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Project-Based Organizations

The right configuration

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1. Introduction

1.1. Project-Based Organizations

The world is increasingly Volatile, Uncertain, Complex and Ambiguous, or VUCA, according to both scientific sources (Mack et al., 2015) and business press (Bennett & Lemoine, 2014; Kraaijenbrink, n.d.). These developments have an impact on organizational structures. The more classical matrix- and functional organizations typically perform well when it is possible to generate economies of scale based on a predictable production process in a stable environment (Hobday, 2000; Nightingale et al., 2011). These circumstances are likely less prevalent, or completely absent, the more VUCA the circumstances the firm operates in get. Different organizational forms and structures are needed in a VUCA world.

One form that is better suited to VUCA circumstances are projects. Projects are better suited to deal with these circumstances because they are capable of dealing with nonroutine complex tasks that require the repeated reconfiguration of organizational structures. Projects can respond in a flexible manner to changing production requirements and they allow the integration of diverse bodies of knowledge (Nightingale et al., 2011, p. 216). Correspondingly, a rise in the amount of Project-Based Organizations (PBOs) is visible in recent years (Bakker et al., 2016; Cattani et al., 2011; Nightingale et al., 2011).

PBOs are organizations that perform their primary processes in projects (Bakker et al., 2016). So that while the organization as a whole is a permanent entity, major parts of the organization are temporarily bound. Temporarily bound means that there is a predetermined moment at which the entity will cease to exist (Cattani et al., 2011, p. XVI). No such point exists for the more classical organizations or the organization as a whole in a PBO. A PBO can thus be called a "semi-temporary organization" (Bakker et al., 2016, pp. 3, 4).

The increase in PBOs has also led to an increase in the study of PBOs. Manning and Sydow have shown how PBOs use so called "collaborative paths", which are sequences of projects that are connected through task and team properties, to allow a measure of stability and continuity across different projects (2011, p. 12). Others have studied which characteristics make certain firms more successful at being a PBO than others (Nightingale et al., 2011), how (strategic) management of a PBO differs from that of a classical organization (Cattani et al., 2011), how learning and the retention of knowledge and skills work in a PBO (Prencipe & Tell, 2001) and what types of PBOs are expected to be prevalent in which industries (Whitley, 2006). These studies, however, are mostly based on theoretical concepts and/or general characteristics of PBOs. They aim to clarify how PBOs function and describe certain aspects of PBOs. These studies rarely explicitly include financial performance (Bakker, 2010). This thesis does explicitly include financial performance and makes it the main outcome of interest. By doing so it fills a gap in the literature and gives insights into which configurations lead to high financial performance.

Following Whitley's study (2006) on the different types of PBOs, this thesis uses two dimensions to identify PBOs. These two dimensions are internal structure and external focus. Internal structure relates to characteristics like which skills are present and the amount of temporary employees. External focus relates to the types of projects, types of clients and sectors in which the firm operates. Additionally, two contextual factors are included: time and size. All these concepts will be expanded upon in later chapters. This thesis will study how different configurations of these dimensions of PBOs affect a firm's financial performance.

In order to do that, a Neo-Configurational perspective is adopted. This perspective has recently gained popularity to study organizational configurations because it enables the study of a configuration in a holistic way by looking at configurations as a set. It is also possible to include causal complexity in the analysis by adopting this perspective (Misangyi et al., 2017, pp. 1–4). While a more classical (multiple) regression method could be used to model the dimensions of the PBO and the firm's financial performance, this would study each of these dimensions independently. In such a regression analysis, any interaction effects that go beyond a two-way interaction are exceedingly difficult to interpret (Fiss, 2007, p. 1182). The study therefore would not include or make very difficult to include aspects of causal complexity like conjunction, equifinality and causal asymmetry (Misangyi et al., 2017). It also would not enable a study of the holistic set of characteristics, but only the individual contributions of each element and their interactions.

As the Neo-Configurational perspective also has not yet been used to study PBOs, using this approach will therefore lead to new insights into both theory and practice. By using this holistic, set-based, approach, this thesis captures not the effects of each individual element, as would happen when using a more traditional regression analysis, but the effects of the complete set. This allows us to review the different variants of PBOs in their entirety. A more in-depth explanation of the Neo-Configurational perspective is included in later chapters.

1.2. Research goal and question

The research goal of this thesis is to further understanding on how internal structure and external focus of project-based organizations impact financial performance, by using a Neo-Configurational perspective. To achieve this goal, the following research question has been formulated:

How do the configurations of internal structure and external focus of project-based organizations impact financial performance?

1.3 Framework and setting

To answer this research question, data on PBOs is needed. This data is collected from the trade association of Dutch architectural firms (Branchevereniging Nederlandse Architecten, BNA). The BNA was chosen because it surveys roughly 1100 architectural firms every year, and thus provides us with a dataset on a whole industry. Architectural firms are a good example of a PBO because their main products are made in projects, but the organizations as a whole is permanent. The projects are the designing of buildings, which has a predefined start and end. The survey the BNA sends out also provides detailed insights into the internal structure and external focus of its members and their financial performance. This makes the data gathered in this survey suitable to use to answer the research question.

1.4 Relevance

The relevance of this study is twofold: it is both scientific and practical. Scientific relevance is defined as in what measure the knowledge gained in the study contributes to the existing knowledge about the subject. Practical relevance is defined as what the knowledge gained in the study contributes to solving current issues in society (Thiel, 2010, pp. 21, 22).

As stated above, this thesis fills a gap in the literature in two ways. The first way is that it studies PBOs financial performance in relation to the internal structure and external focus. This inclusion of financial performance is relatively novel, as previous studies often do not include it (Bakker, 2010). By including financial performance, the results give insights into what kind of configurations are likely to contribute to a firm's success. Understanding how these configurations impact performance is scientifically relevant because firms need to perform in order to persist. A theoretical understanding of PBOs that does not take into account performance is incomplete at best. The second way that this thesis is scientifically relevant is that it uses a Neo-Configurational perspective (NCP) to study PBOs. The NCP allows for a holistic, set-theoretic analysis of the configurations of PBOs. This means that the interdependences and interactions between the various parts of the configurations are explicitly included in an analysis that enables causal complexity to be fully studied. Because studying the different factors that enable or inhibit financial performance is complex, using a method that enables a holistic study of this complexity is both fitting and relatively new in the research field. These two aspects are the main scientific relevance of this study.

Practically this thesis contributes to a growing body of knowledge about PBOs. Since, as stated at the start of this chapter PBOs are increasingly prevalent type of organisation, an increase in knowledge about PBOs helps people like managers and project leaders make (more) informed decisions. Specifically the coupling of internal structure and external focus with financial performance will give new insights as to what set of characteristics is likely to be profitable. A second way in which this study is practically relevant is because it gives insights into which sets are not or underused in practice. This informs people who design and manage PBOs about possible new ways of structuring PBOs. Since this thesis uses data from the BNA, these insights will apply the strongest for architectural firms in the Netherlands. In what way the knowledge gained in this thesis is generalizable will be discussed in the chapter five.

1.5 Structure of the thesis

In chapter two the theoretical framework will be expanded upon. Chapter three consists of the methodology and addresses aspects like research ethics, research limitations and data description. In chapter four the analysis is conducted, which will be followed by the conclusions and discussions in chapter five.

2. Theoretical background

This chapter develops the conceptual model. This model is the basis for the analysis in chapter four, the viewpoint from which the data will be analysed. The conceptual model is based on theories and concepts. For this thesis, two main perspectives are distinguished. The first is the literature on Project-Based Organizations (PBOs), the second is the literature on the Neo-Configurational Perspective (NCP). The PBO perspective provides the substantive theoretical knowledge about what are important aspects to consider when studying PBOs. The NCP perspective adds to this first perspective by offering a specific way of looking at this substantive theoretical knowledge. In this thesis this is called the NCP lens, the way to look at the theoretically important aspects of the cases being studied. The literature on PBOs will be discussed first, followed by that on the NCP.

2.1 Project-Based Organizations

PBOs are (semi) temporary organizations, but what exactly are temporary organizations? In 2010, Bakker wrote an article in which he provided an integrative framework on temporary organizational forms. This paragraph briefly summarizes this framework, in order to establish the characteristics of temporary organizations.

Bakker defines temporary organizations as “a set of organizational actors working together on a complex task over a limited period of time” (2010, p. 468). Notably this definition excludes temporary employment from necessarily being tied to temporary organizations, people might well be permanently employed, but working on this specific task for a limited period of time. This is relevant and important because this structure of permanent employment, combined with temporary tasks is prominent among PBOs (Bakker, 2010, p. 469).

There are four core concepts when studying temporary organizations according to Bakker: time, team, task and context (2010, p. 472). These concepts differ from the concepts used in classical, permanent organizations. For permanent organizations these concepts are survival, goals, working organization and production processes and continual development (Lundin & Söderholm, 1995, pp. 438, 439). For a detailed review of how and why these concepts differ, see Lundin and Söderholm (1995) and Bakker (2010). For this thesis it is important to note that PBOs have to deal with all eight of these concepts to varying degrees. At the firm level survival, goals, working organization and production processes and continual development are important to strive for, but at the project level time, team, task and context are to be taken into account. These concepts are directly mirrored, so survival is for a permanent organization, what time is for a temporary one. These differ in the following way: a permanent organization will strive to exist permanently, to survive without end, a temporary organization has a predefined point at which it will cease to exist. For a PBO this means that the organization as a whole strives to survive without end, whereas the individual projects have a predefined endpoint. This exemplifies the semi-temporary nature of the PBO.

As was stated in the introduction, PBOs are organizations that perform their primary processes in projects (Bakker et al., 2016). PBOs are formed when an entire organization is structured around distinct projects. In general, PBOs focus on highly skilled workers dealing with complex problems to create novel outputs by integrating varied expertise within a fixed timeframe (Whitley, 2006).

These are all general themes among PBOs, but PBOs also do vary quite a bit. These variations can be understood by considering two dimensions: the internal structure and the external focus. These dimensions are the core of the theoretical framework of this thesis and the subject of the next paragraphs.

2.1.1 Internal Structure

Internal structure relates to the way the organization of both the PBO as a whole, as well as its projects are staffed and how much focus or differentiation there is in this staffing. This dimension thus has two aspects: the Employee Skills in the organization and the Workforce in the organization. The employee skills in the organization can be understood as how many different roles there are in an organization. An organization that has only architects has a different internal structure than an organization that has architects, project managers, construction supervisors and project support staff. Proportionality has to be factored in here as well. A PBO with 100 employees that has 80 architects, 5 project managers, 5 construction supervisors and 5 project support staff is less differentiated than a PBO with 20 employees which has 5 of every type.

The second aspect of the internal structure is the measure in which these employees and roles are stable over time and over projects, which is the workforce of the PBO (Whitley, 2006, p. 81). This can be studied by looking at how employees are hired. A company with a lot of permanent contracts is more stable in this aspect than a company with a lot of employees on temporary contracts. Again, proportionality has to be considered. So the percentage of employees with temporary vs permanent contracts, instead of just the absolute numbers.

These two aspects are part of the dimension internal structure which is used in this thesis to study PBOs. This dimension ranges from stable to differentiated. Exactly how the scores on dimensions are determined will be discussed in chapter 3. A conceptual model which includes this dimension is shown in Figure 1 below.

2.1.2 External Focus

External focus relates to which kinds of tasks the PBO undertakes for which market(s) and how much focus or differentiation there is in both of these (Manning & Sydow, 2011; Whitley, 2006). This dimension again has two aspects: Tasks and Markets. Tasks relates to the parts of the project the PBO performs. A PBO might specialize in doing only the initiation of a project or perform all stages of the project on its own. These two extremes are a difference in what the PBO focusses to do. Again, proportionality has to be considered, it is easier for a bigger PBO to do many things, but that does not mean that its focus is truly differentiated. So the percentages and not the absolute numbers have to be considered.

The markets a PBO services can also be but a few or a great many. A PBO that works for individuals, corporations, the government and other firms in related sectors has a more differentiated external focus than one that mostly or only works for housing corporations. The higher the share of different markets a PBO services, the more differentiated the external focus of that PBO is.

These two aspects are part of the dimension external focus, the second dimension used in this thesis to study PBOs. Similar to the first dimension, this dimension ranges from stable to differentiated. The conceptual model showing both these dimensions is shown in Figure 1 below.

2.1.3 Model of the dimensions

In previous paragraphs the two dimensions through which PBOs will be analyzed have been elaborated on. These are the internal structure and the external focus. Both these dimensions range from stable to differentiated. Combining these dimensions in a simple model gives us Figure 1. This is a model akin to Whitley's, who used a similar structure to define the four ideal types of PBOs (Whitley, 2006). In this thesis this model is the baseline for the theoretical framework. The next steps are to include contextual factors and performance. The contextual factors used in this thesis are Time and Size. Once Time, Size and Performance are added the model will be re-evaluated by looking at all these dimensions from Neo-Configurational Perspective.

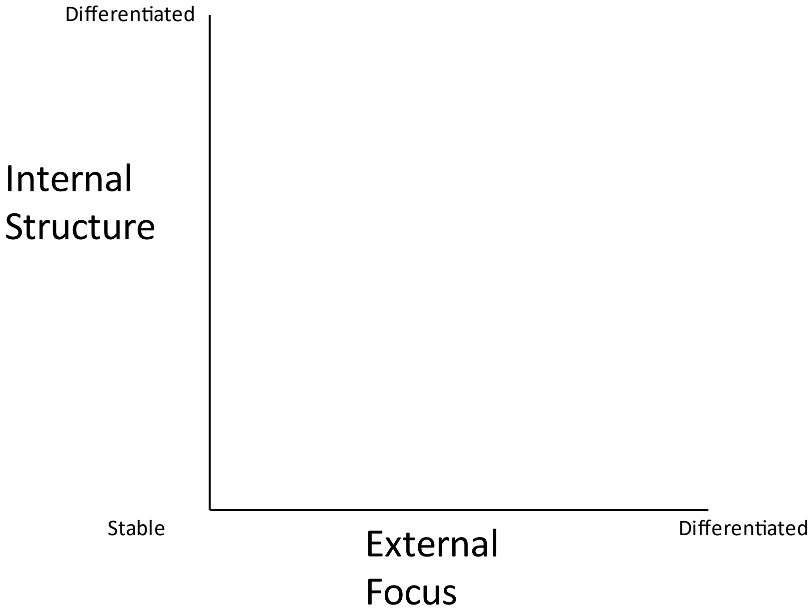

Figure 1: The Two-Dimensional Framework

2.2 Contextual Factors

There are two contextual factors that are included in this thesis: Time and Size. These factors are included because they have a great potential impact on performance. By including these contextual factors their potential impact is explicitly taken into account. How Time and Size impact performance will be discussed in the paragraphs below.

The effect of Size on performance is one of fit, as Amah, Daminabo-Weje and Dosunmu explain in their paper (2013). This means that there is a relation between certain sizes and certain related benefits. Boiled down to its core, large corporations have economies of scale effects and more resources to spend, while smaller companies enjoy higher flexibility and more simplicity in doing business. It thus makes sense to be a large corporation when you can leverage the benefits of economies of scale and having a large amount of resources, if that fits with your business objectives and means of production. Conversely, if flexibility and simplicity are things that increase your ability to perform well, it makes sense to be a smaller company. Size thus is a contextual factor that influences performance, this influence depending on if the size of the organization fits the business model (Amah et al., 2013). Size might also interact with the Internal Structure and External Focus, since different sizes might influence the configurations performance in different way (see: asymmetry in paragraph 2.2). Exactly what this relation is, will be explored in the analysis. In this thesis Size is factored in as a dimension that ranges from small to large.

Time is the second contextual factor in this thesis. Making just a snapshot of the current state of affairs might not be an accurate representation of the longitudinal internal structure and external focus of a PBO. A study of these dimensions should thus include multiple years and study how things either vary or stay the same. This is done by including the Time dimension. The Time dimension is related to both the internal structure and the external focus dimension. So both the internal structure and the external focus are considered in context of the time dimension. More precisely, the variation in both dimensions is considered. If a firm has a very stable internal structure and external focus over multiple years, the Time dimensions is very focussed. Important to note is that if a firm has a very differentiated internal structure and external focus over multiple years, then it also is focussed on the Time dimension. There is, after all, a consistency over the years, the firm is consistently differentiated, it has a focus on differentiation. On the other end of this spectrum, a firm that has changed aspects of its focus or structure is less focussed over time. In the time dimensions the other end of the spectrum is dynamic, so the dimension ranges from focussed to dynamic. The notion of a focus on differentiation is linked to the concept of economies of recombination, which is a term coined by Manning and Sydow (2011), which will be discussed in the next paragraph about performance.

2.3 Performance of PBOs

Though there are many studies on the various forms of temporary organizations, many of these do not explicitly include financial performance. Even when they do, it is usually aimed at the project or team level, and not at the firm level (Bakker, 2010). This study does explicitly include what effects the different configurations of the dimensions have on financial performance. Financial performance will be considered as either being high, or not being high. Exactly why and how this is done will be discussed in chapter 3.

Financial performance links up with the other dimensions in multiple ways. It has been shown that PBOs use so called *Collaborative Paths* to allow both exploiting established but also exploring new resources and capabilities while actively bridging periods of latency in sequences of projects (Manning & Sydow, 2011, p. 1371). Collaborative paths can enable firms to either build upon previous formulas, or explore new possibilities. This indicates either a narrow collaborative path, or a wide one. Narrow collaborative paths boost what are called the economies of repetition, in which learning effects lead to increased performance based on efficiency. Wide collaborative paths boost the economies of recombination, in which learning effects lead to increased performance based on innovation (Manning & Sydow, 2011). Economies of repetition are of course linked to economies of scale and exploiting current resources, which as was stated in the paragraph on Size, are benefits linked to larger organizations. The narrow collaborative path thus theoretically links up well with a larger organization that is stable over time. Economies of recombination are linked to a differentiated internal structure and external focus and dynamism over time. The logic behind economies of recombination is that a wider collaborative path enables innovation and reaps the performance benefits of being creative in that way (Manning & Sydow, 2011). This of course also links up with the benefits of a smaller business mentioned in the paragraph on size: flexibility and simplicity. The expectation is that if the internal structure, external focus and contextual factors create the right synergy, exploiting the right kind of *economy*, that configuration should lead to higher performance. The analysis in chapter 4 will show if this is the case.

This concludes the theoretical perspective on PBOs used in this thesis. In the next paragraphs the Neo-Configurational Perspective is detailed and used to integrate the five dimensions (Internal Structure, External Focus, Time, Size and Performance) into the conceptual model used in this thesis.

2.2 The Neo-Configurational Perspective

The Neo-Configurational Perspective (NCP) is a relatively new perspective, but it is based on the configurational approach which has a longer history in the organizational sciences (Meuer & Fiss, 2020; Misangyi et al., 2017). This paragraph will briefly state the history of the NCP. Afterwards, the so-called NCP lens and its application in this thesis will be explained.

The configurational approach has been prominent in research on organizational design since the 1970s and also was apparent in the Systems Thinking schools of thought in the 1960s. A core element in both of these is to conceptualize organizations as complex systems whose outcomes cannot be inferred from analysing their constitutive parts in isolation. The concept of causal complexity is another important feature of the configurational approach. Causal complexity consists of three aspects: conjunction, equifinality, and asymmetry. Conjunction means that outcomes are the result of multiple interdependent conditions. Equifinality means that there are multiple differing causes that lead to the same effect or outcome. Asymmetry means that the presence of an attribute might both cause the effect and its absence, given different configurations of attributes. By including causal complexity, a more in-depth and holistic analysis of outcomes is made possible (Meuer & Fiss, 2020; Misangyi et al., 2017).

In the late 1970s configurational insights were used to study archetypes of organizational structures, strategies and external conditions as configurations to study which of these archetypes lead to greater performance under which external conditions. Important to note here is that all these elements were studied as sets of characteristics, not in isolation. The 1990s saw the publication of the first foundational works of the NCP as a theoretical framework. In these works the link between the coherence of organizational and environmental elements and organizational effectiveness was made. These works explicitly focussed on integrating causal complexity directly and overtly, but lacked a clear methodology to do so (Meuer & Fiss, 2020; Misangyi et al., 2017). For a more detailed historical perspective of the NCP, see Mysangyi et al (2017).

These developments in the configurational approach then met with the so called Qualitative Comparative Analysis (QCA) methodology as developed by Charles Ragin (Misangyi et al., 2017, p. 4). QCA was a novel configurational approach which was initially developed to study sample sizes too small for regression, but too large for systematic cross-case comparisons. It has since been adapted to also be applicable to larger sample sizes. QCA is uniquely suited to study causal complexity. By applying QCA in combination with the configurational elements as mentioned above, the NCP was born (Misangyi et al., 2017, p. 5). This thesis uses QCA as a methodology, which will be discussed in the next chapter.

The NCP is thus a combination of earlier configurational approaches, which embraces causal complexity at its core, and a novel methodology which enables the study of causal complexity. This embrace of causal complexity is a strong deviation from the dominant linear regression methodology in organizational studies. The differences between these approaches will be expanded upon in the next chapter. The next paragraph will describe the elements of the NCP way of looking, the NCP lens.

2.2.2 The NCP Lens

The NCP lens is strongly based on a set-theoretic approach of causal complexity. What this means can be explained by looking at what Mysangyi et al. characterize as the four distinctive elements of this lens: conceptualizing cases as set-theoretic configurations (1), calibrating cases' memberships into sets (2), viewing causality in terms of necessity and sufficiency relations between sets (3), and conducting counterfactual analysis of unobserved configurations (4) (Misangyi et al., 2017). These elements will be elaborated on in this paragraph.

The first element of the NCP lens is to conceptualize cases as set-theoretic configurations. This means they are conceptualized as combinations of theoretical attributes of interest rather than as a disaggregation of their attributes that are treated in isolation from each other (Fiss, 2007; Misangyi et al., 2017). The lens thus does not consider individual parts of any case, but the entire configuration as a whole. It is a holistic approach in which the sum is not just the combination of the parts. Theory is used to conceptualize causal attributes and outcomes of interest as sets and also to examine the relationships between attributes and outcomes. This is done by using a set-theoretic analysis of subset relations (Fiss, 2007). In these set-theoretic conceptualisations, causal complexity is an important factor. That is to say, different causal recipes are considered. Different attributes might combine to produce a certain outcome (conjunctional), different sets might lead to the same end state (equifinality) and the same attributes being absent and present might lead to the same results, depending on what other attributes are present (asymmetry). This conceptualization as set-theoretic configurations of cases is the baseline of the NCP lens.

The second element of the NCP lens is to calibrate cases' memberships into sets (Fiss, 2007; Misangyi et al., 2017). By deriving meaningful standards for calibration from theory or other knowledge, thresholds for set calibration are developed. This way cases can be measured to be inside certain sets or not. These thresholds are often derived from qualitative theoretical knowledge, but also quantitative data can be used as the basis for the measurement in the analysis. Important to note is that there is a lot of freedom for the research to determine these thresholds. The researcher thus has to describe all choices made in a transparent manner in order to assess the validity of these thresholds and be able to replicate the research design. Set memberships can be calculated in a 'crisp' manner, in which a case is either fully in a set or not, or in a 'fuzzy' manner, which includes different degrees of membership (Fiss, 2007; Misangyi et al., 2017, pp. 8, 9).

The third element of the NCP lens is to view causality in terms of necessity and sufficiency. Causal complexity and its three elements have already been mentioned, but there is another element of causality that is examined through the NCP lens. By using two general analytic strategies, commonalities are examined to determine which attribute(s) are necessary and which are sufficient (Misangyi et al., 2017, p. 10). An attribute being necessary means that all cases experiencing the outcome have the attribute present, but that not all cases that have the attribute experience the outcome. Necessary attributes often lead to situation of asymmetrical causality, as explained above. An attribute being sufficient means that all cases possessing the attribute(s) must experience the outcome. An analysis of sufficiency among attributes can lead to insights into possible equifinality (Fiss, 2007).

The fourth and final element of the NCP lens is to conduct a counterfactual analysis of unobserved configurations. This means investigating if there are logically possible but empirically unobserved configurations. This is done by using a Boolean chart known as a 'truth table' to capture and examine all logically possible combinations of attributes and comparing this to the empirically present combinations (Fiss, 2007; Misangyi et al., 2017). There are two types of counterfactuals that can be distinguished. Easy counterfactuals are consistent with empirical evidence and theoretical knowledge, while difficult counterfactuals are consistent with empirical evidence but not with theoretical knowledge.

This paragraph has stated and explained the four core elements of the NCP lens. In the next chapter the exact application of these elements will be discussed. The next paragraph will detail what this lens contributes to this thesis.

2.2.3 The NCP lens in this thesis

In this thesis the NCP lens will be used to consider the dimensions and aspects mentioned earlier in this chapter. That means that the cases studied are conceptualized as sets of characteristics, after which the different causal recipes are considered. These causal recipes are configurations of the dimensions. By considering these configurations in a holistic way, the effect of the entire set is studied instead of the effect of the individual dimensions. It also allows for the study of potentially missing or underrepresented configurations, based on the theoretical framework.

By adopting the NCP lens, this thesis embraces such a holistic perspective, in which causal complexity is explicitly studied. That has implications for the conceptual model. The model shown in Figure 1 captures the first two dimensions. To include the other dimensions in a similar way the model would have to increase in complexity exponentially. The model in that form also does not include the configurational aspect. A new model is thus needed that includes all the dimensions and the configurational nature of the framework. This model is shown below in Figure 2. Central in this model is the configuration of the PBO. This configuration consists of the dimensions internal structure, external focus and time. These are the dimensions as discussed previously in this chapter. These configurations are then studied to see if they lead to high financial performance, which is depicted on the right side of the model.

This model is the conclusion of the theoretical perspective used in this thesis. In the next chapter, the link between the NCP lens and Qualitative Comparative Analysis (QCA) will be discussed. By applying QCA to this model, the methodology of this thesis is formed.

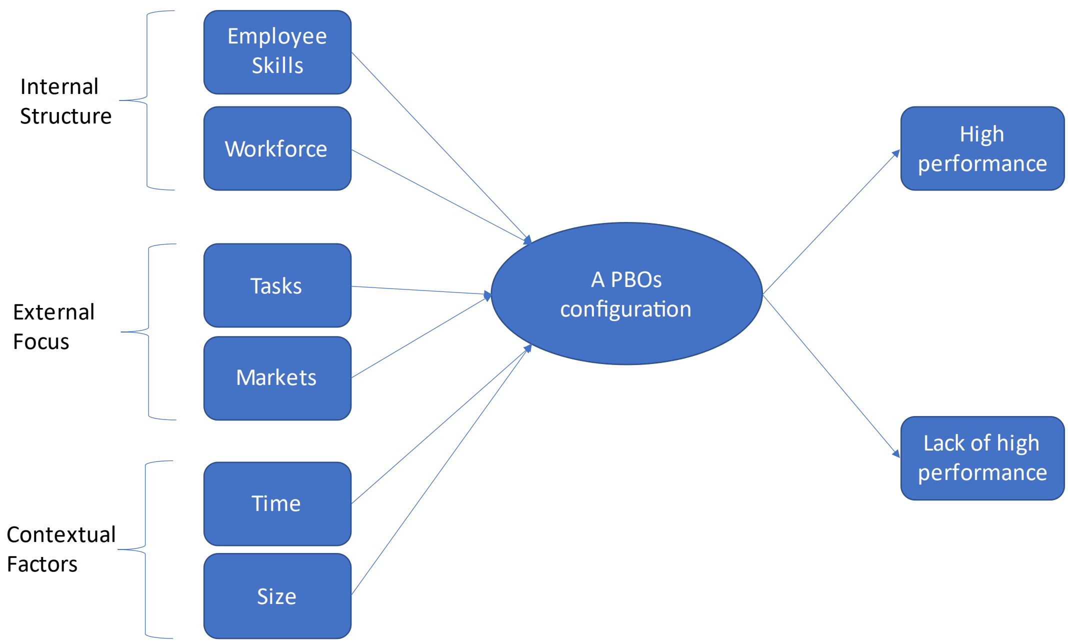

Figure 2: The Conceptual Model

3. Methodology

Qualitative Comparative Analysis (QCA) is the methodology used in this thesis. As was stated in the previous chapter, QCA is closely linked with the Neo-Configurational Perspective (NCP). Both take a holistic perspective and consider cases as configurations of sets (Fiss, 2007; Misangyi et al., 2017). The QCA methodology is suited to answer the research question because it aligns with the NCP and enables answering the research question by providing a clear framework which embraces the set-theoretic and holistic perspective which is central in this thesis. QCA has 6 steps: Building the configurational model (1), Constructing the empirical sample (2), Calibrating the data (3), Analysing the data (4), Evaluating the robustness of the findings (5) and Reporting and interpreting the findings (6) (Greckhamer et al., 2018). Chapter two contains the first step and has provided the configurational model. This chapter will perform steps 2 and 3. In chapter four steps 4 and 5 are discussed and chapter five concludes with step 6. In addition to the aforementioned steps, this chapter includes ethical considerations of this thesis.

3.1 Constructing the Empirical Sample

After constructing the configurational model, the second step in QCA is to construct a theoretically relevant sample to study. This sample has to be able to support answering the research question (Greckhamer et al., 2018). In this thesis the empirical sample is drawn from the Branchevereniging van Nederlandse Architecten's (BNA) yearly survey of its members. This survey is sent to its roughly 1100 members and is called the BNA Benchmark. As organizations architectural firms are relevant to study to answer the research question. This is because they often operate on project basis, with many different projects, over many different sectors (Lieftink et al., 2019). The BNA survey lists 10 different main sectors their members are likely to be involved in. The projects themselves also are quite varied, both in content and in which parts of the process is tackled by the individual firms. The BNA survey lists 6 different segments of projects a firm can perform. Architectural firms thus have a variation in sectors they operate in and segments of projects they can perform. Internally, architectural firms also vary a lot. Some firms focus purely on designing, while others include supervision, management or concessions (BNA, 2020). Architectural firms thus vary both in external focus and internal structure and are considered project-based organizations, which makes them suitable as an empirical sample for this thesis. The benchmark also includes data over multiple years. The data collected in the BNA benchmark is thus purposively collected and is suitable to use to answer the research question, an important aspect of constructing the empirical sample (Greckhamer et al., 2018).

The data collected in this survey from 2017 and 2018 will be used in this thesis. In total these two years include 168 cases. After removing companies that only participated in one year, 48 unique companies are left. These companies will be the empirical sample used in this thesis. The data was provided to the researcher by the Radboud University and is completely anonymous.

The configurational model as constructed in chapter two has to be applied to this empirical sample in order to answer the research question. The model contains four main conditions (Employee Skills, Workforce, Tasks and Markets) and two contextual factors (Time and Size). The following sections considers how these are used in the constructed empirical sample and concludes with a correlation table, table 1, and a calibration table, table 2.

The Internal Structure as defined in the model consists of two conditions: Employee Skills and Workforce. Employee skills is defined as the proportional number of different roles there are in the organization. So when Employee Skills is high, there are a lot of different jobs in a company, whereas if it is low, there are only a limited number of different jobs. To measure this condition, the data on different jobs as supplied in the BNA Benchmark is used. The different job types listed in the Benchmark are: architect, technical design/draftsmen, calculation, project leaders/coordinators, construction supervision, other project employees, office management and other support functions. The spread of employees over these different jobs defines the employee skills an organization.

Workforce is the second condition in the Internal Structure dimension. This condition is defined as the stability of roles within the organization as a whole. To measure this condition, the data about temporary employees and detached employees as supplied by the BNA Benchmark is used. These numbers will be made proportional to the overall workforce of the organization, so that the relative stability is measured.

The second dimension, External Focus contains the Tasks and Markets conditions. Tasks is defined as the part(s) of the project that the firm performs. To measure this condition, the data on the different positions firms fills in a project as supplied by the BNA Benchmark is used. The different positions include: initiative/preliminary research, only design, from design to building permit, from design to esthetical guidance, from design to directing and other. The more different phases of a project the firm does, the more differentiated the tasks are and the higher the value on Tasks is.

Markets is the second condition in the External Focus dimension. This condition is defined as the number of different sectors a firm services. To measure this condition, the data on the amount of income made per sector as supplied by the BNA Benchmark is used. The more markets a firm services, the higher the value on the Markets condition is.

These first four conditions all range from stable to differentiated. To measure the level of differentiation, the Herfindahl-Hirschman Index (HHI) is used for all categories except workforce. Why workforce is not included will be explained later in this paragraph. The HHI index, which is also known as Blau's index, is the sum of the squared percentage on the categories per condition (Harrison & Klein, 2007). In this thesis the value used is 1-HHI. This is done so that a high value correlated with a high spread. To illustrate this, let us consider the following: If the firm's tasks is equally divided over four of the six categories of the 'Tasks' condition, the 1-HHI value would be $[1-(0.25)^2+(0.25)^2+(0.25)^2+(0.25)^2+(0.0)^2+(0.0)^2] = 0.75$. 1-HHI values range from 0 to (# categories – 1)/# categories. The value increases as the spread across the categories gets more equal. It is important to realize that the maximum value of the HHI across the conditions differs. This is why the HHI values are indexed in a following step in this paragraph: to make sure they are all plotted on the same scale.

The HHI will be used in this way for the Employee Skills, Tasks and Markets. Workforce is different because calculating the spread for just two categories is not meaningful. A simple percentage is enough to supply the required information. See table 2 for more details on these categories.

Having defined the main conditions, it is important to consider how they are used in this thesis. As stated above, most conditions use the HHI and are concerned with the spread on a variable. Since data of two different years is used to include variation across the years, two different procedures are used. As a baseline, all main conditions are indexed so that the variations are weighed equally and it is easier to make comparisons of both averages and variance. The first procedure is to average out the HHI (or in the case of Workforce the average) of both years of data (2017 and 2018). This means that the values are added together and divided by two. The resulting values are used for the four main conditions in this thesis: Employee Skills, Workforce, Markets and Tasks.

An average, however does not say much about the spread (and thus the variance) between years. To include this variance, the condition Time is used. Time is measured by considering how many changes there are on the first four conditions when comparing the data of the two years. Time is configured to be the difference in absolute terms of all the main conditions. This is done by adding up these differences and averaging them out.

The final condition is Size, which looks at the number of FTEs a firm has. Size is a contextual factor and the values used here are directly supplied by the BNA Benchmark. Since 2018 is the year of which the outcome of interest is used, the Size values of 2018 will be used as a contextual factor.

All of these conditions, their mean, median, standard deviation, minimum and maximum value as well as their correlations are included in Table 1. Generally, there are few correlations, which indicates that there is no major covariation between the variables. There are some exceptions though. At the 0.05 level the following significant correlations are found: Market and Task, Time and Task, Size and Workforce, Size and Tasks and Size and Market. The correlation between Size and Workforce the only one that is significant at the 0.01 level. Logically that means that there is a significant connection between the spread of different roles in a company increases and the amount of people working in the organization increases. These findings are an indication that there is some correlation between the variables used. This is promising for this study that embraces causal complexity by analysing different configurations of the variables.

Variable	*n*	*M*	$\tilde{X}$	*SD*	*Min*	*Max*	1	2	3	4	5	6	7
1. Employee Skills	48	0.5194	0.4850	0.42	0	1	—						
2. Workforce	48	0.4688	0.2850	0.44	0.5	1	.243	—					
3. Tasks	48	0. 5114	0.5360	0.42	0	.99	.033	.026	—				
4. Market	48	0.4804	0.4800	0.41	0	1	0.247	.190	.402**	—			
5. Time	48	0.5077	0.500	0.40	0.1	1	-.076	.112	-.351*	-0.269	—		
6. Size	48	0.3585	0.1800	0.36	0.04	1	.500**	.440**	.122	.465**	-.112	—	
7. Profit	48	0.0937	0.1036	0.20	-0.63	.45	.268	.188	-.033	.010	-.224	.211	—

Table 1: Descriptive Statistics and Correlations

3.2 Calibrating the Data

The previous paragraph constructed the empirical sample used in this thesis. The next step is to calibrate this data. Calibration is the process of determining cases' memberships in conditions and in the sets representing the outcome (Ragin, 2008). The end result of this process is the calibration table as found in table 2 at the end of this paragraph.

Calibration in QCA is subdivided into two categories: crisp set (csQCA) and fuzzy set (fsQCA). In csQCA all variables are coded as either having set membership (1) or not (0). There are no gradients and once over the threshold membership is instantly maximized. FsQCA allows for partial membership and therefore a more nuanced analysis. In this thesis fsQCA is used precisely for that purpose: to enable a nuanced analysis. There are three thresholds, or calibration anchors, in fsQCA to determine: full membership, crossover and full non-membership. When determining these anchors, theory is the most important guide. There are cases, however, when there is no theory to base the anchors on. This is the case for most variables in this thesis. The second way to determine the anchors is by looking at clear splits in the data. For most variables in this thesis such splits are not present either. That is why the calibration anchors are mostly based upon standards used in prior research (Fainshmidt et al., 2019; Ho et al., 2016). The anchor for full membership is the 75th percentile, that for full non-membership is the 25th percentile and the median is the crossover point. This method of calibration is used for all variables except Size. Size is the exception because the BNA benchmark provides a clear categorization which is adopted in this thesis. So the thresholds chosen for Size are based both upon industry standards. See table 2 for the full calibration table.

Constructs	Measurement	Calibration anchors Full membership/ Crossover/ Full non-membership	Calibration basis Full membership/ Crossover/ Full non-membership
Main conditions			
1. Employee Skills	1 – HHI Categories: ‘Architect’, ‘technical design/draftsmen’, ‘calculation’, ‘project leaders/coordinators’, ‘construction supervision’, ‘other project employees’, ‘office management’ and ‘other support functions’ Potential data range: 0-0.875	0.72 / 0.63 / 0.42	75th/50th/25th percentile of scores
2. Workforce	Combined percentage Categories: ‘Temporary employees’ and ‘Detached employees’ Potential data range: 0-1	0.09 / 0.002 / 0	75th/50th/25th percentile of scores
3. Tasks	1 – HHI Categories: ‘Initiative/preliminary research’, ‘only design’, ‘from design to building permit’, ‘from design to esthetical guidance’, ‘from design to directing’ and ‘other’ Potential data range: 0-0.833	0.73 / 0.63 / 0.5	75th/50th/25th percentile of scores
4. Market	1 – HHI Categories: ‘Houses’, ‘offices’, ‘stores’, ‘education’, ‘healthcare’, ‘sports and recreation’, ‘farming and industry’, ‘city building’, ‘mixed projects’ and ‘other’. Potential data range: 0-0.9	0.72 / 0.61 / 0.48	75th/50th/25th percentile of scores
Contextual Conditions			
5. Time	How much the main conditions vary in absolute terms	0.42 / 0.23 / 0.1	75th/50th/25th percentile of scores
6. Size	# Employees (FTEs)	40 , 20, 2	BNA business size categorization (external benchmark)
Outcome Variable			
7. Profit	Profit percentage	0.2 / 0.1 / 0.04	75th/50th/25th percentile of scores

Table 2: Calibration table

3.3 Ethics

This thesis follows the Netherlands Code of Conduct for Research Integrity (Algra et al., 2018) and thus follows the principles of honesty, scrupulousness, transparency, independence and responsibility, as well as the standards for good research practices listed in this code of conduct. Ethics are important to consider because they influence the researcher's decisions and thus influence the result of the research (Resnik, 2011). This is especially important since the research design used in this thesis includes a lot of freedom for the researcher to set values and limits, the principle of transparency and responsibility are thus especially important. The researcher will have to take great care to explain why certain choices are made. That is why both this chapter and chapter four go into great detail on things like operationalization, calibration, thresholds and the reasoning behind these choices. The researcher has attempted to be as open as possible about the choices made. In this way the principles of honesty, transparency and scrupulousness are upheld.

Another aspect of following the principles and practices used is that the results of this research will be anonymous. This means that the individual firms whose data is used in this research will not be mentioned and the conclusions will not be traceable to any individual firm. This is ensured by design, because the researcher only received anonymous data. It is thus impossible for the researcher to (accidentally) include anything that might reveal the identity of any of the firms used. Thus the principle of responsibility is upheld. Since there is no connection or communication between the researcher and the firms also means that the researcher cannot be influenced by the firms. This means the principle of independence is upheld.

Based upon these ethical guidelines and the calibration in the previous paragraph the data is analysed in chapter 4.

4. Analysis

This chapter contains the main analysis which is based upon the theoretical framework and the methodology established in the previous chapters and checks the robustness of this analysis. This chapter thus details steps 4 and 5 of the QCA research method. Step 4 is the main analysis and step 5 is the evaluation of the robustness of the findings.

4.1 main analysis

The first step in the analysis is to consider if there are any necessary conditions. A condition is necessary when every case that shows the outcome of interest contains that condition. The threshold for necessity is a consistency of >0.90 (Greckhamer et al., 2018). When analysing necessity both the presence and absence of a condition is weighed. This is done by including the negated condition which is indicated by the "~" icon in front of the condition. As is shown in table 3, there are no necessary conditions in this empirical model analysis since the highest consistency value is 0.64 which is well below the 0.90 threshold. This means that there is no condition that has to be present in order for a configuration to have the desired outcome: high performance. There is thus no single (negated) condition which is necessary among the configurations to be analysed.

Condition	*Consistency*	*Coverage*
~WF_Cal	0.484007	0.450980
WF_Cal	0.596801	0.630222
~Tasks_Cal_Cor	0.550000	0.557223
Tasks_Cal_Cor	0.508081	0.491771
~Size_Calibrated	0.619529	0.478077
Size_Calibrated	0.491162	0.678094
~Time_calibrated	0.564394	0.567499
Time_calibrated	0.525673	0.512515
~Market_Calibrated	0.604798	0.576183
Market_Calibrated	0.473064	0.487424
~ES_Calibrated	0.433923	0.446901
ES_Calibrated	0.635943	0.606097

Table 3: Analysis of Necessity

The second step in the analysis is to see if there are any sufficient configurations of conditions. A configuration of conditions is sufficient if it consistently leads to the outcome. This analysis is done by inspecting the so called truth table. The truth table lists all logically possible configuration of conditions, with each row representing a specific configuration. The full truth table is shown in Appendix A. As it includes all logically possible configurations, there are quite a few configurations with no empirical representation. These cases are known as the counterfactuals or logical remainders. These counterfactuals are included in the statistical algorithm used for the analysis, but will not be explicitly mentioned in the analysis. The algorithm includes both the 'easy' and 'difficult' counterfactuals. Easy counterfactuals are consistent with the empirical evidence and with the assumptions based on theory. The difficult counterfactuals are consistent with the empirical evidence, but not with the assumptions made (Greckhamer et al., 2018).

There are multiple aspects to determine if a configuration is sufficient. The first is the threshold for the consistency. There are two types of consistency that are considered: raw and

PRI. Raw is the standard measure of consistency, whereas PRI means 'proportional reduction in inconsistency'. PRI is used in fuzzy set analysis because in rare cases a condition can be both consistent with the outcome of interest as well as the negation of that outcome. The PRI consistency value guards against such relations. A general guideline is that for the raw consistency >0.80 is recommended. A raw consistency >0.75 is considered the minimum for the configuration to be included (Greckhamer et al., 2018). For this analysis the threshold of 0.80 is used, but in a later paragraph a robustness check will be done with the threshold of 0.75. As for the PRI consistency; there should be only a minimal difference between raw and PRI consistency and if the PRI consistency is below 0.50 the configuration should not be included (Greckhamer et al., 2018). The PRI consistency value of 0.50 and raw consistency of 0.80 are the thresholds used to conclude that there are 4 configurations that are sufficient, none of which have to be excluded because of a PRI consistency that is too low or too divergent from the raw consistency.

The consistency analysis (raw output in Appendix D) is shown in table 4. This shows that the intermediate solution has a coverage of 0.32 and a consistency of 0.89. This means that the configurations included in the analysis make up 32% of all the cases with high performance and that all of these configurations have a high enough consistency to be included in the model. Overall the solution pictured in table 4 shows that the configurations have a varying amount of stability and differentiation. Only configuration 3 is consistently stable on the main conditions and configuration 4 is, as will be explained in the analysis below, very consistently differentiated. The contextual conditions also vary a lot, which means that there are different contexts for each set of main conditions to perform well. The remainder of this chapter will detail each configuration and its representative cases.

	Configurations			
	1	2	3	4
	Large Flexible Builders	Small Architect Dominated Firms	Large Stable Builders	Flexible Middle-sized Bureaus
Main conditions Internal Structure				
Employee Skills	●	⊗	⊗	●
Workforce	●	●	⊗	●
External Focus				
Tasks	⊗		⊗	●
Markets		●	⊗	⊗
Contextual conditions				
Time	●	⊗	⊗	●
Size	●	⊗	●	⊗
Raw Coverage	0,19	0,10	0,07	0,06
Unique Coverage	0,14	0,06	0,04	0,02
Consistency	0,89	0,89	0,81	0,84
Overall Solution Consistency	**0,89**			
Overall Solution Coverage	**0,32**			
# of Cases	**8**			

Table 4: Main Analaysis Configurations

In order to interpret the results of the above analysis, it is important to first explain coverage in its different forms. The first form is the overall solution coverage. This measure indicates which percentage of the outcome of interest is covered through the solution as a whole (Gur & Greckhamer, 2019). This means that of all cases that include the outcome of interest (high performance), this solution includes 32%. A benchmark value for solution coverage is 25%, a solution should not be lower than this threshold. Since the solution coverage of this analysis is only 7% above the lower threshold, it is on the lower end of the spectrum. This means that there are quite a few cases that have high performance that are not included in any of these configurations, the implications of which will be discussed in the next chapter. The other two types of coverage are the raw and unique coverage of each configuration. Raw coverage includes all cases that are covered in part by that specific configuration whereas unique coverage includes only the proportion of cases covered uniquely by each specific configuration (Greckhamer et al., 2018). The difference here is between overlapping and neatly separated configurations. The higher the (unique) coverage is, the more impactful a configuration is. The larger the difference between raw and unique coverage, the more that configuration is likely overlapping with other configurations. These are important aspects for the analysis of each configuration that will follow.

The first configuration has a raw coverage of 0.19 and a unique coverage of 0.14. This makes it the most prominent configuration in this analysis. This configuration is thus the most prevalent and has the least overlap with the other configurations. The configuration consists of large companies that have a varied internal structure, but generally perform the same tasks. This configuration will be labelled Large Flexible Builders. As table 4 indicates, these companies tend to be larger (all representative cases are above 20 FTE). They generally have changed (aspects of) their internal structure and external focus quite a bit from 2017 to 2018, which explains the dynamism of the Time condition. On the main conditions there is differentiation in Employee Skills and Workforce, but stability on Tasks. This indicates that these companies generally perform the same role across projects, but do so with different job roles and temporary and/or external employees. The focus within the Tasks dimension is on doing everything in the project from design to esthetical guidance. These firms generally do not do the initial research in a project, but once the project starts they do everything but the overall governance. Because they service such a wide array of the project tasks consistently, it makes sense for them to have a variation in Employee Skills and Workforce. When there are new big projects in which they have to take up a large variety of tasks, it is likely they will have to hire certain expertise temporarily. All these variations lead to a dynamism in Time. Since Markets is not present in the configuration, it is not relevant in this configuration.

The second configuration has a raw coverage of 0.10 and a unique coverage of 0.06. This configuration thus has a much lower coverage. This means there are less cases representing this configuration in the empirical sample. The overall picture of this configuration is that it consists of smaller firms, which utilize a similar set of skills to consistently service many markets with a changing workforce. The configuration can thus be labelled Small Architect Dominated Firms. The companies in this configuration tend to be smaller, generally with less than 10 FTE. They service many different markets, though building houses are the dominant market in the representative cases with about 50% of the revenue. The employees they employ have a very stable set of skills, the vast majority are either architects or draftsmen. The representative cases generally have at least one external employee, which is a large part of the total FTE since the companies are quite small. This explains the differentiation on Workforce. When considering the condition Time it is clear that these cases do not vary much over the years in question. They are consistently differentiated in workforce and market and consistently consistent in their skills.

The third configuration has a raw coverage of 0.07 and a unique coverage of 0.04. The coverage of this configuration is thus again a lot lower than the second configuration. This means that there is but one representative case in the empirical sample. The general outline of this configuration is that these companies are very stable, focused and large. Every main condition is present and all values on these conditions indicate stability. This configuration will be labelled as Large Stable Builders. The representative case in this configuration has about 31,8 FTE in 2018, all of which are permanent internal employees. These employees are generally draftsmen and architects, thus the Employee Skills are stable too. When looking at Markets, 90% of the revenue is generated by building houses. The Tasks this firm does are stable as well with the vast majority being 'design up to building permit'. The only other task that the representative firm does is 'design up to governance' (this means they do the entire project). So the firm either does everything but the governance and esthetical guidance, or every task in the project. Because there are few changes on the main conditions in between the years, the Time dimension shows focus.

The fourth configuration has a raw coverage of 0.06 and unique coverage of 0.04. This configuration has the lowest raw and unique coverage of all the configurations and only one representative case in the empirical sample. This configuration shows the most variation of all the configurations, with only Markets being stable. Interestingly enough this seems to be because of the category 'mixed projects', which is the dominant market in the representative case. So while the analysis shows stability, it could be considered differentiated because the stable category it scores so high on is a mixed (and thus differentiated) category. This configuration will be labelled Flexible Middle-sized Bureaus. This is because while the analysis shows that Size is low, the representative case has about 20 FTE, which is the threshold for the large/small divide used in this analysis. The skills these employees have are also quite varied and vary a lot over time. While in 2017 the representative case had only 5 FTE draftsmen and 4.5 FTE architects, in 2018 there were 9.60 FTE draftsmen and 1.20 FTE architects. This shows both a considerable spread in what skills employees have had a large dynamism over time in how these skills are spread. When it comes to the Workforce dimension about 10% of the FTEs of the representative case is external or temporary, which seems to fit with the variations in the other dimensions. On the Tasks dimensions the spread is clearly visible too, with 3 of the 5 categories having more than 20% of the revenue in one year, and there is a lot of change over time too. The category 'Design to esthetical guidance' has 20% of the revenue in 2017 and 60% in 2018. Similar changes are seen in the other categories. Considering all of this is logical that the Time dimension is dynamic, as every aspect of this representative case is varied and varies over time.

This concludes the main analysis of this thesis. Overall it can be stated that though there is a configuration that shows only stability, there is none that shows only differentiation. In the concluding chapter more attention will be given to this and how it relates to the collaborative paths as defined by Manning and Sydow (2011). As was stated at the start of this chapter and in the theoretical framework, it is important to do several so called robustness checks. This is to consider in which measure the chosen cut-off points for values like consistency and calibration influence the results this analysis produced in an undesirable way. The next paragraph will contain these robustness checks.

4.2 Robustness checks

This paragraph contains common and applicable robustness checks of the QCA methodology. These are to change the calibration anchors, to change the consistency threshold and to analyse the results for the negation of the outcome (Greckhamer et al., 2018). A robustness check that is not performed in this thesis is changing the frequency thresholds. This entails setting a higher (or lower) limit for the amount of empirical cases a configuration needs in order to be included. Because of the relatively small amount of cases included in the main analysis changing the frequency thresholds is not seen as useful: it would exclude too many configurations. The next sections will detail each of the included robustness checks respectively.

4.2.1 Calibration Anchors

The first robustness check is to change the calibration anchors. In the main analysis the calibration was done based on quartiles, meaning the cutoff points are on 25%, 50% and 75% of the respective conditions. For this robustness checks the cutoff points are changed to 20%, 50% and 80%. Depending on how the solution changes, one can judge if the main analysis is robust. The results of this robustness check are shown in table 5.

	Configurations		
	1	2	3
Main conditions			
Internal Structure			
Employee Skills	●	●	⊗
Workforce	●	●	●
External Focus			
Tasks	⊗	●	⊗
Markets		●	●
Contextual conditions			
Time	●	●	⊗
Size	●	⊗	⊗
Raw Coverage	0.20	0.08	0.07
Unique Coverage	0.13	0.02	0.04
Consistency	0.89	0.82	0.81
Overall Solution Consistency	**0.89**		
Overall Solution Coverage	**0.25**		
# of Cases	**6**		

Table 5: Robustness Check, Calibration Anchors

In this analysis configuration has some different outcomes than the main analysis: there is only three configurations included instead of four, the coverage drops to 0.25 compared with

0.32 in the main analysis, the amount of included cases drops to 6 from 8 and the included configurations also change somewhat. Configuration 3 of the main analysis is not present in this robustness check. As this was the only ‘stable’ configuration, this robustness check only has mixed or differentiated configurations. This can be seen as an indication that the differentiated configurations are more robust.

There are also strong similarities between the two analysis. Configuration 1 is identical to configuration 1 in the main analysis, which the configuration with the most (unique) coverage in both analysis. Configuration 2 is very similar to configuration 4 in the main analysis, the only difference is that Market is differentiated in this robustness check. Configuration 3 in this analysis is very similar to configuration 2 in the main analysis, the main difference being that the condition Tasks is now included.

This robustness check thus indicates that calibration anchors of the main analysis are reasonably robust. Though one of the configurations is no longer included, the other three are, albeit with minor changes in two of them, still present and recognizable.

4.2.2 Consistency Threshold

The second robustness check is to change the consistency threshold. Changing the consistency threshold is done by adopting a threshold of 0.75 consistency instead of the 0.80 used in the main analysis in chapter four. 0.75 consistency is recommended as the minimal consistency threshold and adopting this threshold includes as many configurations as possible (Greckhamer et al., 2018). In this robustness check the other thresholds are kept constant and the truth table and the necessary conditions are equal to the main analysis in chapter 4. The analysis performed on this truth table, the consistency analysis, is the only difference. The result of this new consistency analysis is shown in table 6.

	Configurations					
	1	2	3	4	5	6
Main conditions						
Internal Structure						
Employee Skills	●	●	●	⊗	●	⊗
Workforce	●	●	●	●	⊗	⊗
External Focus						
Tasks	⊗	●			⊗	⊗
Markets		●	⊗	●	⊗	⊗
Contextual conditions						
Time	●	⊗	●	⊗	⊗	⊗
Size	●	●	⊗	⊗	⊗	●
Raw Coverage	0,19	0,18	0,12	0,10	0,08	0,08
Unique Coverage	0.09	0,13	0,03	0,04	0,03	0,02
Consistency	0,89	0,77	0,81	0,89	0,79	0,81
Overall Solution Consistency	**0,82**					
Overall Solution Coverage	**0,49**					
# of Cases			**16**			

Table 6: Robustness Check, Consistency Threshold

The overall picture of this robustness check is that of a two relatively impactful configurations (1 and 2), which have a much higher unique coverage than the other configuration. These configurations are dominated by differentiation on the main conditions and have a larger number of employees. The more stable the configuration becomes, the more the unique coverage deceases. This pattern is not seen in the main analysis, where both stable and differentiated scores on various dimensions are found across all configurations except the 3rd (which includes only stability). There is certainly no trend visible in the main analysis that points to a correlation between stability and coverage.

Another difference when comparing this analysis to the main one is that, as is expected, this analysis includes more configurations than the main analysis: 6 instead of 4. Notably configuration 2 and 5 are below the 0.80 consistency threshold adopted in the main analysis. When considering the other configurations, a strong similarity to the main analysis is apparent. The first configuration in this analysis is identical to the first configuration in the main analysis. The third configuration is very similar to configuration four in the main analysis, the only difference is that Tasks is no longer a relevant condition. The fourth configuration is identical to configuration two in the main analysis and the sixth configuration is identical to configuration three in the main analysis. This indicates that the main analysis is decently robust when it comes to calibration anchors, since all configurations show up in this robustness check without major differences.

As is to be expected the overall coverage of the solution has increased from 0.32 in the main analysis to 0.49 in this analysis. Because the threshold for inclusion is lower this solution will cover a higher percentage of the configurations that have the outcome of interest, thus increasing coverage while losing some consistency. With the lowering of the consistency threshold and the inclusion of more configurations, a lot more cases are included as well. The number of cases included doubled from 8 to 16.

Overall this robustness check indicates that the main analysis' configurations are robust. Changing the consistency threshold does not impact the main configurations in a meaningful way.

4.2.3 Negation of the outcome

The third robustness check is to consider the negation of the outcome. This means that instead of looking for configurations that consistently lead to the outcome of interest (high performance), the analysis is instead focused on configurations that consistently lead to not having the outcome of interest. In this thesis that means looking for configurations that consistently lead to the absence of high performance. By performing this analysis and comparing the configurations, lessons can be learned about possible overlaps or differences in the configurations. This can lead to valuable insights in how differences in configuration lead to different performance outcomes and is important to do considering the causal complexity included in these analyses. In particular this gives insights into asymmetric causality. As was stated in chapter two, a key part of QCA is embracing causal complexity, which has three aspects: conjunction, equifinality and causal asymmetry. Causal asymmetry means that an attribute can both cause the effect and its absence. This robustness check is used to see if there are overlapping configurations, which would indicate that these configurations thus both consistently lead to the desired outcome (high performance) and the negation of that outcome (the absence of high performance).

This analysis focusses on the truth table analysis, for which factors like the consistency threshold (0.80) and calibration anchors are identical to the main analysis. The overall image of this analysis is that coverage is higher than in the main analysis (0.45 compared to 0.32), it includes more configurations (6 compared to 4) and cases (12 compared to 8) and no configurations included in the main analysis are included in this analysis.

	Configurations					
	1	2	3	4	5	6
Main conditions						
Internal Structure						
Employee Skills		⊗		⊗	⊗	●
Workforce	⊗	⊗	⊗	⊗	●	●
External Focus						
Tasks	●	●	⊗	⊗	●	⊗
Markets	●		●	●		●
Contextual conditions						
Time	⊗	⊗	●		●	⊗
Size	⊗	⊗	⊗	⊗	⊗	●
Raw Coverage	0,16	0,15	0,13	0,13	0,11	0,08
Unique Coverage	0,06	0,05	0,04	0,01	0,07	0,04
Consistency	0,85	0,80	0,94	0,88	0,89	0,93
Overall Solution Consistency	**0,88**					
Overall Solution Coverage	**0,45**					
# of Cases	**12**					

Table 7: Negation of the outcome

When considering the configurations included, it is noticeable that Markets is only present as differentiated, whereas that is only true for one configuration in the main analysis. Another interesting difference is that Workforce is generally stable, whereas it is mostly differentiated in the main analysis. In addition to that, the configurations in this analysis mostly include Size as small, whereas the main analysis's configurations are varied in size. As stated none of the configurations in this analysis match or closely resemble the configurations in the main analysis.

The (unique) coverage of the configurations included in this analysis are quite similar and there is generally a large difference in the unique and raw coverage. This indicates that these configurations overlap more than those in the main analysis. There is also no clearly dominant configuration in this robustness check, whereas the main analysis does contain one.

As indicated the coverage in this analysis (0.45) is much higher than in the main analysis (0.32), even though the consistency threshold is identical. This combined with the increase in configurations in this analysis (6 as opposed to 4) means that there are many more cases and configurations that consistently lead to the negation of the outcome than to the 'positive' outcome. This is consistent with the idea that it is harder to succeed than to fail in business: there are many more ways to fail to achieve high performance than there are to succeed in doing so.

Overall this robustness check indicates that there are different configurations that lead to the negation of the outcome, which underlines that there is causal asymmetry. There is no clear link between the configurations that lead to the outcome and the negation of the outcome, which makes the configurations that lead to high performance unique to producing that outcome and not its negation.

4.3 Conclusion of the analysis

This chapter contained the main analysis and various robustness checks. The main analysis concludes that there are four configuration which consistently lead to high performance. These configurations were dubbed Large Flexible Builders (1), Small Architect Dominated Firms (2), Large Stable Builders (3) and Flexible Middle-sized Bureaus (4). The three robustness checks that were done (calibration anchors, consistency threshold and negation analysis) indicated that these configurations are relatively robust. Usually a QCA analysis closes with general themes or overlapping characteristics in the configurations. Such themes are not present in this analysis. There is no single condition or combination of condition that is present across the different configurations. It is thus not possible to condense or generalize the results further and the four distinct configurations are the result of the analysis. The next chapter includes a more thorough discussion of the results and their meaning.

5. Discussion

This chapter contains the conclusions of this thesis and a discussion of the results. This is done by first recapping the previous chapters and answering the research question. Afterwards the limitations of this research are discussed. This is followed by both the theoretical and practical implications of this thesis and suggestions for further research.

5.1 Research question answered

This thesis started out asking how the configurations of internal structure and external focus of project-based organizations (PBOs) impact performance. In order to answer this question a theoretical framework based on existing work on PBOs was established (Bakker, 2010; Lundin & Söderholm, 1995; Manning & Sydow, 2011; Whitley, 2006). This framework is then linked to performance by using the theory of Manning and Sydow on collaborative paths (2011). This formed the basis of the conceptual model used in this thesis (see figure 1 on page 8). In order to embrace aspects like causal complexity and to gain a holistic perspective, this conceptual model was then 'viewed' through the lens of the Neo-Configurational Perspective (NCP). The final conceptual model (see figure 2 on page 12) thus included not only the dimensions of the PBO literature (internal structure and external focus) and performance, but also contextual factors and the holistic viewpoint of configurations of conditions. These configurations either resulted in high performance or a lack thereof, which was analysed in chapter 4, based on the methodology as set up in chapter 3.

This analysis resulted in 4 configurations which met the set requirements. These configurations have various different conditions, yet they all consistently lead to having a high performance, which is the outcome of interest in this thesis. In order to validate the robustness of these findings, robustness checks were performed. These robustness checks can be found in section 4.2 and concluded that the configurations that resulted from the main analysis are reasonably robust. Configuration 3 of the main analysis is the only configuration that showed minor robustness issues. The interpretation of this will be discussed in the next paragraph.

The research question to be answered in this thesis is how configurations of internal structure and external focus of PBOs impact performance. The answer to this question is that based on this research there are four configurations that consistently lead to high performance. These are: Large Flexible Builders (1), Small Architect Dominated Firms (2), Large Stable Builders (3), Flexible Middle-sized Bureaus (4). The first configuration, the Large Flexible Builders, consists of large companies that have a varied internal structure, generally perform the same tasks and show dynamism over time. The second configuration, Small Architect Dominated Firms, consists of smaller firms, which utilize a similar set of skills (architects) to consistently service many markets with a changing workforce. This configuration shows little dynamism over time. The third configuration, Large Stable Builders, share the size and the stability of tasks with the first configuration, yet has no variation on any of the other conditions. There is also no dynamism over time in this configuration. The fourth and final configuration, Flexible Middle-sized Bureaus, shows the most differentiation of all the configurations and has dynamism over time. The only stability in this configuration is in the markets, which is likely explained by the presence of the category 'mixed projects'. These are the four ways in which to configure the internal structure and external focus of a PBO in order to consistently achieve high performance.

Overall it can be concluded that most of these configurations are a mixture of differentiation and focus, as well as different values on contextual factors. There is one configuration that shows only stability, but none that show only differentiation. This means that the collaborative path named the economy of recombination is not present in its purest form, whereas the economy of repetition is (Manning & Sydow, 2011). More research is needed to see if this pattern is consistent and exactly why this pattern emerges.

5.3 Theoretical implications

This paragraph will delve into what the results of this thesis mean for the theories used to construct the empirical model as well as for further research related to these theories. This paragraph thus details the scientific relevance of this thesis: the measure in which the knowledge gained in this thesis contributes to the existing knowledge about the subject. This thesis adds to the existing scientific knowledge in two major ways: the inclusion of empirical data which is analysed to draw conclusions about financial performance of PBOs and the inclusion of the NCP to embrace causal complexity and offer an holistic perspective.

The inclusion of empirical data which is analysed to draw conclusions about the financial performance of firms can further understanding on the use of the *collaborative paths* that Manning and Sydow studied (2011). Because of the limitations mentioned in the next paragraph, drawing general conclusions that apply to all PBOs or even organizations in general is not possible based upon this thesis. This means that this thesis does not supply either support or a rebuttal to the theory of collaborative paths. A more expansive study is necessary that encompasses more sectors and countries to draw such general conclusions. It is the belief of the researcher that the conceptual model developed in this thesis is useful when conducting such a study, which is the largest contribution this thesis offers to the development of the theory of collaborative paths. The contributions of this thesis to the theory of Mannig and Sydow is showing that the economy of recombination is not present in this empirical sample and that most configurations are a mixture of focus and stability. Further research could explore how much stability or focus qualifies a company as possessing the economies of recombination or repetition.

A second theory which this thesis contributes to is that of Whitley (2006). Whitley's model offers characteristics upon which ideal types of PBOs can be distinguished. These characteristics were used to analyse empirical reality. Because of the mentioned limitations no definitive conclusions can be drawn, but there is some indication that there is a correlation between the measure of stability a configuration displays and financial performance. It requires further research to see if this correlation exists beyond this empirical sample. It is an opening for further research to see if certain quadrants of Whitleys model (i.e. stable internal structure and differentiated external focus) consistently lead to higher or lower financial performance than other quadrants. Another line of research that could be pursued is to see if certain ideal types are more common than others and specifically under which conditions.

The inclusion of the NCP combined with the empirical search for financial performance is another theoretical contribution of this thesis. The NCP allows for a holistic and causally complex analysis of configurations of attributes (Greckhamer et al., 2018). In this way this thesis does not isolate any particular condition but focusses on the configuration as a whole. Though the results of this thesis are limited, the researcher hopes that it has been demonstrated that the inclusion of the NCP brings many benefits. This application, especially when combined with the aforementioned theoretical frameworks, is relatively novel. Further research is needed to see if the conceptual model used in this thesis can be improved upon. This thesis contributes by showing that the model is usable to study configurations and their performance empirically. Improvements are likely possible to increase the coverage and generalizability. Another interesting avenue for further research is to use other theories to supply the core conditions of the conceptual model and compare which lead to the most promising results.

5.4 Practical implications

This paragraph details what the knowledge gained in this study contributes to solving current issues in society. As was established in the introduction, the amount of PBOs has increased in recent years. This thesis gives practitioners concrete information about what configurations consistently lead to high performance in addition to which configurations consistently do not. This is useful information when making decisions about how to structure or focus your organization. As in the previous paragraph the limitations of this thesis should be considered here. The configurations this thesis are most relevant for practitioners in Dutch architectural firms. The results are not readily generalizable to other sectors or countries, though they are likely still relevant in sectors like film and construction. Another contribution of this thesis to society is the holistic view adopted. This allows a practitioner to consider the entirety of the organization and consider if adopting a certain configuration would fit. As an example, if a PBO is small and dynamic, different configurations of the main conditions are likely to lead to high performance than when a firm is large. Practitioners can thus weigh which context and conditions fit with their current state or business plan.

5.2 Limitations

There are various aspects which limit the results produced in the analysis of this thesis. These limits follow from the empirical sample used and affect the generalizability of the results, the coverage of the solution and the results of the robustness checks.

The first limitations follow from the empirical sample. Though this sample is very adequate to answer the research question, it makes it hard to generalize the results broadly. The results apply very well to Dutch Architects and might reasonably be construed to be applicable to other similar PBOs like construction firms, film studios and consultancy firms, yet it is hard to say in what measure these results apply to PBOs in these sectors in other countries. This is true based purely on the research design, but since the solution produced in this thesis only includes 8 cases there is further caution to be advised in generalizing the results. It would be wise to apply the model used in this thesis to different sectors and/or countries and to compare the results before attempting to draw more general conclusions based upon this thesis.

That there are only 8 cases included in the solution is a limitation in another way: it is an indicator of the relatively low coverage of the solution this thesis produced. With only 32% of the cases that result in high performance included, 68% of cases with high performance are not covered by this solution. No conclusions can be drawn about this 68% based on this research, which is a severe limitation to the results. Further research is needed to explore the characteristics of this 68%.

The final major limitation of this thesis is the robustness of the third configuration and the implication for the effects of stability and differentiation. When the calibration anchors were changed in paragraph 4.2.1, configuration three of the main analysis was no longer included in the solution. This configuration is the only 'pure stability' configuration, with no differentiation on any of the main conditions. That this configuration is not present in the robustness check indicates that it is less robust than the other configuration. The most robust configurations are thus all mixes of stability and differentiation. Together with the results of the analysis of the negation of the outcome in paragraph 4.2.3 gives the impression that overall the more differentiated configurations are better at achieving higher performance, but that a configuration with only differentiation is not robust or consistent at all at achieving high performance. This results indicates a trend between the measure of stability and performance. This thesis does not, however, draw a conclusion on this aspect because it cannot. This is in part because of the previous limitations mentioned, but also because the research was not designed to draw such a conclusion. It was designed to produce configurations that consistently lead to high performance, not to analyse trends in the configurations that do. Such trends are very valuable and meaningful to detect and not being able to analyse them is both a limitation of this thesis and an opening for further research.

These limitations are important to consider when interpreting the results produced in this thesis. They also influence the theoretical and practical implications of this thesis which is presented in the following paragraphs.

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Appendix A: Truth Table for the outcome high performance

Conditions						Outcome: High performance			
Employee Skills	Workforce	Tasks	Markets	Time	Size	Presence	# of Cases	raw consistency	PRI consistency
1	1	0	0	1	1	1	2	0.920424	0.87069
0	1	0	1	0	0	1	1	0.857537	0.746063
0	1	1	1	0	0	1	1	0.856115	0.74359
1	1	0	1	1	1	1	2	0.847452	0.692408
1	1	1	0	1	0	1	1	0.840909	0.748201
0	0	0	0	0	1	1	1	0.806451	0.713131
1	0	0	0	0	0	0	1	0.790973	0.72836
1	1	0	0	1	0	0	2	0.787431	0.654827
1	1	1	1	0	1	0	5	0.768987	0.59562
1	1	1	0	0	0	0	1	0.73816	0.596477
0	1	1	1	0	1	0	2	0.730251	0.511173
0	1	0	0	0	0	0	1	0.720016	0.575942
1	0	1	0	0	0	0	1	0.684849	0.604262
0	0	0	0	0	0	0	2	0.673941	0.545784
1	1	0	1	0	1	0	1	0.6534	0.17506
0	1	1	1	1	0	0	2	0.64472	0.154629
0	0	1	1	0	1	0	1	0.610806	0.426451
1	0	1	1	1	0	0	2	0.57395	0.424984
0	1	0	0	1	0	0	2	0.527912	0.38475
1	0	0	0	1	0	0	2	0.5141	0.409377
0	0	0	0	1	0	0	2	0.482191	0.363612
0	1	1	0	1	0	0	1	0.481714	0.141126
0	0	1	1	0	0	0	2	0.472973	0.174715
0	0	0	1	0	0	0	1	0.466667	0.234947
0	0	1	0	0	0	0	1	0.42267	0.23241

0	0	1	0	1	0	0	4	0.386263	0.28873
1	0	1	1	0	0	0	2	0.356123	0.102267
0	0	0	1	1	0	0	1	0.337778	0.10827
1	0	0	1	1	0	0	1	0.239982	0.0290867

Note: the other 35 configurations had no empirical cases (percentage of unobserved configurations = 54,7%).

Appendix B: Truth Table for the negation of the outcome high performance

Conditions						Outcome: High performance			
Employee Skills	Workforce	Tasks	Markets	Time	Size	Presence	# of Cases	raw consistency	PRI consistency
1	0	0	1	1	0	1	1	0.977231	0.970913
1	0	1	1	0	0	1	2	0.926651	0.897733
1	1	0	1	0	1	1	1	0.926448	0.82494
0	0	0	1	1	0	1	1	0.919596	0.89173
0	1	1	0	1	0	1	1	0.914838	0.858874
0	1	1	1	1	0	1	2	0.87516	0.70295
0	0	0	1	0	0	1	1	0.836214	0.765053
0	0	1	0	0	0	1	1	0.825196	0.76759
0	0	1	1	0	0	1	2	0.801802	0.689637
0	0	1	0	1	0	0	4	0.750861	0.711269
0	1	1	1	0	1	0	2	0.717919	0.488827
0	0	1	1	0	1	0	1	0.710623	0.573549
0	1	0	0	1	0	0	2	0.704777	0.61525
0	0	0	0	1	0	0	2	0.704141	0.636388
1	0	1	1	1	0	0	2	0.685115	0.575016
1	0	0	0	1	0	0	2	0.663209	0.590622
0	1	0	0	0	0	0	1	0.619735	0.424058
1	1	1	0	0	0	0	1	0.612956	0.403524
1	1	1	1	0	1	0	5	0.601586	0.302591
0	1	1	1	0	0	0	1	0.582734	0.25641

0	1	0	1	0	0	0	1	0.581447	0.253937
1	1	0	1	1	1	0	2	0.565725	0.124345
1	1	0	0	1	0	0	2	0.550524	0.270135
0	0	0	0	0	0	0	2	0.548454	0.370974
1	1	1	0	1	0	0	1	0.527273	0.251799
0	0	0	0	0	1	0	1	0.518855	0.286869
1	0	1	0	0	0	0	1	0.518788	0.395738
1	1	0	0	1	1	0	2	0.464191	0.12931
1	0	0	0	0	0	0	1	0.439527	0.27164

Note: the other 35 configurations had no empirical cases (percentage of unobserved configurations = 54,7%).

Appendix C: Necessity analysis of the negation of high performance

Outcome variable: ~Winst_Cal

Condition	*Consistency*	*Coverage*
~WF_Cal	0.656766	0.624314
WF_Cal	0.422442	0.455111
~Tasks_Cal_Cor	0.485314	0.501620
Tasks_Cal_Cor	0.571617	0.564445
~Size_Calibrated	0.771452	0.607340
Size_Calibrated	0.337046	0.474724
~Time_calibrated	0.509901	0.523064
Time_calibrated	0.578383	0.575297
~Market_Calibrated	0.512376	0.497995
Market_Calibrated	0.563944	0.592801
~ES_Calibrated	0.594885	0.625054
ES_Calibrated	0.473597	0.460489

Appendix D: Raw output of the main analysis

****
TRUTH TABLE ANALYSIS
****

File: PBO Data Cal Final.csv
Model: Winst_Cal = f(ES_Calibrated, WF_Cal, Tasks_Cal_Cor, Market_Calibrated, Time_calibrated, Size_Calibrated)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.806452

Configuration	*Raw Coverage*	*Unique Coverage*	*Consistency*
*~ES_Calibrated*WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated*	0.100168	0.0628367	0.894737
*ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Time_calibrated*Size_Calibrated*	0.194444	0.135648	0.886756
~ES_Calibrated~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*Size_Calibrated*	0.0747054	0.0378788	0.806452
*ES_Calibrated*WF_Cal*Tasks_Cal_Cor*~Market_Calibrated*Time_calibrated*~Size_Calibrated*	0.0622895	0.0151936	0.840909

solution coverage: 0.32138
solution consistency: 0.888527

Cases with greater than 0.5 membership in term ~ES_Calibrated*WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated: 8 (0.75,0.89),
66 (0.54,0.93)

Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Time_calibrated*Size_Calibrated: 115 (0.9, 0.62), 142 (0.8,0.86), 65 (0.68,0.99), 103 (0.59,0.98)
Cases with greater than 0.5 membership in term ~ES_Calibrated*~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*Size_Calibrated: 138 (0.7,0.96)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*Tasks_Cal_Cor*~Market_Calibrated*Time_calibrated*~Size_Calibrated: 132 (0.54,0.98)

****
TRUTH TABLE ANALYSIS
****

File: PBO Data Cal Final.csv
Model: Winst_Cal = f(ES_Calibrated, WF_Cal, Tasks_Cal_Cor, Market_Calibrated, Time_calibrated, Size_Calibrated)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.806452
---------- ---------- ----------

Configuration	*Raw Coverage*	*Unique Coverage*	*Consistency*
*~Market_Calibrated*Size_Calibrated*	0.238636	0.0484006	0.835052
*Time_calibrated*Size_Calibrated*	0.297559	0.104377	0.772678
*WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated*	0.136364	0.0719697	0.870968
*ES_Calibrated*Tasks_Cal_Cor*~Market_Calibrated*Time_calibrated*	0.100673	0.0190236	0.770867

solution coverage: 0.448737
solution consistency: 0.7949

Cases with greater than 0.5 membership in term ~Market_Calibrated*Size_Calibrated: 103 (0.89,0.98), 138 (0.7,0.96), 65 (0.68,0.99)
Cases with greater than 0.5 membership in term Time_calibrated*Size_Calibrated: 142 (0.96,0.86), 115 (0.95,0.62), 103 (0.73,0.98), 65 (0.68,0.99)

Cases with greater than 0.5 membership in term WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated: 8 (0.83,0.89), 66 (0.54,0.93)
Cases with greater than 0.5 membership in term ES_Calibrated*Tasks_Cal_Cor*~Market_Calibrated*Time_calibrated: 132 (0.711,0.98)

****
TRUTH TABLE ANALYSIS
****

File: PBO Data Cal Final.csv
Model: Winst_Cal = f(ES_Calibrated, WF_Cal, Tasks_Cal_Cor, Market_Calibrated, Time_calibrated, Size_Calibrated)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.806452
---------- ---------- ----------

Configuration	*Raw Coverage*	*Unique Coverage*	*Consistency*
*~ES_Calibrated*WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated*	0.100168	0.0628367	0.894737
*ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Time_calibrated*Size_Calibrated*	0.194444	0.135648	0.886756
~ES_Calibrated~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*Size_Calibrated*	0.0747054	0.0378788	0.806452
*ES_Calibrated*WF_Cal*Tasks_Cal_Cor*~Market_Calibrated*Time_calibrated*~Size_Calibrated*	0.0622895	0.0151936	0.840909

solution coverage: 0.32138
solution consistency: 0.888527

Cases with greater than 0.5 membership in term ~ES_Calibrated*WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated: 8 (0.75,0.89),
66 (0.54,0.93)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Time_calibrated*Size_Calibrated: 115 (0.9,0.62), 142 (0.8,0.86), 65 (0.68,0.99), 103 (0.59,0.98)
Cases with greater than 0.5 membership in term ~ES_Calibrated*~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*Size_Calibrated: 138 (0.7,0.96)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*Tasks_Cal_Cor*~Market_Calibrated*Time_calibrated*~Size_Calibrated: 132 (0.54,0.98)

Appendix E: Raw output of the consistency robustness check

****
TRUTH TABLE ANALYSIS
****

File: C:/Users/basva/OneDrive/OD&D/Thesis/Bronnen/Databewerking/PBO Data Cal Final.csv
Model: Winst_Cal = f(ES_Calibrated, WF_Cal, Tasks_Cal_Cor, Market_Calibrated, Time_calibrated, Size_Calibrated)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.768987
---------- ---------- ----------

Configuration	*Raw Coverage*	*Unique Coverage*	*Consistency*
*~ES_Calibrated*WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated*	0.100168	0.044192	0.894737
*ES_Calibrated*WF_Cal*~Market_Calibrated*Time_calibrated*~Size_Calibrated*	0.123737	0.0282407	0.809917
*ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Time_calibrated*Size_Calibrated*	0.194444	0.0942761	0.886756
ES_Calibrated~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*~Size_Calibrated*	0.075968	0.0256734	0.790973
~ES_Calibrated~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*Size_Calibrated*	0.0747054	0.0185185	0.806452
*ES_Calibrated*WF_Cal*Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*Size_Calibrated*	0.18367	0.132365	0.768987

solution coverage: 0.494529
solution consistency: 0.816029

Cases with greater than 0.5 membership in term ~ES_Calibrated*WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated: 8 (0.75,0.89),
66 (0.54,0.93)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*~Market_Calibrated*Time_calibrated*~Size_Calibrated: 31 (0.78,0.37),
58 (0.6,0.79), 132 (0.54,0.98)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Time_calibrated*Size_Calibrated: 115 (0.9, 0.62), 142 (0.8,0.86), 65 (0.68,0.99), 103 (0.59,0.98)
Cases with greater than 0.5 membership in term ES_Calibrated*~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*~Size_Calibrated: 1 (0.67,1)
Cases with greater than 0.5 membership in term ~ES_Calibrated*~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*Size_Calibrated: 138 (0.7,0.96)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*Size_Calibrated: 92 (0.88,0.66),
122 (0.79,0.85), 129 (0.72,0.7), 86 (0.67,0.58),
125 (0.63,0.17)

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TRUTH TABLE ANALYSIS
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File: C:/Users/basva/OneDrive/OD&D/Thesis/Bronnen/Databewerking/PBO Data Cal Final.csv
Model: Winst_Cal = f(ES_Calibrated, WF_Cal, Tasks_Cal_Cor, Market_Calibrated, Time_calibrated, Size_Calibrated)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.768987
raw unique
coverage coverage consistency
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Configuration	Raw Coverage	Unique Coverage	Consistency
~Market_Calibrated*Size_Calibrated	0.238636	0.0349327	0.835052
ES_Calibrated*WF_Cal*Time_calibrated	0.291667	0.103956	0.807692
WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated	0.136364	0.0572392	0.870968
ES_Calibrated*Tasks_Cal_Cor*Size_Calibrated	0.235774	0.100252	0.691947
ES_Calibrated*~WF_Cal*~Tasks_Cal_Cor*~Time_calibrated	0.111153	0.0277779	0.74248

solution coverage: 0.574958
solution consistency: 0.752548

Cases with greater than 0.5 membership in term ~Market_Calibrated*Size_Calibrated: 103 (0.89,0.98),
138 (0.7,0.96), 65 (0.68,0.99)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*Time_calibrated: 58 (0.96,0.79),
31 (0.95,0.37), 115 (0.9,0.62), 132 (0.89,0.98),
65 (0.82,0.99), 142 (0.8,0.86), 103 (0.59,0.98)
Cases with greater than 0.5 membership in term WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated: 8 (0.83,0.89),
66 (0.54,0.93)
Cases with greater than 0.5 membership in term ES_Calibrated*Tasks_Cal_Cor*Size_Calibrated: 86 (0.971,0.58),
92 (0.94,0.66), 129 (0.931,0.7), 122 (0.841,0.85),
125 (0.63,0.17)
Cases with greater than 0.5 membership in term ES_Calibrated*~WF_Cal*~Tasks_Cal_Cor*~Time_calibrated: 1 (0.87,1)
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TRUTH TABLE ANALYSIS
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File: C:/Users/basva/OneDrive/OD&D/Thesis/Bronnen/Databewerking/PBO Data Cal Final.csv
Model: Winst_Cal = f(ES_Calibrated, WF_Cal, Tasks_Cal_Cor, Market_Calibrated, Time_calibrated, Size_Calibrated)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---

frequency cutoff: 1
consistency cutoff: 0.768987
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Configuration	*Raw Coverage*	*Unique Coverage*	*Consistency*
*~ES_Calibrated*WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated*	0.100168	0.044192	0.894737
*ES_Calibrated*WF_Cal*~Market_Calibrated*Time_calibrated*~Size_Calibrated*	0.123737	0.0282407	0.809917
*ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Time_calibrated*Size_Calibrated*	0.194444	0.0942761	0.886756
ES_Calibrated~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*~Size_Calibrated*	0.075968	0.0256734	0.790973
~ES_Calibrated~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*Size_Calibrated*	0.0747054	0.0185185	0.806452
*ES_Calibrated*WF_Cal*Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*Size_Calibrated*	0.18367	0.132365	0.768987

solution coverage: 0.494529
solution consistency: 0.816029

Cases with greater than 0.5 membership in term ~ES_Calibrated*WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated: 8 (0.75,0.89),
66 (0.54,0.93)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*~Market_Calibrated*Time_calibrated*~Size_Calibrated: 31 (0.78,0.37),
58 (0.6,0.79), 132 (0.54,0.98)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Time_calibrated*Size_Calibrated: 115 (0.9,0.62), 142 (0.8,0.86), 65 (0.68,0.99), 103 (0.59,0.98)
Cases with greater than 0.5 membership in term
ES_Calibrated*~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*~Size_Calibrated: 1 (0.67,1)

Cases with greater than 0.5 membership in term
~ES_Calibrated*~WF_Cal*~Tasks_Cal_Cor*~Market_Calibrated*~Time_calibrated*Size_Calibrated: 138 (0.7,0.96)
Cases with greater than 0.5 membership in term
ES_Calibrated*WF_Cal*Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*Size_Calibrated: 92 (0.88,0.66),
122 (0.79,0.85), 129 (0.72,0.7), 86 (0.67,0.58),
125 (0.63,0.17)

Appendix F: Raw output of the negation of the outcome

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TRUTH TABLE ANALYSIS
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File: C:/Users/basva/OneDrive/OD&D/Thesis/Bronnen/Databewerking/PBO Data Cal Final.csv
Model: ~Winst_Cal = f(ES_Calibrated, WF_Cal, Tasks_Cal_Cor, Market_Calibrated, Time_calibrated, Size_Calibrated)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.801802
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Configuration	Raw Coverage	Unique Coverage	Consistency
~ES_Calibrated*~WF_Cal*Tasks_Cal_Cor*~Time_calibrated*~Size_Calibrated	0.149629	0.0495462	0.790196
~WF_Cal*Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*~Size_Calibrated	0.162335	0.0586634	0.852285
~WF_Cal*~Tasks_Cal_Cor*Market_Calibrated*Time_calibrated*~Size_Calibrated	0.131807	0.036675	0.941367
~ES_Calibrated*WF_Cal*Tasks_Cal_Cor*Time_calibrated*~Size_Calibrated	0.114728	0.0749176	0.890205
ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*Size_Calibrated	0.0758663	0.0410891	0.926448
~ES_Calibrated*~WF_Cal*~Tasks_Cal_Cor*Market_Calibrated*~Size_Calibrated	0.125083	0.00990102	0.883965

solution coverage: 0.448185
solution consistency: 0.878041

Cases with greater than 0.5 membership in term ~ES_Calibrated*~WF_Cal*Tasks_Cal_Cor*~Time_calibrated*~Size_Calibrated: 87 (0.921,0.47),
16 (0.79,1), 61 (0.52,0.87)
Cases with greater than 0.5 membership in term ~WF_Cal*Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*~Size_Calibrated: 87 (0.78,0.47),

64 (0.75,0.97), 139 (0.74,0.99), 61 (0.521,0.87)
Cases with greater than 0.5 membership in term ~WF_Cal*~Tasks_Cal_Cor*Market_Calibrated*Time_calibrated*~Size_Calibrated: 113 (0.65,1),
59 (0.62,1)
Cases with greater than 0.5 membership in term ~ES_Calibrated*WF_Cal*Tasks_Cal_Cor*Time_calibrated*~Size_Calibrated: 48 (0.7,0.66), 33 (0.62,0.48), 49 (0.501,1)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*Size_Calibrated: 41 (0.74,0.81)
Cases with greater than 0.5 membership in term ~ES_Calibrated*~WF_Cal*~Tasks_Cal_Cor*Market_Calibrated*~Size_Calibrated: 151 (0.64,0.92),
59 (0.58,1)
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TRUTH TABLE ANALYSIS
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File: C:/Users/basva/OneDrive/OD&D/Thesis/Bronnen/Databewerking/PBO Data Cal Final.csv
Model: ~Winst_Cal = f(ES_Calibrated, WF_Cal, Tasks_Cal_Cor, Market_Calibrated, Time_calibrated, Size_Calibrated)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.801802
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Configuration	*Raw Coverage*	*Unique Coverage*	*Consistency*
~WF_Cal~Tasks_Cal_Cor*Market_Calibrated*	0.193317	0.0860974	0.907612
*~WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated*	0.209983	0.0730611	0.845515
*~ES_Calibrated*WF_Cal*Tasks_Cal_Cor*Time_calibrated*	0.138655	0.0889852	0.756301
~ES_Calibrated~WF_Cal*Tasks_Cal_Cor*~Time_calibrated*~Size_Calibrated*	0.149629	0.0495462	0.790196
*ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*~Time_calibrated*	0.0985561	0.042368	0.743079

solution coverage: 0.507467

solution consistency: 0.805514

Cases with greater than 0.5 membership in term ~WF_Cal*~Tasks_Cal_Cor*Market_Calibrated: 113 (0.809,1),
151 (0.64,0.92), 59 (0.62,1)
Cases with greater than 0.5 membership in term ~WF_Cal*Market_Calibrated*~Time_calibrated*~Size_Calibrated: 61 (0.92,0.87),
87 (0.78,0.47), 64 (0.75,0.97), 139 (0.74,0.99),
151 (0.6,0.92)
Cases with greater than 0.5 membership in term ~ES_Calibrated*WF_Cal*Tasks_Cal_Cor*Time_calibrated: 33 (0.9,0.48),
48 (0.81,0.66), 49 (0.501,1)
Cases with greater than 0.5 membership in term ~ES_Calibrated*~WF_Cal*Tasks_Cal_Cor*~Time_calibrated*~Size_Calibrated: 87 (0.921,0.47),
16 (0.79,1), 61 (0.52,0.87)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*~Time_calibrated: 41 (0.74,0.81)
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TRUTH TABLE ANALYSIS
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File: C:/Users/basva/OneDrive/OD&D/Thesis/Bronnen/Databewerking/PBO Data Cal Final.csv
Model: ~Winst_Cal = f(ES_Calibrated, WF_Cal, Tasks_Cal_Cor, Market_Calibrated, Time_calibrated, Size_Calibrated)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 1
consistency cutoff: 0.801802
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Configuration	*Raw Coverage*	*Unique Coverage*	*Consistency*
~ES_Calibrated~WF_Cal*Tasks_Cal_Cor*~Time_calibrated*~Size_Calibrated*	0.149629	0.0495462	0.790196
*~WF_Cal*Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*~Size_Calibrated*	0.162335	0.0586634	0.852285
~WF_Cal~Tasks_Cal_Cor*Market_Calibrated*Time_calibrated*~Size_Calibrated*	0.131807	0.036675	0.941367

*~ES_Calibrated*WF_Cal*Tasks_Cal_Cor*Time_calibrated*~Size_Calibrated*	0.114728	0.0749176	0.890205
*ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*Size_Calibrated*	0.0758663	0.0410891	0.926448
~ES_Calibrated~WF_Cal*~Tasks_Cal_Cor*Market_Calibrated*~Size_Calibrated*	0.125083	0.00990102	0.883965

solution coverage: 0.448185
solution consistency: 0.878041

Cases with greater than 0.5 membership in term ~ES_Calibrated*~WF_Cal*Tasks_Cal_Cor*~Time_calibrated*~Size_Calibrated: 87 (0.921,0.47),
16 (0.79,1), 61 (0.52,0.87)
Cases with greater than 0.5 membership in term ~WF_Cal*Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*~Size_Calibrated: 87 (0.78,0.47),
64 (0.75,0.97), 139 (0.74,0.99), 61 (0.521,0.87)
Cases with greater than 0.5 membership in term ~WF_Cal*~Tasks_Cal_Cor*Market_Calibrated*Time_calibrated*~Size_Calibrated: 113 (0.65,1),
59 (0.62,1)
Cases with greater than 0.5 membership in term ~ES_Calibrated*WF_Cal*Tasks_Cal_Cor*Time_calibrated*~Size_Calibrated: 48 (0.7,0.66), 33 (0.62,0.48), 49 (0.501,1)
Cases with greater than 0.5 membership in term ES_Calibrated*WF_Cal*~Tasks_Cal_Cor*Market_Calibrated*~Time_calibrated*Size_Calibrated: 41 (0.74,0.81)
Cases with greater than 0.5 membership in term ~ES_Calibrated*~WF_Cal*~Tasks_Cal_Cor*Market_Calibrated*~Size_Calibrated: 151 (0.64,0.92),
59 (0.58,1)