Administrative Strategies for Complex Governance Systems

Challenges of Making Public Administration and
Complexity Theory Work—COMPACT II

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Chapter 4

Managing unplanned events in large infrastructure projects: Results from an in-depth comparative case evaluation

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This contribution intends to move beyond the truism that infrastructure project management is contextual and evaluates which configurations of management actions and contexts produce what outcomes. Therefore, we introduce multi-value Qualitative Comparative Analysis (mvQCA) as a complexity-informed method, and apply it to the Dutch A2 Maastricht infrastructure project. An analysis of eighteen cases within the project showed that context is explanatory for the different and sometimes contradictory results produced by management strategies. In particular, we found that (1) internal-oriented private management seems strongly associated with low satisfaction, (2) external-oriented management is strongly associated with high satisfaction in cases of social, local unplanned events, and (3) sometimes internal-oriented management is associated with high satisfaction, depending in particular on the nature of the cooperation between principal and contractor.

Introduction

Many transportation infrastructure projects are characterized by cost overruns (Flyvbjerg et al., 2003) and lingering implementation processes (Advisory Committee VBI, 2008; De Hoo, 1982). In the literature two more or less opposite management strategies are distinguished that are said to contribute to better outcomes. The internal-oriented strategy focuses on clear goals and control, and the external-oriented strategy emphasizes interaction with the environment. Research suggests that the latter leads to better outcomes (Edelenbos & Klijn, 2009; Klijn et al., 2010) although, importantly, not necessarily so (Verweij et al., 2013). Consequently, proposals focus on a balance between the two strategies (e.g., Atkinson et al., 2006; Edelenbos & Teisman, 2008; Hertogh et al., 2008; Hertogh & Westerveld, 2010). But what does this 'balancing' entail, and how is it that sometimes a certain management strategy results in good outcomes, and sometimes not? These are largely underexposed questions. We argue that managers *within* an infrastructure project act in specific circumstances and that achieving satisfactory outcomes depends on the particular *interaction* of those management actions with the particular situation in which they take place. In this contribution we want to move beyond the truism that infrastructure project management is contextual and *evaluate which configurations of management actions and contexts produce what outcomes.*

Whilst the contextual nature of infrastructure project management is increasingly acknowledged (e.g., Hertogh & Westerveld, 2010; Owens et al., 2012), methodologies to systematically evaluate which configurations of management actions and contexts produce what outcomes seem to run behind (Verweij & Gerrits, 2013). First, little attention is given to the actual day-to-day management actions in specific circumstances whilst these are pivotal for understanding how outcomes are produced in complex projects (cf. Atkinson et al., 2006; Cicmil et al., 2006). Second, traditional evaluations of projects tend to focus on comparing 'before and after' thereby often inadequately reckoning with project contextuality in their assessments. This

significantly impedes learning from evaluations since little insight is gained into the ways in which outcomes are produced (Pawson & Tilley, 1997; Sanderson, 2000). Evaluation methodologies need to match the complex nature of transportation infrastructure projects (Verweij & Gerrits, 2013). Thus, we need a method that is grounded so as to study management actions in specific contexts, and that is able to systematically evaluate when and why these produce good outcomes and when they do not, such that learning is facilitated in a meaningful way.

In previous publications we laid the groundwork for this method (Gerrits & Verweij, 2013; Verweij & Gerrits, 2012; 2013). In this contribution we apply it to the Dutch A2 Maastricht project. This is done through a number of steps. First we will explain the method and the perspective on managing infrastructure projects that underlies it. Then we introduce the A2 Maastricht project and the data we collected. Thereafter we analyze the data. In the final section we draw conclusions and we discuss the research findings and the methodology.

Researching complex infrastructure projects

Properties of complexity in infrastructure project management

A transportation infrastructure project is implemented in a complex socio-physical context that influences the development of the project. Unplanned events may require managers to act in an attempt to prevent, for instance, time delays and budget overruns (cf. Atkinson et al., 2006). In complex projects, managers have to deal with different and multiple such *cases* of events, which may require various management actions. The A2 project can be understood as a long-term spatial program that consists of strings of cases. Importantly, these cases of management actions to deal with events "do not operate according to general rules applied in all contexts" (Buijs et al., 2009: 37). In different contexts the same management act can produce different outcomes and different management acts can

produce similar outcomes (cf. Byrne, 2011a; 2011b; Pawson & Tilley, 1997; Sayer, 2000). For example, within a single infrastructure project a certain management strategy may result in preventing the project planning to go awry in one case but not in another; this depends on the properties of the event. Such notions may seem superfluous, but all too often transportation infrastructure projects are evaluated as if they are exclusively governed by general patterns that explain the development and outcomes, thereby disregarding the underlying diversity that provides insights into the ways that outcomes are actually produced (Verweij & Gerrits, 2013).

Knowledge about the management of transportation infrastructure projects is situated and contextual. This applies to both the evaluator and the managers working in the project. The actions of managers are context-dependent. They interpret their reality and consequently act upon it and these actions influence the project's development. Therefore, to understand the ways in which outcomes are produced, it is essential that the researcher's interpretations and assessment of transportation infrastructure development are grounded in those of its managers (cf. Gerrits & Verweij, 2013). This perspective favors a qualitative research approach in which managers are studied in their contexts—what they do, why and with what outcomes—upon which causal explanation is grounded (cf. Cicmil et al., 2006; Verweij, 2012).

It may not be possible to define beforehand what management acts, context conditions and outcomes should be researched. Because managers act in an uncertain and badly-predictable context (Atkinson et al., 2006), and because the actions of managers are informed by their interpretations of reality and not by the theories proposed by evaluators (cf. Pawson & Tilley, 1997), what constitutes a case of 'management action to deal with an unplanned event' cannot be predefined by the researcher. "It is not possible to construct verbal formulations (i.e., theory, ed.) that can embrace or contend with the complexity and diversity of the empirical world. For these and related reasons, cases often must be delimited or found in the course of re-

search" (Ragin, 1992: 220). "Discovering them and studying how they operate might be a key component or objective of the research" (Sayer, 2000: 20).

Researching complexity in infrastructure project management with mvQCA

Following these properties, the first step of the method involves the grounded collection of data. Open, qualitative interviews are especially suitable for this (e.g., Weiss, 1994) because this allows the researcher to fully grasp the managers' perspectives on the situation (instead of testing those of the researcher), their consequent management actions and the outcomes. The second step is to code the interview data (e.g., Boeije, 2010). Coding facilitates the synthesis of different respondent perspectives into a single coherent reconstruction per case. Through coding and memo-writing ideas about the collected interview data are recorded thus allowing for those ideas to be reinterpreted (Schwartz-Shea & Yanow, 2012). This interpretive process is influenced by existing ideas about complexity and managing infrastructure projects with which the researcher is familiarized. Ragin coins this quest "casing"—which is best understood as a dialogue between ideas and evidence or theory and data—which can bring operational closure to the relationship between the empirical world and the way we frame it (Ragin, 1992; Ragin & Amoroso, 2011). This second step results in the construction of conditions—i.e., management, context and outcomes—that constitute a case (cf. Byrne, 2005).

Qualitative Comparative Analysis (QCA) is deployed in the third step. QCA allows for the iterative examination of patterns of complex causality through pairwise comparison of cases as configurations (Ragin, 1987; Schneider & Wagemann, 2012). The basic logic of the approach is (1) to construct cases as configurations of conditions and to put them in a raw data matrix, (2) to organize the cases over the logically possible configurations in a truth table, (3) to assess the outcomes associated with these configurations, and (4) to identify minimal configurations of (necessary and) sufficient

conditions through pairwise comparison of configurations that agree on the outcome and differ in but one other condition (i.e., 'minimization').

A condition is necessary if the outcome cannot be produced without it. A condition is sufficient if it can produce the outcome by itself. However, necessary and sufficient conditions often combine in configurations. Within a configuration, a condition is INUS, i.e., an *insufficient* but *necessary* part of an *unnecessary* but *sufficient* condition (Mackie, 1980). This combining (intersection) of conditions is expressed by the operator *logical and* (* sign). The existence of different and multiple configurations is expressed by the operator *logical or* (+ sign). The degree to which the empirical evidence supports claiming necessity and/or sufficiency is expressed in terms of consistency, i.e., "the degree to which the cases sharing a given combination of conditions agree in displaying the outcome" (Ragin, 2008: 44). The empirical strength of a configuration is expressed in terms of coverage (Schneider & Wagemann, 2012).

Importantly, interpretation of the patterns occurs throughout the iterative process and is of pivotal importance in concluding the analysis. For a detailed explanation and overview of QCA we refer to e.g., Rihoux and Ragin (2009) and Schneider and Wagemann (2012). In the present analysis, we used the specific type of multi-value QCA (mvQCA) (Cronqvist & Berg-Schlosser, 2009). The first reason is that the conditions we constructed do not represent interval or ratio scales. Second, prior to the mvQCA analysis, we ran a crisp set QCA (csQCA) and a fuzzy set QCA (fsQCA) but these produced contradictions which could largely be resolved with mvQCA. The mvQCA was performed using Tosmana software (Cronqvist, 2011).

Data-collection about the A2 Maastricht project

The Dutch A2 passageway Maastricht project concerns the construction of a 2.3 km long double-deck, double tube tunnel under the city of Maastricht, real estate development, landscaping, and the infrastructure projects

reconstruction of nearby highway junctions. The project is managed by a public-private partnership that consists of four governments—Rijkswaterstaat, the Province of Limburg, and the Municipalities of Maastricht and Meerssen ('the Project Agency')—and construction consortium 'Avenue2'. Rijkswaterstaat is the executive arm of the Dutch Ministry of Infrastructure and the Environment. It is responsible for the design, construction, management and maintenance of the main infrastructure facilities in the Netherlands. The project replaces the former highway that divided the city. The construction formally started in 2011 and the commissioning of the tunnel is planned for the end of 2016.

Eighteen interviews with public and private managers of the A2 Maastricht project were conducted between September 2011 and December 2011. In addition, project visits, observations of project meetings, documents and the website www.a2maastricht.nl further facilitated interpreting the interview data. The interviews were transcribed, and then coded and recoded in an iterative fashion (cf. Boeije, 2010) using ATLASti coding software.

Analysis

The analysis proceeds as follows. First we construct eighteen cases in the A2 Maastricht project. Second, we compare these using mvQCA so as to find out which configurations of management actions and contexts produce what outcomes. Finally, the results are explained.

Case constructions in the A2 Maastricht project

Table 1 describes the eighteen unplanned events that we identified after several iterations. Since we focus on how managers act, and because we focus on the implementation process, the table only concerns cases after the contract closure between principal and contractor in October 2009.

ID	Label	Brief description of the unplanned event
TUN	Tunnel standard	Due to ambiguity hence discussions about the safety standards for Dutch tunnels and delayed commissioning of tunnels resulting therefrom, Rijkswaterstaat established a Tunnel Director to develop a general tunnel standard to be anchored in legislation. At the time of interviewing, this caused uncertainty about changes in the technical tunnel system requirements and related rising costs of the tunnel and technical systems.
BI1	Bicycle bridge	The plan was to create a temporary bicycle bridge to compensate the closure of two bicycle tunnels. A subcontractor identified problems with the design which caused discussion within Avenue2 about how to proceed.
BI2	Bicycle bridge	In the end, this bridge was cancelled by Avenue2 for technical and safety reasons not foreseen in the procurement of the plan. Consequently, the Cyclist Union objected. The Union mobilized politicians in the municipal council—who appeared not to be informed of the change—who called the alderman to account.
WAT	Waterboard	The Waterboard needed to issue permits for parts of the project. It imposed additional requirements related to water retention and drainage when a permit was applied for by Avenue2. This affected the project scope. According to several respondents, this was due to not involving the Waterboard in the planning of the project.
LAN	Land acquisition	Over 400 apartments had to be purchased by the Municipality of Maastricht (Project Agency) to be demolished. A small number of residents objected, and some even appealed at the Council of State (the highest Dutch administrative court).

ID	Label	Brief description of the unplanned event
ZON	Zoning plan	Leading up to the endorsement of the zoning plan by the Municipality of Maastricht, the content was agreed upon by the responsible municipal manager and the manager planning of the Project Agency. However, as a consequence of internal municipal dynamics—e.g., limited decision-making power of the municipal manager—the municipal manager reconsidered the agreements twice.
ENV	Environmentalists	Environmental interest group 'Kloar Loch' appealed at the Council of State to enforce a higher air quality near the tunnel mouths in the final situation, and during project construction. Parallel to the legal procedure, the group also contacted the Project Agency to negotiate an agreement.
LEE	Leeuwenborgh	Vocational school Leeuwenborgh lodged an objection at the Project Agency to the phasing of a road bypass during construction for reasons of safety, health and limited parking space.
WES	West8	In detailing the design of the project, the angle of a small tunnel relative to the highway was slightly altered by Avenue2 when they applied for the construction permit at the Municipality of Maastricht. Landscape architect West8 objected, mobilized the municipal Building and Housing Inspectorate, and demanded the undoing of the alteration.
RIJ	Rijkswaterstaat	Rijkswaterstaat needed to verify the Route Decisions (i.e., 'national zoning plans') developed by the Project Agency. Leading up to the endorsement the content was agreed upon between the Agency and Rijkswaterstaat, but then Rijkswaterstaat specialists demanded some changes in the design for reasons of air quality which would affect the project's budget.

ID	Label	Brief description of the unplanned event
TRA	Traffic audit	During construction Rijkswaterstaat performed an unannounced audit concerning traffic measures. The audit judged that the traffic measures taken by Avenue2 were insufficient and that unsafe situations existed.
CR1	Crisis	Part and parcel of the plan and Avenue2's business case is the construction of 1.100 houses and 30.000 m^2 of commercial properties between 2016 and 2026. The financial and real estate crisis caused uncertainty regarding the balance of the budget.
CR2	Crisis- and Recovery Act	In the beginning of 2010 the Crisis- and Recovery Act was enacted. This law aims to shorten procedures at the Council of State.
SOI	Soil contamination	During the reconstruction of the 'Geusseltvijver' soil contamination was discovered that was heavier than expected in the reports. By law, this contamination had to be removed.
BAD	Badger	Leading up to the contract closure the local badger habitat was identified. After the contract closure it appeared that the habitat had changed resulting in the need for scope changes (i.e., badger tunnels).
PRO	Prorail	Decommissioning the railway near the project area is necessary for project construction purposes. When the Project Agency requested the decommissioning, Prorail (the organization responsible for the Dutch rail network) acted obstructive since they felt passed over as they were not consulted about the issue during plan preparation.
CIV	Civil initiative	In 2011 a city artist and an architect approached the Project Agency with an initiative to perk up the construction site with sunflowers.
THE	Theft	Construction materials were stolen from the Avenue2's site.

Table 1 *Unplanned events in the A2 Maastricht project*

Through an iterative process, we constructed these cases as configurations of conditions, i.e., context, management and outcomes. The first condition concerns the nature of the unplanned event. In this analysis, we operationalize this as the context. Contemplating Table 1, the nature of the events varies widely. In some cases it originates from the physical system (i.e., SOI and BAD), in other cases it primarily relates to the local societal environment (i.e., BI2, LAN, ENV, LEE, and CIV), the project system (i.e., BI1, WES), the local governance system including mother departments of the public partners (i.e., BI2, WAT, ZON, WES, RIJ, TRA and PRO) or outside the sphere of the project (i.e., THE, TUN, CR1 and CR2). What sets the middle three categories apart is that these strongly relate to what Hertogh and Westerveld coin "social complexity" which is "prominently visible in the relationship between the project delivery organization and local stakeholders" and "between the project delivery organization and their principal and parent organizations" (2010: 150). The first and latter categories could be said to be similar in that respect, but differ from one another in terms of their remoteness to the project. In sum, the first condition is broken down into five categories: physical, societal, project, public, and remote.

The second condition concerns the way in which managers acted upon the event. As can be seen from Table 2, they try to deal with events by internal-oriented management—e.g., doubling the shifts, changing planning and changing construction modes—or by external-oriented management, i.e., engaging with the stakeholders, or some combination of both. It is important to note here that not all events are dealt with by both public and private managers; some are of concern to only one party. This is expressed in the third condition.

The third condition concerns the relationship between principal and contractor which appeared to be a focal point in the interviews. This condition consists of two dimensions. First, an event may be acted upon by either principal or contractor, or both (i.e., interaction). This concerns the presence of public-private interaction. Second, if *inter*acted upon, this may

be characterized, to greater or lesser extent, by either cooperation or conflict between principal and contractor, i.e., join forces or shirk risks. This concerns" the nature of the interaction. Hence, four basic types of public-private interaction can be distinguished: autonomous public, autonomous private, conflict and cooperation. The empirical manifestation of the interaction is at least partly determined by the contract between principal and contractor which provides directions for how they are to interact.

The fourth and final condition concerns the 'outcome'. Here we follow Verweij *et al.* (2013) to the extent that no unambiguous measure of 'good outcomes' can be used in projects with multiple actors and interests. Hence, we take the satisfaction of managers "based on their realized preferences and goals, and the time and energy spent achieving those" (Verweij *et al.*, 2013: 1038) in a case as the outcome, which predominantly concerns time, budget, quality and/or the public-private relationship (Verweij, 2012). For instance, if goals are realized but with considerable energy spent, satisfaction is assessed as moderately high.

In the next section, the qualitative data in the preceding Table 1 and the following Table 2 are calibrated and quantified in a data matrix. The detailed qualitative descriptions for each case in Table 2 are provided elsewhere (Verweij & Gerrits, forthcoming).

Comparing cases with mvQCA and results

The calibration rules for Table 2 are shown in Table 3. In a first mvQCA we used Version A of the calibration. However, as it turned out, this produced logical contradictions, i.e., configurations that are associated with the outcome in one case and with the absence of the outcome in another. Contradictions are problematic because they cannot be included in the comparison of different configurations. In addition, Version A produced logical remainders, i.e., logically possible configurations that are empirically absent. This means that there are fewer configurations that agree on the outcome

ID	Event	Management	Interaction	Satisfaction
TUN	Remote	Internal	Cooperation	High
BI1	Project	Internal	Private	Low
BI2	Societal/ Public	External (primarily)	Public (primarily)	Indifferent or moderate
WAT	Public	External	Cooperation	Indifferent or moderate
LAN	Societal	External	Public	High
ZON	Public	External	Public (primarily)	Moderate to high
ENV	Societal	Internal	Public	High
LEE	Societal	External (primarily)	Public (primarily)	High
WES	Project/ Public	External (primarily)	Private	Moderate to high
RIJ	Public	External	Cooperation	High
TRA	Public	Internal (primarily)	Private (primarily)	Low
CR1	Remote	Internal	Private (primarily)	Indifferent or moderate
CR2	Remote	Internal	Public	Moderate to high
SOI	Physical	Internal	Private (primarily)	Indifferent or moderate
BAD	Physical	Internal	Private	Low
PRO	Public	External	Public	Indifferent or moderate
CIV	Societal	External	Cooperation	High
THE	Remote	Internal	Private	Indifferent or moderate

Table 2 *Dealing with unplanned events*

and differ in but one other condition. The more contradictions and remainders, the less there is to compare.

Specifically, first, EVENT{0} and EVENT{2} did not distinguish between cases in any significant way (i.e., it did not resolve a contradiction), but it did produce more logical remainders. That is, the remoteness of the event to the project does not account for the difference in outcome between cases. However, the difference between the social or non-social nature of the event does usefully distinguish different cases from one another. Second, INTERA{1} (i.e., conflict) is empirically absent in our data, and two of the four contradictions could be resolved by distinguishing between 'autonomous private' and 'autonomous public' interaction instead. In other words,

Condition	Abbreviation	Calibration mvQCA (Version A)	Calibration mvQCA (Version B)
Event	EVENT	0 = Physical 1 = Societal, project, public 2 = Remote	0 = Physical, remote 1 = Societal, project, public
Management	MAN	0 = Internal 1 = External	0 = Internal 1 = External
Interaction	INTERA	0 = Autonomous public, private 1 = Conflict 2 = Cooperation	0 = Autonomous public 1 = Autonomous private 2 = Cooperation
Satisfaction	SATIS	0 = Indifferent or moderate, low 1 = High, moderate to high	0 = Indifferent or moderate, low 1 = High, moderate to high

Table 3 Calibration of conditions for mvQCA

Case-ID	EVENT	MAN	INTERA	SATIS
TUN	0	0	2	1
BI1	1	0	1	0
BI2	1	1	0	0
WAT	1	1	2	0
LAN	1	1	0	1
ZON	1	1	0	1
ENV	1	0	0	1
LEE	1	1	0	1
WES	1	1	1	1
RIJ	1	1	2	1
TRA	1	0	1	0
CR1	0	0	1	0
CR2	0	0	0	1
SOI	0	0	1	0
BAD	0	0	1	0
PRO	1	1	0	0
CIV	1	1	2	1
THE	0	0	1	0

Table 4 Data matrix (calibration Version B)

the first analysis with Version A of the calibration suggested that actions being performed either by the public or the private actor autonomously is possibly an important explanatory feature for assessing the satisfaction with how unplanned events are dealt with. Following these first results, the calibration was adjusted to Version B (see Table 3). The resulting data matrix is depicted as Table 4.

In the next two steps we organized these cases over the logically possible configurations in a truth table and assessed the outcomes associated with these configurations. This resulted in Table 5. The 'C' in the SATIS column indicates that cases disagree (i.e., contradict) on the outcome. The logical remainders are not included in this truth table.

In the final step we identified minimal configurations that are associated with the same outcome through pairwise comparison. Contradictory configurations were not included in this minimization process. The results are reported in Table 6.

EVENT	MAN	INTERA	SATIS	N	Cases
0	0	2	1	1	TUN
1	0	1	0	2	BI1, TRA
1	1	0	C	5	BI2, LAN, ZON, LEE, PRO
1	1	2	C	3	WAT, RIJ, CIV
1	0	0	1	1	ENV
1	1	1	1	1	WES
0	0	1	0	4	CR1, SOI, BAD, THE
0	0	0	1	1	CR2

Table 5 *Truth table*

Statement of sufficiency		Outcome
[1]	MAN{0}*EVENT{1}	SATIS{0}
Cases	BI1,TRA+CR1,SOI,BAD,THE	
[2]	MAN{0}*INTERA{0}+ EVENT{0}*MAN{0}*INTERA{2}+ EVENT{1}*MAN{1}*INTERA{1}	SATIS{1}
Cases	ENV+CR2 TUN WES	

Table 6 *Results of the truth table minimization*

Explanation of the results

The first solution is associated with low satisfaction. It states that in six of the eighteen cases, irrespective of the nature of the event, internal-oriented private management actions dealing with unplanned events are associated with low satisfaction. This is certainly the case for BI1, BAD and TRA were with low satisfaction. For the other three cases (THE, CR1 and SOI) where satisfaction was low. For the other three cases (THE, CR1 and SOI) where satisfaction is indifferent or moderate, this is less clear-cut. In these three cases it is reasonable to say that the events could not have been prevented by the contractor. This could explain the moderate or indifferent satisfaction expressed by managers in those cases. This may be different for the first three cases.

The second solution consists of three terms. The first term indicates that in two cases, irrespective of the nature of the event, internal-oriented public management actions dealing with unplanned events are associated with high satisfaction. In the case of dealing with the environmental interest group 'Kloar Loch' (ENV), the responsible public planning manager did not engage with the group during the legal procedure. He managed by the adage of 'anything you say can and will be used against you in the court of law'. In the case of the Crisis- and Recovery Act (CR2) this is a different story. Here the event is remote to the project and the internal-oriented management qualification reflects this.

The second term indicates that a remote event that is dealt with internal-oriented and in cooperation between principal and contractor is associated with high satisfaction. In this case (TUN), internal management strategies were oriented at anticipating the impact of the future legislation on the project. This event was considered by the respondents as a priority issue with a potentially large impact that could not reasonably be left to Avenue2 to be dealt with. This was recognized by both public and private partners, and this provided a good basis for public-private cooperation.

The third term indicates that a social, local event (i.e., from the project system) that is dealt with by external-oriented private management is associated with high satisfaction. In the case of the objections raised by landscape architect West8 (WES), some plan adjustments were made which resolved the issue without significant delays or budget overruns. Although this finding is only formally supported by one out of eighteen cases, it is corroborated by the first solution formula [1] which states that when private managers do not engage with the societal environment to deal with the issue (MAN{0} * INTERA{1}) this is associated with low satisfaction.

Arguably, these three statements of sufficiency towards high satisfaction can be said to be empirically quite weak. That is, although they are consistent (i.e., there are no contradictions on the outcome between the cases covered by them), the second solution formula is covered by only four of the eighteen cases, and the unique coverage of the individual solution terms is even lower. As explained in the QCA literature, this tradeoff between consistency and coverage is by no means uncommon (e.g., Ragin, 2008). Utilizing this tradeoff to fortify the empirical strength of our results, we performed an additional mvQCA where we included the contradictory configurations (see Table 5) in the minimization for SATIS{1}. Thereby we increased the number of cases covered by the solution formula [2] by eight (higher coverage), and simultaneously the inconsistency since the added cases BI2, LAN, ZON, LEE, PRO, WAT, RIJ and CIV do not all have a score of 1 on the outcome. However, only three of those eight cases do not score 1 (i.e., BI2, PRO, WAT) and none of those three cases has a score in the lowest category. Hence, arguably, including these eight cases in the minimization would yield lower consistency scores, but not significantly lower.

This additional mvQCA iteration produced somewhat similar results. The first and second terms of solution formula [2] in Table 6 remained unchanged. However, the third solution term that was solely covered by WES changed. It became more parsimonious since, logically, it does not matter whether interaction (INTERA) is autonomous public {0}, autonomous pri-

vate {1} or cooperative {2}; satisfaction is produced nevertheless. Hence, the INTERA condition is dropped from the solution term to yield the more parsimonious result: EVENT{1}*MAN{1} → SATIS{1}. In other words, 'social, local events that are dealt with by external-oriented management actions' is sufficient for high satisfaction. Thus, external-oriented management is an INUS condition; it is necessary for dealing with unplanned events, but not sufficient since it only coincides with a social, local event. Moreover, as indicated by the existence of the two other solution terms, there are other combinations of conditions that are also associated with high satisfaction.

Conclusions and discussion

We first conclude our analysis by evaluating which configurations of management actions and contexts produce what outcomes. Then we discuss the underlying results and provide interpretations and directions for future research. We finish our contribution by briefly discussing some methodological issues.

Conclusion

We were puzzled by the observation that sometimes a certain management strategy results in good outcomes and sometimes not and we set out to evaluate how events in infrastructure projects are dealt with, i.e., which configurations of management actions and contexts produce what outcomes. We constructed eighteen cases of managing unplanned events within the A2 Maastricht project and via a grounded and iterative research process we arrived at a number of results. Most importantly and contrary to the sometimes rather one-sided 'either/or explanations' in the infrastructure project management literature, we showed that context is crucial in explaining the different and sometimes contradictory results produced by management strategies. Sometimes internal-oriented and sometimes external-oriented management is associated with high satisfaction. This depends on the nature of the event, and/or of the cooperative relationship

between principal and contractor. In particular, (1) internal-oriented private management seems strongly associated with low satisfaction, (2) external-oriented management is strongly associated with high satisfaction in cases of social, local events, and (3) sometimes internal-oriented management is associated with high satisfaction, depending in particular on the nature of the cooperation between principal and contractor. Moreover, we showed that balancing management strategies actually entails a *mix* of often not-so-much balanced management actions *within* a project.

Discussion of results

We used the term 'associated' repeatedly instead of the more generally (mis)used 'caused' or 'resulted'. This is for good reasons. "QCA does not in itself open up the 'black box' of complex phenomena and processes. However, it rather acts like a flashlight that points at some crucial spots in the black boxes of the cases under investigation" (Rihoux *et al.*, 2009: 170). We have illuminated some spots, but many remain to be studied. Claiming causality, despite of the set-theoretic necessity/sufficiency nature of QCA, seems bold, especially since there are so many more potential explanations available. In addition, recognizing a certain pattern does not yet equal satisfactory explanation.

We pointed at a difference between cases that are covered by the first path associated with SATIS{0}. In all these cases, the event was dealt with by the contractor, but satisfaction was rather low nevertheless. This is not to say that when private managers deploy internal-oriented strategies, low satisfaction follows. As mentioned above, during the interviews some managers expressed indifference (both verbally and non-verbally) regarding some events (THE, CR1 and SOI). Some events are just impossible to influence or prevent. In other remote events, the perceived potential impact on the project's critical path (planning) is too big to ignore. This is most prominent for the development of the new tunnel standard (TUN). The need to anticipate this impact was felt by both Avenue2 and the Project Agency;

...lanned events in large infrastructure projects

respondents referred to the northerly A73 Roermond tunnel which, since its commissioning in 2008, is plagued by closures for safety reasons, resulting in traffic jams. With this snafu in mind, principal and contractor want to build a safe tunnel but not at the expense of construction delays and cost overruns. Indeed, the idea that the city has to endure the discomforts of the construction works after 2016 is deemed undesirable. The shared sense of urgency seems to have provided a good basis for contractor and principal to cooperate in this case (cf. Verweij, 2012). The same line of reasoning can be said to apply to the crisis (CR1): there is a large potential impact and there is a shared desire for real estate development. However, in this case, Avenue2 plans to develop the real estate in a 10-year period between 2016 and 2026, so respondents think that there is enough flexibility to deal with the crisis. This discussion points at an additional explanatory condition: perceived potential impact on the critical path of construction.

Another possible condition underlying the differences within the first path associated with SATIS{0} may be the extent to which the contractor had a (too) strong a focus on design and planning issues (BI1, TRA and BAD). Encouraged by the deadline-driven nature of new types of public-private partnership contracts, contractors tend to focus on making rapid progress thereby sometimes losing sight of the local, social environment in which a project is embedded. This may backfire on the project's process. However, this does not seem a big issue here since the A2 project enjoys local public and societal support given its clear added value for the city and its citizens. But in more contested infrastructure projects this may be a whole different story. Support for a project may also be an important condition to include in further studies that compare projects.

The second solution formula [2] indicates that sometimes, internal-oriented management strategies are associated with higher satisfaction (ENV, CR2 and TUN). Although, the cases associated with these two configurations are quite diverse, they seem to have in common that they have a potentially large impact on the project's development. The TUN case was

discussed above. For the ENV and CR2 cases, as public planning and procurement were interwoven (Van Valkenburg & Nagelkerke, 2006) and the bidder was selected before the public planning was finished, changes in the public zoning and Route Decision plans may result in a failed procurement and high costs since the bidder was already selected. Hence, there was relief when the Council of State declared the public plans irrevocably.

Finally, as concluded in the previous section, the analysis showed that external-oriented management is strongly associated with high satisfaction and that the opposite is often the case for internal-oriented management. However, it should be kept in mind that this could be concluded after including two logically contradictory configurations. Hence, the question remains what explains these two contradictions, although the contradictions are not very strong. Nevertheless, what the three cases with indifferent or moderate satisfaction (BI2, PRO and WAT) seem to have in common relative to the five other cases is that respondents expressed their satisfaction in terms of missed opportunities to involve particular actors in the planning of the projects. Not involving Prorail (PRO), the Waterboard (WAT) and the Cyclist Union and municipal council (BI2) respectively was perceived to have caused the events in the first place. This suggests the importance of involving stakeholders in the planning phase.

Final reflection on the method

Previously, we developed QCA as a complexity-informed approach to evaluate infrastructure projects (Gerrits & Verweij, 2013; Verweij & Gerrits, 2012; 2013). We used this approach here to evaluate the management of the A2 Maastricht project. In addition to our findings we hope to have contributed a systematic and transparent evaluation approach. On the one hand it appreciates the uniqueness, diversity and contextual nature of projects, and on the other hand it appreciates the need for patterns. This is imperative so as to transfer lessons of individual case analyses to future projects. On that note, some final remarks need to be made. First, the time dimension,

which is inherent to any complexity-informed perspective in some way or another, is strongly underexposed in QCA approaches. In our analysis we have carefully paid attention to time by constructing the cases in such a way that the event is chronologically prior to the other three conditions (MAN, INTERA and SATIS) in each case. Moreover, time is also expressed in the qualitative interpretation. Nevertheless, QCA is an approach that is weak on researching the dynamics of cases such as infrastructure projects (Verweij & Gerrits, 2013). Second, we decided to work with mvQCA. This is arguably not the best method for any evaluation. What to use, e.g., csQCA, mvQCA or fsQCA, ultimately depends on the conditions to include in the analysis and how these are best calibrated. Crisp, multi- and fuzzy sets all have some distinct disadvantages and advantages (Schneider & Wagemann, 2012; Thiem, 2013; Vink & Van Vliet, 2009; 2013), as do the different software packages related to those methods (see www.compasss.org for an overview). Finally, through the iterative processes of data-collection, coding and casing, we arrived at a certain set of conditions to be included in the QCA process. Other projects with different characteristics, and other methods and techniques of data collection may result in a different set of conditions. However, this does not invalidate in any way the usability of the approach we introduced here for researching diversity and patterns in infrastructure development.

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