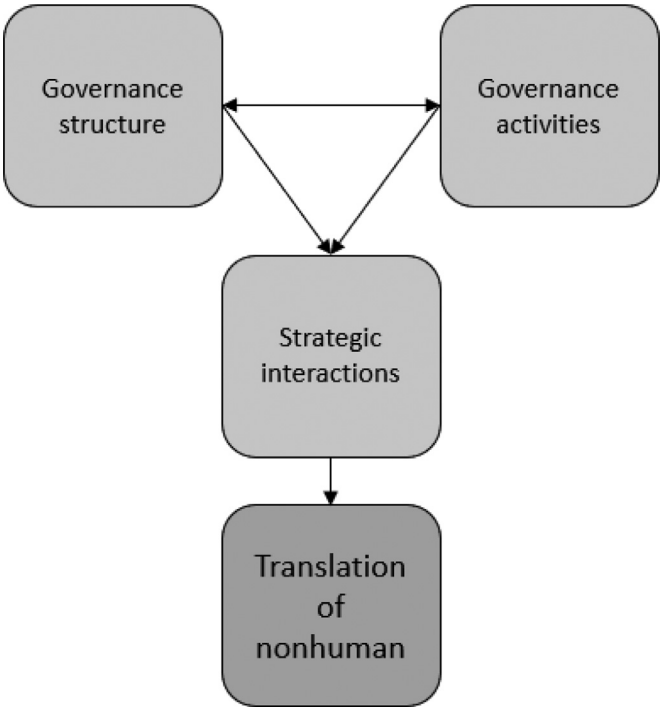

Fig. 1. Conceptual model on examining the governance of nonhumans within a project.

3.1. Case selection

The case selection required a construction project that allowed to assess the governance of the underground in a web of multiple project interests. For this case study we believed the new terminal project to be an adequate case. Utilities needed to be relocated at the center of one of Europe's busiest and one of the oldest airports in the world. The unit of analysis was the utility relocation project in a pre-construction phase prior to the construction of a new terminal.

We expected Schiphol to be a deviant case as it owns their utilities networks. We consequently assumed that governing the underground utilities would have a high priority: damages to the utilities could have a dramatic effect on the airport operations. Therefore, we anticipated that the underground would possess a central position within the actor-network. However, Schiphol turned out to be a typical case in that the underground was not central in the project and governing the underground proved to be a challenging task for the project governance, like in so many other infrastructure projects (Von der Tann, Sterling, Zhou & Metje, 2020).

Our findings with regard to the specific causal pathway that occurred in this case, are not necessarily generalizable to other infrastructure projects, given the specific conditions and dynamics that may vary among various projects. However, we expect our framework to be applicable to similar projects of governing the translation of the underground, or more generally materiality, in order to identify how generic mechanisms result in specific causal pathways in the relationship between governance and materiality that occur in those projects (Blatter & Haverland, 2012; Yin, 2013).

3.2. Data collection

It was decided that the best data collection approach was to employ an engaged scholarship approach. We understand engaged scholarship as the application of rigorous academic research methods in a reciprocal relationship with practitioners (van Marrewijk & Dessing, 2019). To make sense of the intrinsic project complexity—the interactions between the various interests—it is important that the researchers have prolonged and intense exposure to the project (Krefting, 1991). Through a Dutch joint industry research collaboration between practitioners and researchers allowed the researcher to observe the project for a period of 12 months – between January and December 2019.

To promote the credibility of the data, the researchers used a triangulation of data sources. First, observations were conducted to follow the present status of the project. These observations were made by the first author in the role of 'participant-as-observer', which means that the identity of the researcher is known to those being studied, but the researcher holds a neutral position when observing (Worline, 2012). The researcher was embedded within the Schiphol project organization and initially tried to understand who the involved actors were and what they represent. This goal was accomplished by submerging himself in different project activities, such as meetings and walking around the construction pit. When it was clear who the involved actors were and what they represented, the observations were used to capture the dynamics between actors uttered during the meetings. For example, the researcher wrote down the arguments that actors used to comply with, or resist, certain policy proposals. Second, in addition to numerous informal talks, 44 semi-structured interviews were conducted with 36 key persons about the project to make a reconstruction of the project (see Appendix A). Retrospective tracing of respondents' interpretations of decisions made about the underground might result in respondents recollecting events differently (Hammersley, 2004). Therefore, this project accomplished a factual project reconstruction by using a biographical conversation method (Rosenthal, 2004); this method helped respondents to go back in time and present a more accurate image of the decision-making process. Third, documents such as soil contamination reports, utility drawings, photos, and the project contract were collected to compare it with the data retrieved from the interviews and observations (see Appendix B).

All the interviews were transcribed. Throughout the end of the data collection period, the researcher focused more on corroborating data or filling in missing links in the process description (Hermanowicz, 2002).

3.3. Data analysis

We used a process-tracing technique to reveal governance mechanisms on the translation of nonhumans. Guided by our theoretical framework and informed by the interpretation of the respondents' recollection of the interactions with other project actors and the sequences of decisions within the project, we made a reconstruction of the project. Process tracing determines the temporal order in which factors work together to produce an outcome, establishes the factors that are sufficiently important for the outcome, and identifies the social mechanisms that form the basis for explanations (Blatter & Haverland, 2012). It allows us to identify the specific causal patterns that are not necessarily generalizable towards a similar population. Nevertheless, identifying the generic social mechanisms that underlie these specific pathways enable us to strengthen our generic theoretical insights on the relationship between materiality and governance and the applicability of our framework to other cases. Additionally, the rounds model is used to distinguish different rounds in the translation process that evolved during the project. Identifying different rounds enabled an systematic examination of the interactions among actors within these rounds (Teisman, 2000). The researchers have identified the formal project phases as the rounds that need to be analyzed. The formal project phases are delineated from each other by formal product outcomes, notably the project plan, the design, the contract, the construction of the project, and the transfer of the project. This way of formalizing the different phases is broadly adopted within construction projects and project management literature (Ahadzie, Proverbs & Olomolaiye, 2008; Al-Reshaid, Kartam, Tewari, & Al-Bader, 2005). A specific round is based on a specific controversy and contains a specific project goal, governance structure, management strategy, and strategic interactions by project actors to realize the project goal. Each round, or project phase, cumulates to a specific outcome of the round that we see as the translation: the way the underground is translated in that phase. The operationalization of the theoretical concepts in each phase can be found in Table 1.

To understand the mechanisms of a round, it is important to make sense of the data (Halcomb & Davidson, 2006). To come to the right conclusions, we compared the different data sources based on the principles of idea convergence and the confirmation of findings (Knafl & Breitmayer, 1989) and used member check where the researchers' interpretation of the data is shared with the respondents on a weekly – sometimes daily – basis (Krefting, 1991). By sharing our interpretations with our respondents in this way, we ensured a shared interpretation with our respondents.

4. Findings

In this section, the findings are presented by describing the five phases that make up the translation process within Schiphol's utility reallocation project. The phases are presented by first describing the governance structure and the project's goal in the respective phase. Next, the translation process is described by discussing the strategic interactions and governance management activities. This is followed by the description of the translation. Each subsection is concluded with a short analysis of how the translation process and its outcome can be explained.

4.1. Planning phase (2014–2015)

In 2014, Schiphol's board of directors decided to build a new terminal and pier to accommodate the increased throughput of passengers. Following a spatial exploration study conducted by Schiphol's project department, the board chose to put the new terminal and pier at the heart of the busiest part of the airport (Respondent 2.4). The project department's assignment in the planning phase was to develop these plans further and show what shape or form the terminal should have within this location while including all necessary functionalities.

4.1.1. The translation process

Shortly after the project department took on the assignment, it gradually became clear that the new terminal and pier would have 'a major impact on the utilities', as project managers mentioned in interviews. To assess the impact on utilities, a senior project manager was invited to a meeting. However, at this meeting, this senior project manager asked about the status of the cables and pipelines, 'but nobody could give a satisfactory answer about the status' (Respondent 2.6). Subsequently, the senior project manager argued that more than the project group's estimate of €100,000 was needed to make the underground 'function-free'. After this meeting, the senior project manager accepted the request to become the project manager utilities for this project.

As project manager utilities, he was responsible for delivering various alternative underground utility solutions (Document no. 1) that would allow the project decision-makers to pick one of their likings. This strategy to deliver various alternatives was critical because 'the terminal design constantly changed, for example, at that moment we did not even know that the whole of p2 [parking lot 2] would be demolished' (Respondent 2.6). According to the asset managers, the study of alternatives also provided 'some guidance' with regard to future plans for the terminal.

The different alternatives were based on feasibility and not necessarily practicality. It means that alternatives have been developed that were considered unpractical from an underground utility point of view,

Table 1
Operationalization of the conceptual model.

Concept	Definition	Indicator	Data gathering
Round	Temporal bracketed situation about a controversy	Formal project phase	Gather contextual and temporal information about a controversy How is controversy solved
Governance structure	Instruments that shape the activities of actors	Organizational structure of the project	Who's involved in the controversy Who do project actors interact with
Governance management	Efforts to contribute to the development of the project	Project manager's decisions on the process of the project	Asking about motives of project manager Observing actions on controversy
Strategic interaction in translation process	Activities aimed at influencing controversy	Behavior of project actors to influence translation of nonhuman	Identify actions and motives of project actors Relate actions to the controversy
Translation outcome	Outcome of the controversy	The formal product at the end of the project phase	Reflect on the product with project actors Understand content of the product

but allowed more functionality for the construction of the terminal. An asset manager denotes 'normally, we do not put utilities under hardened pavement, but okay we can do it with optic fiber as a concession'. Because there is so less space in the underground, 'it was the question if it is possible at all to make good alternative given the amount of available space and the demands of the asset managers'. Finally, the project manager utilities wrote a report which specified six possible variations to relocate utilities that included utility drawings and a financial calculation of each variation. On 10 April 2015, the project manager formally submitted the different utility variations on paper to the project group (Document no. 1).

4.1.2. Outcome of the translation process

The project group finished the spatial plan on 12 June 2015 (Document no. 2). The implication for the subsoil was no consideration in the selection process for the terminal variant. The project leader of that time argued that the choice was made 'fully independently of the [underground] variations' (Respondent 2.4). The terminal variant implied that the cost of relocating utilities would be around €23 million.

The chosen alternative was 'the least favorable option' from an asset manager's standpoint (Respondent 1.1). The choice resulted in less space in the underground for future utility work, which was compensated by laying utilities under the hardened pavement. But this variation 'allows a terminal with an *X* amount of passengers, that's important' (Respondent 2.3). Addressing the discontent was considered useless, because 'we are just a tiny part of the project, we have to settle for the decisions made by higher powers' (Respondent 1.1).

4.1.3. Analysis

In this phase, the controversy was about which utility variation the project decision-makers should adopt. The decision for a specific variation was based on the size and shape of the terminal itself and not on arguments related to the underground. In the translation process, *strategies* aimed at using drawings, financial data, and a report proved unsuccessful to convince project decision-makers of the asset managers' translation.

Within the *governance structure,* the project manager utilities was the link between asset managers and the project decision-makers. The *governance management approach* adopted implied that asset managers participated on the basis of an informal request by the project manager utilities to provide information on the underground utilities. The implications of the underground were not a central concern in the decision-making within the actor-network.

4.2. Design phase (2015–March 2017)

In 2015, the board founded a new project organization called Capital Program, which attracted internationally specialized airport builders to realize the project. Between June and October 2015, the project organization prepared the tender for the design. A definitive design was requested that integrated the surface and the underground within the terminal design (Respondent 2.7). A combination of five international design teams was hired to present a feasible and engineerable design (Document no. 3). It was the project manager utilities' role to manage the process of delivering the underground design.

4.2.1. The translation process

Once an engineering firm was contracted to make a design, concerns were raised by asset managers about the 'quality of the design' and 'our Schiphol's way of working'. The asset managers thought that the firm lacked the local knowledge that was critical for interpreting the overall utility networks and could not understand the logic of the drawings in a wider Schiphol context (Respondent 1.2).

The contract to design the underground was based on a system engineering approach. This approach was predicated, according to the engineering firm's project leader, 'on the idea that you think about the requirements beforehand. Therefore, it is important for a client organization [the asset managers] to think in requirements instead of solutions' (Respondent 3.2). Because of the asset managers' concern about the quality of the design, they provided solutions for the drawings and told the firm what to do. This was initially not accepted by the firm and therefore not automatically adopted.

It became increasingly clear that the ideas and interests of the asset managers and the surface designers diverged. Therefore, contradicting solutions were brought up by asset managers that did not facilitate a smooth process. The engineering firm's designers said that 'there were many different interests at Schiphol. One said this, while the one said that, and including both requirements was impossible' (Respondent 3.3). At some points, the debates between the asset managers and the consultants became so heated that the project manager utilities had to 'send out people from the meeting' to avoid an escalation of events (Respondent 2.6). To deal with this problem, the engineering firm appointed a process manager to manage the information flow between the asset managers, the surface designers, and the engineering firm. This process manager was there: to coordinate and emphasize the human aspect, with whom you're going to sit down, how you make joint decisions, how you record the decisions, and how to get stability amid the stakeholders' changing ideas. (Respondent 3.2).

This intervention led to contradictory requirements becoming apparent, and the asset manager's role was clarified. After this intervention, the relationship between the asset managers, the project manager utilities, and the engineering firm became 'progressively more constructive' (Respondent 3.3).

4.2.2. Outcome of the translation process

The engineering firm delivered the definitive design in July 2017 (Document no. 3). The asset managers and the engineering firm's de-

signer were moderately satisfied with the design, describing it as 'could do better', and 'it was not a great design. Still many flaws could be found.' Nevertheless, they agreed that 'it was enough to continue the process' (Respondent 1.1).

4.2.3. Analysis

In this phase, the controversy was about the design solutions of the underground utilities. The translation by the asset managers was not convincing for the engineering firm in making the design, because (1) design solutions were not welcomed, and (2) asset managers fell into different factions that hampered a congruent translation. Regarding the translation process, the *strategies* deployed by the asset managers were aimed at stressing their local knowledge and the different ways of working at Schiphol, whereas the design team's hold on to the contractual agreement of the systems engineering approach which required functional specifications.

The *governance structure* in this phase forced the project manager utilities to manage the process between the engineering firm and the asset managers. The *governance management approach* was in essence top-down and underpinned the different approaches, making it difficult for the engineering firm and the asset managers to engage in a constructive dialog. The intervention of the external process manager improved relationships but was insufficient to converge the translation between the different actors.

4.3. Tender phase (April 2017–October 2017)

After the formal invitation on 24 April 2017 (Document no. 4), the project decision-makers – the program director and the commercial lead of Capital Program – hired a project and contract management firm (PMCM) to prepare the tender (Document no. 5). During the preparations, the program director and the commercial lead responsible for procurement and risk management eventually had to decide how they wanted to tender the underground.

4.3.1. The translation process

It was immediately decided that a FIDIC (Fédération Internationale Des Ingénieurs-Conseils) contract would be used because of the international environment in which the program now operated. The commercial lead argued: 'I think the decision to go with the FIDIC contract was quite simple because we needed something that worked under Dutch law but is also international and in English and you know the FIDIC is perfect for that. The FIDIC contract allows us to be flexible – in terms of money and time – during the relocation of utilities, which is needed because of the many unknowns in the underground' (Respondent 2.3). Flexibility is important 'because the exact size of the terminal is still undetermined' (Respondent 2.2).

To decide how to make an exact tender for the risks in the underground, PMCM made a risk assessment based on various studies on the utilities, such as reports of trial trenches and geotechnical reports of the underground. The sources for the assessment dated back to 1990 (Documents no. 8 and no. 9). Also, 3D technology was used as a non-intrusive tool to assess objects in the underground. According to the contract manager, the extra techniques did not facilitate a more reliable picture of the underground though. The commercial lead stated: 'We started knowing 20%. Then we knew about 60%. You never know 100% until the project is finished' (Respondent 2.3). This shows that the project decision-makers assumed that there were still unknowns residing within the underground.

The lack of a reliable picture of the underground led to two positions emerging about who should be responsible for damage to utilities. On the one hand, the project director thought that no liability with regard to the utilities should be taken. He argued that it was the contractor's job to cope with risks. On the other hand, there was the stance that the risks should be allocated to the actors that could bear them. Risks that are unknown because of a lack of proper documentation should not be the responsibility of the contractor, was the reasoning of the decision-makers.

4.3.2. Outcome of the translation process

The lack of proper documentation forced the decision-makers to take responsibility for the unknowns in the underground and allocate the risks of the known to the contractor, but allows flexibility when changes need to be made 'due to terminal design changes' (Respondent, 2.3).

Contractually, the project organization also needed to take ownership of the risks by adding clauses to the contract that stated that the project was in the lead in cases of contingencies (Document no. 6, clause 1.9). In addition, the project wanted to take ownership by insisting that its members should be part of 'advance warning event' meetings, if the contractor deemed that necessary (Document 6, particular conditions part B, Clause 4.26). Finally, a clause was added that implied that only in cases of 'default' or 'gross negligence' (Document no. 6, clause 17.6) the contractor would be liable for the damage that it caused. The underground was therefore considered a 'risky and liable environment that affects the tender price drastically' (Respondent 2.8).

4.3.3. Analysis

The controversy in this phase is about the unwillingness of the underground to be known. The project organization turned out not to be able to fully translate the underground, resulting in clauses that ultimately make the project organization responsible for unknown nonhumans in the underground.

In the translation process, the *strategies* of the project organization to translate the underground was to collect historic reports and up-to-date data about the underground was insufficient to come to a full translation.

The *governance structure* excluded asset managers from active involvement. The *governance management approach* was focused on making a risk analysis and drafting a contract for which input from the asset managers was deemed unnecessary.

4.4. Construction phase (October 2017–Fall 2019)

During the construction phase, PMCM, which acted on behalf of Capital Program, coordinated the utility relocation with the contractor. The project manager utilities coordinated the conduct of the PMCM. The relocation of utilities had to be conducted controllably and predictably.

4.4.1. The translation process

From the start of the construction phase in October 2017, weekly informal meetings were scheduled between the asset managers, PMCM, and the contractor. At these meetings, the contractor informed them of the activities that would be undertaken during the week (Respondent 3.9).

On 16 January 2019, the project manager utilities received an e-mail from an asset manager conveying a shared concern of the asset management about the conduct of the contractor and sent seven pictures as 'proof' of damaging situations of utilities (Document no. 7). The asset managers described being 'concerned' and 'scared' that another big incident would occur, just like the incident in October 2018, in which the contractor hit a residual air traffic control cable, resulting in a significant disruption of air traffic and tens of thousands of euros of damage. The number of daily alarm bells that went off during this big incident, as a consequence of various cable strikes, did not decrease since the incident. Consequently, the asset managers did not feel entrusted that their assets were in good hands with the contracted and therefore started to check on the conduct of the contractor by occasionally walking by the construction pit and taking photos. These photos were sent to the project manager utilities in the e-mail.

To address these concerns, the project manager utilities organized a meeting on 27 February 2019. Within this meeting, the PMCM site manager and the project manager utilities teamed up to 'take them [asset

managers] by the hand and explain what exactly we are doing' (Respondent 3.6). The asset managers were there to listen to the presentation. After the presentation, the asset managers asked questions in relation to specific cases about their assets, such as why there were cables out in the open for weeks or what did the project do to prevent litter from entering excavation pits. To finalize the discussion and regain the trust of the asset managers, the project manager utilities invited the asset managers on a field trip to look at the construction pit. Furthermore, it was agreed that the asset managers would be present when the utilities were covered with soil at the end of the project.

4.4.2. Outcome of the translation process

The meeting resulted in two positions toward the quality of work in the underground. On the one hand, the asset managers remained reserved over the project's engagement with their assets. One installation manager reflected on the meeting by stating 'I hope we do not only talk together, but that they understand that some of these pictures show that the work is not properly done and that a whole new way of working is required' (Respondent 1.10). Furthermore, no asset managers showed up for a scheduled trip at the construction site. On the other hand, PMCM and the project manager utilities were relatively satisfied with the meeting. The site manager argued: 'it was quite a good meeting I guess; we have outlined what we planned' (Respondent 3.6). While the project manager utilities also added 'we are not going to change the way of working, that is not necessary, there are enough procedures in place'. In reaction to the absence of the asset managers, the utility supervisor argues 'I do not know why they did not come, maybe they did not feel it was necessary anymore' (Respondent 3.9).

4.4.3. Analysis

In this phase, the asset managers were involved in a controversy with the PMCM and the project manager utilities about the quality of work with the underground utilities. Because the working procedures did not change, the asset managers were not able to convince the project manager utilities of their translation. The asset managers used photos as a *strategy* to confront the project manager with their concern.

The asset managers were not formally embedded in the project's *governance structure* and lost sight of what was happening. The *governance management approach* was aimed at being transparent and building trust, but this failed because the way of working itself could not be questioned.

4.5. Transfer phase (Spring 2019–Fall 2020)

In this phase, the relocation of utilities was almost finished and the project was planning to transfer the work to another project team that focused on the delivery of the terminal. In this phase, the project manager utilities and the other project team's manager played an important role in the transfer of knowledge on the subsoil utilities.

4.5.1. The translation process

In the spring of 2019, confusion suddenly emerged about the goal of the utility relocation project. The project manager utilities asserted that the goal was to make the underground function-free, meaning that utilities should be relocated to provide utility installation points for the terminal, leaving the offline cables underground (observation, meeting 17 May 2019). In contrast, the project team responsible for the construction of the terminal expected to receive a greenfield site, namely, that the underground would be totally empty and therefore fit for surface construction work (Respondent 2.6).

This misunderstanding was caused by the practice of sending letters to other project teams for updates about the specifics of the project teams' conduct which should have revealed interfaces between project teams. These letters had to be approved by a specific foreman in order for them to be officially read. However, the letter stating that the underground project would merely relocate the utilities was 'poorly read', and 'not followed up on' (Respondent 2.6) and therefore overseeing important interfaces.

When the confusion became apparent, the alleged solution was to organize four meetings in May and June 2019 to devise a plan for the sequencing of the removal of offline cables: who was going to do that and when (observation, meeting 9 May). The project manager utilities, the other team's project manager, the asset managers, and the contractor's utility designer attended the meeting. To reach the goal, the terminal team's project manager needed every asset manager from the disciplines involved, such as water, gas, electricity, telecommunication, and air traffic control's data cables, to fill in an Excel template (observation, meeting 16 May).

4.5.2. Outcome of the translation process

The meetings did not result in the delivery of the proper documentation to assist the next stage of the project. The documentation was needed to hand their project over to the next project on 21 December 2019. However, this project milestone 'would not be met in time' (Respondent 2.6), partially due to a difference in the interpretation of what was meant by 'function-free'. At the frustration of the project manager, the asset managers could not provide input for the documentation because they did 'not know how to fill in the form' (Observation, meeting 16 May), which made a clear schedule for the sequencing of cable removals impossible at that moment. The delay in removing the offline cables caused the program to start an 'early works project' (Respondent 2.6) which was integrated into the team responsible for the construction of the terminal. The project manager utilities said: 'the early works are going to do everything else that is needed to make the underground ready'. This meant that cables had to be re-relocated consequent to a changing terminal design.

4.5.3. Analysis

In this phase, the controversy revolved around what is being transferred toward the next project team. While one team thought that the whole underground would be cleared of utilities, the other team translated the underground as a place where only offline cables still exist. In the translation process, the *strategy* to send letters and develop Excel sheet with an inventory of the offline cables did not provide a clearer translation due to the complexity of the underground that is not simply translated into generic lay-outs.

The *governance structure* in this phase consisted of two project organizations involved in the transfer of the utility relocation work. The *governance management approach* consisted of several sessions to repair the situation, involving the contractor and the asset managers to provide information about the location of the utilities. Eventually, this top-down approach, which attempted to create an overview, had to be abandoned, and the problem was transferred to the subsequent project team.

5. Analysis: the governance of the translation of the underground

On the basis of the findings regarding the translation process in the various project phases, in this section, we analyze the overall pattern of the translation of the underground (see Table 2).

In the planning phase, the underground was originally simply forgotten and only marginally taken into account, given the choice of the least favorable alternative for the terminal from a utilities' point of view. In the design phase, the project management settled for a suboptimal design, in order to make progress. In the tender phase, the remaining uncertainties about the subsoil were defined as risk, thus transferring their implications again to future phases. In the construction phase, problems with utilities became visible by questioning the quality of the contractor's performance, resulting in an omission on changing the working procedures. In the transfer phase, misunderstandings about how the underground should be transferred became apparent, resulting in a failed attempt to come up with a complete inventory of the utilities underground.

Table 2
Overview of governance of the translation process of the underground in the Schiphol utility relocation project.

	Planning phase	*Design phase*	*Tender phase*	*Construction phase*	*Transfer phase*
Translating actors	*Asset managers versus project key decision-makers*	*Asset managers versus external designers*	*Underground versus project key decision-makers*	*Asset managers versus PMCM and project manager utility*	*Different project teams*
Translation process/ strategic interactions	Different variations of underground utilities are made by the asset managers. Asset managers used drawings and trial trenches to translate the underground	Different design solutions have been discussed to organize underground utilities. Asset managers' strategic approach contradicts the systems engineering approach	The invisibility of the underground hampers the project's goal to make the underground known. Consultants mapped utilities and eventually focused on the allocation of the risks from remaining uncertainties	The quality of the contractor's engagement is discussed govern cable strikes and working methods. The asset managers used photos to confront the project manager with their worries.	Confusion over function-free underground due to unfamiliarity with the contract. Asset managers had difficulty in inserting tacit knowledge in Excel sheet
Translation of nonhuman	Impact of the least favorable alternative on the underground, which had to be mitigated in the next phases.	Incomplete, but the best possible design.	Construction contract in which unknown risks were allocated to the client.	No changes in the contractor's working procedures	Although the confusion was tackled, an incomplete inventory was built.
Governance structure	A project manager utilities appointed, the asset managers did not participate in formal decision-making	The project management outsourced and the design in the hands of external consultants	The project management hired external consultants; asset managers were not involved during this phase	Contractor relocated utilities, monitored by the project management; asset managers informed	After completion of the relocation, the site was transferred to the project team for the future construction of the terminal
Governance management	The project manager utilities organized informal meetings with asset managers to assess the implications of plans	Informal meetings of consultants with asset managers using a systems engineering approach; intervention of process management to improve the interaction process	The project management sought risk allocation with the contractor	The project management informed asset managers and tried to remove asset managers' worries by providing information	The management required asset managers to fill in an Excel sheet with their knowledge on the existing utilities in the subsoil; eventually, the tasks were transferred to a new project team

The findings show a pattern of translating the underground throughout the phases: information of the underground remained inconclusive at the end of every project, while actors most knowledgeable about the underground were systematically unable to represent themselves in the translation outcome of the underground. It turned out that the uncertainty related to the underground made project decision-makers constantly compromised an adequate translation of the underground while focusing mostly on the delivery of the terminal instead of the underground. As a consequence, transferring uncertainties and their implications to future phases, while space to deal adequately with the lack of a sufficient translation proportionally decreased. Given the problems encountered by the project during construction and the delays in the transfer phase, it can be stated that the translation of the underground was far from optimal. The problems in the later phases can be traced back to the translations in the earlier ones.

In looking for explanations for this translation process, we have analyzed the governance structure, the governance management strategies, the strategic interactions, and the nature of the project and nonhuman within the project.

Regarding the *governance structure* of the project, the outsourcing of the project management to an external party had a major impact on the actor-network and introduced new actors and new and unfamiliar ways of working at a great distance from local practices and local knowledge. The representation of the underground was institutionalized by appointing a project manager utilities, and the management organized informal meetings throughout the project to obtain insight into the utilities underground. However, the asset managers were not formally embedded in the project: parties with knowledge of the underground were not represented on the level on which decisions on the project were taken.

The marginalized position of actors with local knowledge of the underground within the actor-network was further exacerbated by the top-down nature of the *governance management strategies* deployed. Attempts by the project management to deal with the invisibility of the underground by directly seeking knowledge of the underground by 3D technology and trial trenches proved to be in vain. Attempts to extract knowledge from the asset managers by informal meetings, filling in Excel sheets, and the like also remained unsatisfactory. Because of the informal way in which the asset managers were involved, their information and viewpoints reached project decision-makers only indirectly, through in-between parties or written reports. As a result, the full extent of the asset managers' knowledge was not exploited. Attempts by the project management to bridge differences and smoothen interactions were hampered by the fact that communication remained one-sided and the asset managers did not feel that they were heard. In the construction phase, they became so frustrated and alienated that they were not willing to contribute constructively.

In the interaction process, actors used various strategies to usher in underground knowledge. The asset managers used drawings, but that is not the language that managers understand. In the transfer phase, asking the asset managers to fill in an Excel sheet did not prove effective, again showing that this medium, like the earlier drawings and systems engineering approach, did not successfully fulfill the function of a boundary object, bridging the knowledge differences between human actants on the existing association of nonhumans underground. Certainly, it was

not helpful that not all actors were familiar with these methods. Perhaps even more important, however, may be the fact that the intentions and expectations of those involved in the translation process were not aligned.

Finally, the nature and context of the nonhuman explain the translation of the underground. The context of the underground is a preconstruction project that is part of a larger project. The resources and focus of the project organization have therefore been on the terminal and not on the underground. This was for example observed in the planning phase, where the least favorable utility variation was picked but the most favorable for the terminal. Furthermore, the nature of the underground is that it is invisible. The invisibility of the underground makes it difficult to overcome controversies because it is an actor that is hard to be known. The invisibility hampers a convergent translation in the various controversies. For example, in the design phase certain proposed solutions by the external designers would be impossible if the underground would be visible and therefore specific proposals by the designers would not ignite a controversy. Within the transfer phase a controversy would not exist if the offline cables would be visible. Hence, discussions endure because the underground is not to be known, leaving space for other actors to fill the knowledge vacuum in the underground in accordance with their interests.

6. Discussion

This study shows that the relationship between materiality and project governance is problematic and may hamper the translation of material conditions within projects. In fact, this is surprising, since projects—especially infrastructure projects—focus on the realization of products and services that have material dimensions. So, it prompts the question how can it be that materiality in this context is problematic? We suggest that projects are often of a complex nature (Pitsis et al., 2014) and require the representation of various forms of materiality by different experts. The unique nature of the experts' knowledge of specific types of nonhumans makes it difficult to convey substantive knowledge to each other and to project managers. The associations between project managers and other actors are, therefore, not primarily of a substantive, but of a process and procedural nature. This may explain why, materiality is less prominent in project studies, compared to ideas on processes and procedures (De Bruijn & Ten Heuvelhof, 2010; Demirkesen & Ozorhon, 2017). Nevertheless, materiality matters as project governance involves the alignment and integration of various forms of materiality. In these governance processes, a group of heterogeneous actors are involved in the interpretation, appropriation, and representation of various material conditions that compete for attention and allocation of resources. Governance is about the coordination of these translation processes (Gao, 2005). Our study provides insights in the various factors that may hamper this translation process and its governance.

Our case study, firstly, shows that this governance challenge is complicated by the specific characteristics of the material conditions that are involved in the project. In our case, the invisibility of the underground obscured its substance and hampered representation of nonhumans within the decision-making process. Here, the invisibility and the uncertainty that is associated with the underground hampered a convergent translation. The invisibility, hence, left space for actors to interpret and frame information on the underground according to their own beliefs and interest. Secondly, our analysis of the translation process reveals the shortcoming of (governance) strategies that project actors employ to gain full and objective knowledge of the underground. Although implicitly the asset managers had knowledge on the underground, their knowledge was hard to extract, incomplete, and not always up-to-date. Attempts of project managers to directly obtain information about the material conditions, bypassing asset managers, via 3D technology and trial trenches also proved to be of limited success. Therefore, we conclude, translating nonhumans—in this case the underground—is not simply a question of knowledge extraction and transfer (compare Temple, 2005), but requires an ongoing and collaborative process of knowledge exchange and interpretation throughout the phases of the project.

Our analysis also displays relevance for project studies by illustrating that strategies aimed at the use of boundary objects did not necessarily succeed in breaching the boundaries between the different project actors (Latour, 2005). We found that drawings, reports, engineering approaches, and Excel sheets did not fulfill the role of boundary objects, since they were not embedded in practices in which actors shared intentions and expectations about one another's roles (Taylor, 2007; van Eeten, 1999). Without the right conditions, boundary objects may even enhance difference between project actors, instead of overcoming them, as shows the example of the failed application of the Excel sheets during the transfer phase that frustrated asset managers as well as the project manager.

Very importantly, our analysis shows how governance may hamper, instead of facilitating, a balanced translation of material conditions. This can be explained by the role of cognitive biases in decision making processes; psychological prepossessions that result in suboptimal decisions by filtering the way information is sought and processed (Das & Teng, 1999; Féris, Zwikael & Gregor, 2017; Meyer & Kunreuther, 2017). Firstly, our case shows an optimism bias as the overall governance approach focused almost exclusively on a single goal, the construction of the terminal, with an underestimation of the implications of the underground's role and related risks. Secondly, our case shows a simplification bias which is the tendency to accept a limited representation of a phenomenon as reality. Because actors that are most closely associated with the underground were kept out of the project's central decision-making arena, suboptimal decisions were made in governing the underground. These two biases are especially relevant for decision making and project governance in projects where materiality is, due to its invisibility, hard to know.

Moreover, the overall governance was dominated by outsourcing, which included hiring expertise from outside the organization. To a large extent, the governance structure was based on the philosophy that big engineering projects are worldwide largely similar and can be uniformly governed by global management approaches (compare Badiru & Osisanya, 2016). Consequently, international actors, often consultancy firms, were brought into the actor-network and acquired a central place therein, at the expense of important knowledge of local actors. This project's philosophy resulted in a top-down management approach aimed at the extraction of knowledge from local asset managers, instead of operating through an ongoing and mutual dialog. Since outsourcing and the neglect of in-house knowledge and expertise are more generic practices in governing projects, our findings emphasize the significance of revalidating local knowledge, local actors, local conditions, bottom-up processes, and materiality in project governance, as has been asked for by, among others, Floricel et al. (2014), van Marrewijk (2018) and Ninan et al. (2020).

Finally, our analysis shows how materiality influences governance. In line with earlier studies (e.g. Floricel et al., 2014; Ninan et al., 2020; Sage et al., 2014; van den Ende et al., 2015), we found that the way materiality is translated, in our case the underground, had a strong impact on the governance of the project. The translation of the underground in the various project phases was disappointing, despite a continuous effort in adjusting the governance of the project. Project management sought better ways to translate the underground, which can be seen as learning (Senaratne, Jin, & Balasuriya, 2017). At the same time, it should be noted that the changes that were carried through in the governance were constrained by the overall governance approach that was decided upon in earlier phases, and that these changes were largely insufficient in overcoming the limitations of that overall approach. This did not remain without consequences for the effectiveness of the governance and the project as a whole, given it's disappointing outcomes. The acknowledgment that the relationship between governance and materiality is recursive has implications for our conceptual framework. We suggest

that inserting feedback relations between translation and governance would support future research in addressing this recursive relationship more explicitly, also allowing for the identification of learning within the relationship between materiality and governance.

7. Conclusion

This study aimed to increase our understanding of the relationship between governance and materiality by examining the question how the governance of projects influences the translation of material conditions of projects. The findings of this case study show that the translation hampered the relocation of utilities in the project, eventually resulting in delays and budget overrun. The translations that emerged during the process were inspired by tradeoffs between the need to gain an understanding of the underground and the pressure to make progress in realizing the overall project objective: the building of the terminal. The explanation for this pattern in the translation process can be found in the characteristics of the nonhuman involved—the invisibility of the underground—and the inadequacy of actors' translation strategies and the project governance to arrive at a common understanding of this material condition.

Our study contributes to the project governance debate (Ahola et al., 2014; Brunet & Aubry, 2016; Pitsis et al., 2014) in two ways. First, it demonstrates the usefulness of the translation concept as a heuristic tool to better understand the interaction between project governance and material conditions in projects, as has been asked for by others (e.g. Floricel et al., 2014). Translation theory helps to describe and explain the evolution of interaction processes in projects in which materiality, in our case the underground utilities, is important. It also demonstrates how governance can hamper, but also improve, a project's performance; by embedding actors that have associations with crucial nonhumans, more centrally in the actor-network; by enhancing governance that includes bottom-up processes and balances various interests (compare Koppenjan et al., 2008); and by supporting the mutual transfer and interpretation of (local) knowledge among the parties involved in the various project phases. These insights contribute to governance theory, but also may inform the practice of project governance.

Secondly, this paper contributes to project studies by examining the link between project governance and materiality (Floricel et al., 2014; Pitsis et al., 2014). During all project phases, uncertainty over material conditions influenced the project's governance process, as has been observed earlier (Ninan et al., 2020; van den Ende et al., 2015). Our study shows how the unique properties of the material conditions influence the project governance and efforts of project decision-makers to adjust the governance by aligning the project with its material conditions seemed to be difficult. Also, the governance influenced how the material conditions are translated: by focusing on the project's overall goals, the risks related to the material conditions are not adequately addressed.

A limitation of this case study of the translation of the underground in is the Schiphol Terminal project is that its findings cannot simply be generalized to other cases. In order to further develop our knowledge of translation processes regarding materiality and how they are governed, other (comparative) case studies are needed. These cases might be focused on other infrastructure projects in which the underground plays an important role, comparing for instance projects that are focused on underground facilities in which this nonhuman is central, with projects that primarily focus on other facilities in which the underground is not the primary concern and marginal in the actor-network. But similar studies may focus on the translation of other marginal and difficult to know nonhumans like sustainability or safety. In the Netherlands, further research in the role of the underground in project governance may concern projects in the Port of Rotterdam (as the Rotterdam Port Authority does not own the utilities in the port unlike Schiphol), projects governed by the Dutch Road and Water Agency (RWS), or projects within urban areas, in which municipal governments sometimes take the role of coordinator. Similar projects can be identified in other countries, given that the need to integrate nonhumans in project development is an issue that is relevant worldwide. In addition to (comparative) case studies, we might aim for more quantitative studies. Building on in-depth, qualitative case studies like the current one on Schiphol, using the qualitative comparative analysis (QCA) method in which a medium N of cases are compared, might be a logical next step in the direction of more quantitative approaches.

To practitioners, we would like to convey the message that the processes of interpreting, appropriating and, representing material conditions are a serious issue for the governance of complex projects, especially when these nonhumans have a marginal position and are difficult to pin down, like the underground in our case. Our study clearly shows that project leaders should take these material dimensions seriously by empowering, acknowledging, and integrating material conditions in the early stages of the governance in infrastructure projects. Our analysis of the Schiphol case reveals difficulties and pitfalls that project managers may want to avoid. It also suggests ways in which to move forward that may inspire them in governing the difficult task of translating materiality within their projects.

Available of data and materials

Due to individual privacy conditions, the datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Declaration of Competing Interest

None.

Funding

This study was supported by the Dutch NWO (Netherlands Organization for Scientific Research) with project number 439.16.805.

Appendix A: List of respondents

Respondent	Function	Department/ organization	Phase
1.1	Technical expert, utility root specialist	Asset management	1, 2, 4
1.2	Technical expert, high-voltage specialist	Asset management	1, 2, 4
1.3	Technical expert, permits	Asset management	1, 2, 4
1.4	Technical expert, water	Asset management	1, 4
1.5	Service manager infrastructure	Asset management	1, 4
1.6	Service manager infrastructure	Asset management	1, 4
1.7	Clerk of works, gas	Asset management	1, 2, 4
1.8	Operational technical expert, gas	Asset management	1, 2, 4
1.9	Tester	Asset management	1
1.10	Installation manager	Asset management	1, 4
1.11	Licensing authority	Asset management	2, 4
2.1	Project director landside	Project Organization	3, 4
2.2	Design lead	Project Organization	2, 3
2.3	Commercial lead	Project Organization	3, 4
2.4	Project director Area A	Project Organization	1, 2, 3, 4
2.5	Project manager, project leader	Project Department	1
2.6	Project manager utilities	Project Organization	1, 2, 3, 4
2.7	Project manager roads and utilities	Project Organization	1, 2, 3, 4
2.8	Contract manager	Project Organization	3, 4
2.9	Project manager pier	Project Organization	3, 4
2.10	Safety and security manager	Project Organization	4
3.1	Senior consultant urban water	PMCM	2, 4
3.2	Market sector leader	PMCM	2
3.3	Senior specialist infrastructure	PMCM	2
3.4	Project manager	PMCM	3, 4
3.5	Project coordinator	PMCM	1, 2, 3, 4
3.6	Site manager	PMCM	3, 4
3.7	Field engineer manager	PMCM	3, 4
3.8	Risk manager	PMCM	3, 4
3.9	Utilities supervisor	PMCM	4
4.1	Head execution	Contractor	4
4.2	Design specialist infrastructure	Contractor	2, 3, 4
4.3	Company director	Contractor	3, 4
4.4	General construction manager	Contractor	4
4.5	Project organizer	Contractor	3, 4
5.1	Senior network designer	Telematics	1, 2

Appendix B: List of documents

Document number	Author	Title	Release date	Description
1	Project manager utilities	Kabels and Leidingen A-gebied. Uitwerking terminal variant 4 ten behoeve studie planelogische inpassing	April 10, 2015	One of 6 alternatives investigated
2	Unknown	Planelogisch concept: A-gebied	June 12, 2015	A confidential document describing the spatial planning of the project
3	ENP Newswire	Design teams present new Amsterdam Airport Schiphol terminal	July 27, 2017	News article showing that the design of the terminal has been presented to the public
4	Project team landside	Invitation to tender: C3500 General Contractor Landside roads and utilities (WP1A) Schiphol	April 24, 2017	Twenty-nine pages in which the tender procedures and awards are laid out
5	Marketline Newswire	Amsterdam Schiphol hires new team to manage pier and terminal development	August 1, 2017	Media announcement underscoring the different consultancy firms that are going to assist Schiphol with the construction of the new terminal and pier
6	Capital Program	Landside Infrastructure: Contract, particular conditions Part B	April 10, 2017	Part of the contract describing particular conditions in contrast to more generally described contractual agreements
7	Respondent 1.10	FW: Fotos	January 16, 2019	E-mail sent to the project manager utilities containing photos with problematic situations during construction
8	Fugro B.V.	Rapport betreffende verhoogde toevoerwegen ten behoeve van N.V. Luchthaven Schiphol	October 10, 1990	A geotechnical report of the terminal region
9	Unknown	Ondergrondse Inmeting Schiphol Deelgebied A	May 23, 2017	The 3D description of the underground measurements

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