Journal of Purchasing & Supply Management ∎ (∎∎∎∎) ∎∎∎–∎∎∎

Contents lists available at ScienceDirect

Journal of Purchasing & Supply Management

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

When are contracts and trust necessary for innovation in buyer-supplier relationships? A Necessary Condition Analysis

Wendy van der Valk [a,*], Regien Sumo [b], Jan Dul [c], Roger G. Schroeder [d]

[a] Tilburg School of Economics and Management, Tilburg University, P.O. Box 90153, Room K1102A, 5000 LE Tilburg, The Netherlands
[b] School of Industrial Engineering, Eindhoven University of Technology, P.O. Box 513, CNT 0.16, 5600 MB Eindhoven, The Netherlands
[c] Rotterdam School of Management, Erasmus University Rotterdam, Burgemeester Oudlaan 50, Mandeville Building, Room 10-55, 3062 PA Rotterdam, The Netherlands
[d] Carlson School of Management, University of Minnesota, 321 19th Avenue S., Minneapolis, MN 55455, United States

ARTICLE INFO

Article history:
Received 10 February 2016
Received in revised form
8 June 2016
Accepted 9 June 2016

Keywords:
Necessary Condition Analysis
Contracts
Trust
Innovation
Buyer-supplier relationships

ABSTRACT

Main stream research predominantly views contracts as being *sufficient* for (i.e., driving) performance. In contrast, necessity-thinking implies that contracts *allow* performance to exist: if the necessary condition is not in place (at the right level), the desired performance will not occur, irrespective of other drivers of performance. Statements implying necessity are common in supply management research; yet, to date, an appropriate tool for testing such statements has been lacking. This article makes the case for the newly developed Necessary Condition Analysis (NCA) method, and applies it to data on forty-eight buyer-supplier service outsourcing relationships to explore the necessity of contracts for a specific relationship outcome, i.e., supplier-led innovation. Also, the necessity of trust is explored, as contracts are implemented within a broader context that involves social characteristics of relationships. The results show that successful relationships, i.e., relationships that have high levels of innovation (as observed in the top ten percent of the relationships studied) must necessarily have contracts with at least medium levels of contractual detail, as well as the highest levels of trust. In relationships with low levels of innovation (i.e., innovation levels that can be achieved by about half of the relationships), neither of the conditions (i.e., contracts and trust) is necessary. As such, applying NCA results in a fundamentally different understanding of the relationship between innovation, and contracts and trust. The results indicate that managers should first ensure the right levels of these necessary conditions, before giving attention to other factors that (on average) produce innovation.

1. Introduction

Research focusing on the performance effects of contractual governance (e.g., Anderson and Dekker, 2005; Schepker et al., 2014) has in common that contracts are predominantly viewed as *causing* or *driving* performance: increasing the level of contractual governance is *sufficient* to obtain a certain increase in performance (X produces Y). Sufficient conditions can be considered one distinct logical part of the notion of causality (Dul, 2016b).

The other distinct logical part concerns *necessary* conditions: performance will not be attained when contractual governance is absent (no Y without X). Thus, while a sufficient cause produces the outcome, a necessary cause allows the outcome to exist. Conversely, without the necessary cause, the outcome will not exist despite other factors being present. In the extant literature, necessary conditions are often implicit and more commonly referred to using alternative formulations, such as X being critical or a pre-condition for Y. In the governance literature For example, Lazzarini et al. (2004) point out that contracts are "crucial" for cooperation (under low probability of continued exchange). Such a claim can reasonably be interpreted as a necessary condition statement: a contract must be present to have cooperation; without a contract, there will be no cooperation.

Such examples of necessary condition statements are common in the organizational sciences in general (Dul, 2016b; Dul et al., 2010). To date however, necessary condition hypotheses could not appropriately be tested because traditional data analysis approaches (e.g., correlation or regression analysis) are based on the presumption that condition X is *sufficient* to increase outcome Y, but not necessary because Y can also be increased by other conditions. Recently however, an appropriate technique for analyzing necessary condition hypotheses has become available in the form of Necessary Condition Analysis (NCA) (Dul, 2016b). This article

* Corresponding author.
E-mail addresses: w.vdrvalk@tilburguniversity.edu (W. van der Valk), r.a.f.sumo@tue.nl (R. Sumo), jdul@rsm.nl (J. Dul), rschroed@umn.edu (R.G. Schroeder).

http://dx.doi.org/10.1016/j.pursup.2016.06.005
1478-4092/

explores the applicability and usefulness of applying NCA to an existing dataset of service outsourcing relationships.

In terms of content, this article explores the necessity of contracts for supplied-led innovation in service outsourcing relationships. Our main substantive research question is: are contracts necessary for supplier-led innovation to occur in service outsourcing relationships? The focus is on supplier-led innovation, as suppliers have become a critical source of innovative solutions, ideas, and technologies (Roy et al., 2004; Van Echtelt et al., 2008), not only to enhance the buyer's value proposition, but also for the improvement and optimization of the internal processes or daily operations that buyers increasingly outsource to suppliers. Innovation thus refers to the supplier-initiated changes and improvements to contracted (outsourced) service activities, or to activities involved in achieving a certain contracted service performance that may or may not accompany daily service delivery. This as opposed to innovation contracts (Beneito, 2006; Gilson et al., 2009), where innovation is the sole performance outcome contracted. Contracts are operationalized in terms of the level of contractual detail, i.e., the extent to which obligations and behaviors (i.e., term specificity) and unanticipated contingencies, including relevant guidelines for handling these contingencies (i.e., contingency adaptability), are delineated in the contract (Luo, 2002). Besides the necessity of contracts, the necessity of trust is also investigated, as contracts are agreed and implemented within a broader context, which involves social characteristics of the relationship such as trust. Trust has been suggested (but not properly confirmed) to be *necessary* for performance outcomes such as inter-firm collaboration and value creation (Lumineau and Malhotra, 2011), but is trust also necessary for innovation? A distinction is made between goodwill trust, which is trust that a supplier *intends* to fulfill its role in the collaboration, and competence trust, which is trust in the supplier's *ability* to fulfill an agreed-upon obligation (Das and Teng, 2001; Malhotra and Lumineau, 2011; Sako, 1992).

Foremost, this article makes a methodological contribution by introducing NCA as an additional logic and data analysis tool for a more fine-grained understanding of purchasing and supply management phenomena. This more fine-grained understanding stems from the fact that in the presence of unfulfilled necessary conditions, increasing the values of sufficient conditions identified using for example multiple regression will *not* increase the level of the outcome, as this outcome cannot exist without fulfilling *all* necessary conditions. In other words: necessary conditions have strong managerial implications: managers will not attain the desired level of the outcome unless they put in place all single conditions (at the right level) that are necessary for the desired level of the outcome to occur. As the study of necessity relationships is not widespread in purchasing and supply research nor in business research in general, this article suggests to use NCA and explains how a Necessary Condition Analysis is done.

The remainder of this article is organized as follows. First, in Section 2 ("Theoretical background") a brief review of extant (regression-based sufficiency thinking) literature on contracts and trust in relation to performance in general and innovation in particular is presented. Next, in Section 3 ("The logic of necessary conditions") necessity logic and how it compares to traditional sufficiency logic is extensively discussed. Then in Section 4 ("Research methods") the research design and data collection approach are presented, followed by an explanation on how NCA is applied to the dataset. Finally, the results are shown and discussed in Section 5 ("Results") and Section 6 ("Discussion and conclusion").

2. Theoretical background

Inter-firm governance is critical for the stability of buyer–supplier relationships (Benton and Maloni, 2005; Carr and Pearson, 1999) and concerns the formal and informal rules of exchange, actions and mechanisms governing the behavior of parties in an inter-organizational collaboration (Vandaele et al., 2007), such as a buyer-supplier relationship. In general, two governance strategies have been studied: formal or contractual governance, and relational governance (Cao and Lumineau, 2015; Griffith and Myers, 2005).

Contractual governance refers to a buyer-supplier relationship being managed by means of a formal and written contract which explicitly stipulates the responsibilities and obligations of each party (Cao and Lumineau, 2015; Ryall and Sampson, 2009). Most commonly viewed from a Transaction Cost Theory perspective, contracts act as safeguards against ex-post performance problems, and reduce the risks that might result from opportunism on the part of either or both parties (Luo, 2002). Contracts act as safeguards by prescribing each partner's appropriate behavior in addition to its role and obligations, and by providing guidance on the allocation of outcomes, on how to act in the event of future contingencies, and on penalties for violating the contractual agreement (Poppo and Zenger, 2002; Wang et al., 2011).

At the same time, contracts by themselves may be inadequate to prevent opportunism and promote cooperation. Consequently, other mechanisms, such as relational governance, have been used to complement contracts (Macaulay, 1963). The sociological interpretation of relational governance, as advanced by Social Exchange Theory (SET), is that trust is essential for the stability of social relationships (Cao and Lumineau, 2015) in which buyer-supplier exchanges are usually embedded (Granovetter, 1985), as trust derived from and the social interactions taking place within such relationships are effective instruments for managing these relationships. Existing literature identifies two types of trust: goodwill trust and competence trust (Das and Teng, 1998; Malhotra and Lumineau, 2011; Sako, 1992). Goodwill trust is the trustor's confidence that the trustee *intends* to fulfill their role in the collaboration, particularly trust that both parties will act fairly when the possibility for opportunistic behavior is present (Das and Teng, 2001; Lui and Ngo, 2004; Nooteboom, 1996). Competence trust refers to the confidence of the trustor in the trustee's *ability* to fulfill an agreed-upon obligation (Das and Teng, 2001; Lui and Ngo, 2004; Nooteboom, 1996). Ability here concerns the trustee's technical, cognitive, organizational, and communicative competences (Klein-Woolthuis et al., 2005).

Extant research on contracts and trust in relation to performance has been mostly regression-based, i.e., identifying sufficient causes of performance rather than necessary causes. The number of studies suggesting necessity of contracts for certain outcomes are limited. For example, although they do not focus on necessary conditions, Lazzarini et al. (2004) suggest that contracts are necessary for cooperation, while Lumineau and Malhotra (2011) focus on value creation as a relevant performance outcome. Focusing more specifically on innovation, the extant (regression-based) literature provides some evidence for contracts as a *producer* of innovation. Contracts may facilitate the acquisition of both the explicit and tacit knowledge that is usually involved in innovation (Li et al., 2010). Detailed contracts can curb opportunistic behavior in buyer-supplier relationships (Luo, 2002), and therefore facilitate knowledge transfer and improve innovation performance. Furthermore, the costs and risks associated with knowledge transfer and innovation are reduced when a detailed contract underlies the buyer-supplier relationship (Wang et al., 2011).

Although trust has been suggested to be *necessary* for performance outcomes such as inter-firm collaboration and value

Please cite this article as: van der Valk, W., et al., When are contracts and trust necessary for innovation in buyer-supplier relationships? A Necessary Condition Analysis. Journal of Purchasing and Supply Management (2016), http://dx.doi.org/10.1016/j.pursup.2016.06.005

creation (Lumineau and Malhotra, 2011), extant knowledge on trust and *innovation* is again mostly regression-based. Goodwill trust has specifically been found to lower transaction costs and to curb opportunistic behavior in buyer-supplier relationships, thereby making more energy and resources available for absorbing and utilizing knowledge that can result in innovative outcomes (Lane et al., 2001; Wang et al., 2011). When goodwill trust is present, there is closer cooperation, more open information exchange, and a higher degree of commitment (Fryxell et al., 2002; Lui and Ngo, 2004) and more informal interaction between parties (Wang et al., 2011), which all facilitate the creation and sharing of knowledge that may result in innovation. Competence trust reduces the need for repeated explanations of the obligations, which results in less frequent but higher-quality communication and therefore greater innovation (Nooteboom et al., 1997; Roy et al., 2004). In the presence of competence trust, both parties are more likely to listen to each other, and absorb and take action on the information and knowledge received (Levin and Cross, 2004). In contrast, a lack of competence trust lowers the chance of innovation (Roy et al., 2004).

Governance studies that have adopted innovation as the focal performance outcome suggest that contracts and more strongly trust are producers of innovation. Contracts and trust in relation to innovation have to date not been viewed or analyzed in terms of necessity. Therefore, NCA is applied to existing data on contracts, trust and (supplier-led) innovation. The next section first elaborates on the logic of necessity-thinking and contrast it with more common sufficiency-thinking.

3. The logic of necessary conditions

Although the majority of business research focuses on factors that produce certain outcomes, factors that enable outcomes (i.e., that are necessary for the outcome to occur) are equally important for organizational decision makers. Such enabling factors are necessary conditions. A necessary condition is a condition that *must* be present to enable a certain outcome; without the condition, the outcome will be absent. For example, in the context of purchasing and supply management, ISO14000 certification can be considered a necessary condition for suppliers to be on their buyers' shortlists. Buyers will not award business to suppliers that do not have such a certification, and hence, suppliers will not be included in the buyer's shortlist in the absence of ISO14000 certification. The notion of necessary conditions implies causality, as removing the antecedent will cause the outcome to disappear: a supplier that currently is on the shortlist, but loses its certification, will be removed from the buyer's future shortlists. Hence, a necessary condition can be considered a bottleneck preventing a desired outcome from occurring (Dul, 2016b). Consequently, necessary condition statements also have very specific managerial implications: “put and keep in place necessary condition X (i.e., make sure you have ISO14000 certification), or else you will fail (i.e., not be able to participate in the bid)”.

Assertions implicitly *reflecting* necessity are quite common in business research. For example, although they do not focus on necessary conditions, Misangyi and Acharya (2014) suggest that in an intra-firm setting, the substitution view of monitoring and CEO incentive mechanisms implies that only one of the two “need to be present” for effective governance, while the complementarity view implies that both types of mechanisms need to be present. Necessary conditions have however rarely been appropriately *tested* (Van der Valk and Wynstra (2012) and Goertz et al. (2013) being exceptions in operations management and political science respectively), as such a test requires a specific analytical technique which has only recently become available in the form of Necessary Condition Analysis (NCA) (Dul, 2016b). NCA is a data-analytic tool that can be used *alongside* traditional data-analytic tools (i.e., correlation or regression analysis) to better understand the relations between variables (i.e., identify necessary rather than sufficient conditions in datasets).

The philosophy of necessary conditions can be applied to different kinds of variables, and to single and multiple antecedents. Regarding the first, the NCA can be applied to variables that are dichotomous (i.e., being ISO14000 certified or not), but also to variables that have multiple discrete levels or are continuous in nature (Dul, 2016b). For example, suppliers will likely require at least a certain level of technological knowledge to achieve at least a certain ranking on the shortlist. Not meeting this technological knowledge threshold implies a lower ranking than would have been possible had the supplier possessed the required level of technological knowledge.

Regarding the second, the concept of necessary conditions can be applied to single antecedents (bivariate approach), or multiple antecedents (multivariate approach). In the multivariate approach, *all* necessary conditions need to be put in place to prevent failure. A lower (than required) value for one necessary condition cannot be compensated for by a higher value of another causal factor. In order to achieve the desired outcome, managers should work on each separate condition that does not meet its threshold level regardless of the levels of any other (necessary or sufficient) conditions.

Necessary causality thus differs in kind from the more common notion of sufficient causality. The common notion of (additive) sufficiency causality is that the antecedent produces (i.e., is sufficient, but not necessary, for increasing) the outcome. Consequently, necessity and sufficiency should be considered distinct but complementary elements of causality (Dul, 2016b), each requiring specific analytical approaches (i.e., the NCA technique for necessary conditions versus regression or correlation for sufficient conditions). Below the NCA technique and how it compares to more traditional techniques is discussed in more detail.

3.1. The NCA technique

In the simple, dichotomous situation (Dul, 2016b), identifying a necessary condition (i.e., X is necessary for Y) requires investigating in an XY-scatterplot whether the intersection $X=0$, $Y=1$ has no data points. If this intersection has data points, the condition X is not necessary for Y. In a more common situation, the variables have more than two levels and a scatter plot with an empty space in the upper left corner suggests the presence of a necessary condition. The upper-left part of a scatterplot is separated from the lower-right part by a so-called ceiling line (Goertz et al., 2013), a line between the area with and without data points. The ceiling line indicates the levels of the condition that are necessary for given levels of the outcome.

To draw ceiling lines, various techniques are available. These techniques assume non-decreasing (piecewise) linear ceilings that maximize the ceiling zone (i.e., the area above the ceiling line) with few or no observations in the empty space. Techniques that leave the ceiling zone completely empty are considered 100% accurate, while the accuracy of techniques that allow some points (i.e., outliers) above the ceiling line is below 100%. Drawing the best ceiling line hence requires trading off the size of the ceiling zone with the number of exceptions: the larger (smaller) the ceiling zone, the more (fewer) observations in the ceiling zone, and hence the lower (higher) the accuracy. The ceiling line and several parameters including accuracy can be calculated using the NCA software (Dul, 2016a).

The necessary condition can be evaluated in terms of the effect size, i.e., the constraint that the ceiling poses on the outcome. Dul

Please cite this article as: van der Valk, W., et al., When are contracts and trust necessary for innovation in buyer-supplier relationships? A Necessary Condition Analysis. Journal of Purchasing and Supply Management (2016), http://dx.doi.org/10.1016/j.pursup.2016.06.005

(2016b) expresses the effect size (d) as the size of the ceiling zone relative to the total space in which observations can be theoretically expected or empirically observed (i.e., the theoretical or empirical "scope"). The larger the ceiling zone, the stronger the effect. Like others (e.g., Goertz et al., 2013; Karwowski et al., 2016), the empirical scope was selected as the reference for calculating effect sizes, for two reasons. First, it is unlikely that constructs will attain minimum scores, especially if they are measured using many items. In such cases, opting for the theoretical scope would lead to a substantial overestimation of the effect size. Second, Goertz et al. (2013) indicate that the empirical scope is more often selected for scope decisions. In line with Dul (2016b), effect size was evaluated as follows: $0 < d < 0.1$ a "small effect",[1] $0.1 \leq d < 0.3$ a "medium effect", $0.3 \leq d < 0.5$ a "large effect", and $d \geq 0.5$ a "very large effect".

3.2. Necessity thinking and NCA versus sufficiency thinking and regression

This section compares necessity thinking and NCA with sufficiency thinking and regression as to better understand their similarities and – more importantly – their differences. First, in both approaches, there is presumed causality, i.e. that X precedes and is related to Y. Managerial implications for each of the two types of thinking are however substantively different: while identification of a sufficient cause suggests that managers should invest in this cause as to (*on average*, thus *not in all situations*) increase the outcome, identification of a necessary cause requires managers to ensure a minimally required level for that cause or else the outcome will not occur (*in any situation)*. It is not possible to compensate for not meeting identified necessary conditions: in a situation where X and Y are each individually necessary for Z, the absence (or in the discrete situation: a lower level) of X cannot be compensated by having more of Y or by the presence of other (necessary or sufficient) factors.

Second, both approaches have in common that the validity of any causality inferred predicates on the adequacy of theory, quality of sampling and quality of measurement. Results may be flawed when these requirements are not met.

Third, in contrast to a sufficiency analysis that aims to predict outcomes using (many) variables simultaneously, a necessity analysis can be done for each variable separately or for one variable only. The reason is that the necessary condition operates in isolation from the rest of the causal structure (which is exactly the reason why the condition is necessary). Consequently, the effect size and other characteristics of the necessary condition are not influenced by the presence or absence of other variables in the empirical model. Therefore, necessity analyses can be performed with "incomplete" models, whereas sufficiency analyses must be performed with models that are as complete as possible (including control variables).

4. Research methods

4.1. Research design and data collection

NCA may be well applied to investigate possible new insights in the role of contracts and trust for innovation in buyer-supplier relationships by exploring which levels of contractual detail, goodwill trust and competence trust *are necessary* for certain desired levels of innovation. The data for this exploratory research originated from a 2013 survey of service outsourcing relationships, as such buyer-supplier relationships are well known for the use of both formal and relational governance mechanisms (Aghion and Holden, 2011). A questionnaire study is appropriate when the study objective is exploration, as it benefits from a reasonable number of observations, which can efficiently be collected using a questionnaire (Åhlström and Westbrook, 1999). Given the exploratory nature, this article does not state or test formal hypotheses, but explores presumed relationships.

Data collection took place in the maintenance sector as asset owners increasingly outsource maintenance activities to specialist suppliers, who are then also expected (but not contractually obligated) to undertake innovative activities as part of daily operations. In the context of maintenance, innovation may concern minor changes that lead to a more efficient or more effective maintenance process (e.g., a performance dashboard which diagnoses specific problems in advance of the supplier's site visit, or using more durable spare parts).

Data were collected from 430 asset owner (i.e., buyer) members of the Dutch association for maintenance services using a self-administered online questionnaire.[2] The association's board was contacted to obtain its approval and support, and subsequently the research was presented as a joint effort between researcher and association, with the goal of maximizing the number of returned questionnaires. All members received the questionnaire and an enclosed introductory letter explaining the intent of the study, assuring anonymity, and indicating the preferred informant. Informants were subsequently asked to complete the questionnaire for either a fixed-price contract, a cost-plus contract, or a performance-based contract, depending on which contract type they were most familiar with. Incorporating multiple types of commonly used contracts ensures variation in the key variables: e.g., contractual detail will be lower for a performance-based contract than for a cost-plus contract.

After three reminders, and a round of telephone calls to identify members that had not responded, 75 questionnaires were received (17.4% overall response rate), of which 27 were discarded due to excessive missing information. The analyses are thus based on a limited set of 48 usable responses. While this small number is considered acceptable for an exploratory investigation aiming to illustrate the application of a new methodology, there are some important limitations, which will be dealt with in our limitations section.

Of the responding firms, 19 are active in the process industry, 11 in the real-estate sector, 8 in food, beverage, and pharmaceuticals, 5 in infrastructure, 4 in manufacturing, and 1 in the fleet sector. Maintenance manager, contract manager, advisor, and general manager were the most common roles of respondents. Around 55% of the organizations have more than 250 employees, and the average revenue is around €2192 million. On average, the respondents have 13 years of experience in managing relationships with external suppliers and they managed, on average, 19 contracts in 2012. These last figures suggest high levels of competence for the respondents, and hence that responses should be of sufficient quality.

As respondents were anonymous, all were called to identify any non-respondents for assessing respondent bias. Non-respondents were found to be reluctant to answer even a limited number of questions because of a lack of time. Therefore potential respondent bias was assessed by conducting a wave analysis (Armstrong and

[1] Note that small effect sizes may be highly meaningful as they still imply that in the specific context of the research a particular condition *must* be put in place for the desired outcome to occur.

[2] The data for this article originates from a larger dataset on 106 buyer-supplier relationships, containing non-dyadic data obtained from buyers and suppliers of maintenance services. The current analysis draws on the set of buyer responses only, as the buyer is seeking innovation during the contract execution stage.

Please cite this article as: van der Valk, W., et al., When are contracts and trust necessary for innovation in buyer-supplier relationships? A Necessary Condition Analysis. Journal of Purchasing and Supply Management (2016), http://dx.doi.org/10.1016/j.pursup.2016.06.005

Overton, 1977). The final sample includes 33.3% of the responses in the first wave and 66.7% in the second wave after the first reminder. The main variables were compared, as well as various descriptive characteristics such as the sector the respondent is active in, the respondent's function, the number of employees of the respondent's organization, the respondent's experience, and the number of contracts managed by the respondent in 2012. No substantial differences were found between early and late respondents. The descriptive characteristics were also investigated for a small group of respondents (36%) that provided only very few answers, assuming that these could be representative of non-respondents. Again, no substantial differences between this group of respondents and the respondents in the dataset. These findings, combined with the fact that non-respondents indicated lack of time as the main reason for non-participation, suggest that non-response bias is not a serious threat.

4.2. Questionnaire and measures

A questionnaire was used for measuring the variables. The variables were operationalized using both reflective and formative multiple-item measures that are perceptual in nature. Existing scales are used as much as possible, but minor modifications were made when appropriate given the research objectives and context (Appendix A shows the measurement of the key variables). Measurement took place using a mix of five- and seven-point Likert scales to reduce the threat of pattern responses (Dillman et al., 2009).

The questionnaire was then refined in several stages following standard scale and questionnaire development techniques. First, a limited number of respondents—from firms not included in the main analysis, and subsequently management researchers—were interviewed and asked to pre-test the questionnaire to identify any ambiguities and to verify whether the wording was appropriate for business practitioners. Minor changes to the wording were made based on the feedback received. Second, a pilot study was conducted with purchasing managers from various industries to evaluate the study's feasibility, the time taken to complete the questionnaire, and any adverse events, as well as to evaluate and validate measurement items.

The measures are elaborated hereafter; the complete dataset and the descriptive statistics of the variable scores are shown in Tables 1 and 2, respectively.

Innovation items were derived from the incremental[3] innovation scale used by Verbeeten (2014), who adapted Jansen et al.'s (2006) scale of exploitative innovation to study the use of performance-based contracts in the maintenance sector (Verbeeten, 2014). The seven items focus on the extent to which the maintenance provider continuously improves the maintenance process, and the provider's ability to increase asset utilization. The scale values are the averages of the item values. The empirical minimum (1) and maximum (5) (i.e., the observed minimum and maximum for innovation) equal the scale minimum and maximum (Table 2).

A formative seven-item, seven-point Likert scale captures the two dimensions of contractual detail: term specificity and contingency adaptability. Based on existing items (Argyres et al., 2007; Mayer, 2006; Ryall and Sampson, 2009) contractual detail were captured by items that, for example, evaluate whether the contract states how the supplier should develop certain technologies and whether the supplier has the freedom to adapt to unforeseen circumstances in the way they think best. The scale value is the

[3] Given the nature of the maintenance sector and the sorts of innovations that can reasonably be pursued in this sector, it is appropriate to focus on incremental innovation.

Table 1
Data set with all observations.

Relationship	Innovation	Contractual detail	Goodwill trust	Competence trust
1	3.57	3.24	2.71	4.00
2	3.57	2.71	2.43[a]	3.00[a]
3	1.29	2.29	4.00	4.00
4	2.14	4.14	3.71	4.00
5	1.00[a]	2.43	3.29	3.50
6	3.43	1.86[a]	3.86	4.50
7	2.71	4.00	4.43	4.50
8	5.00[b]	5.43	5.00[b]	5.00[b]
9	4.14	3.71	5.00[b]	5.00[b]
10	3.00	2.29	4.00	3.50
11	3.00	2.57	4.57	4.50
12	1.29	3.57	3.57	4.00
13	3.00	4.00	4.00	5.00[b]
14	3.71	3.00	3.43	4.00
15	2.43	2.29	3.57	4.50
16	3.71	3.43	4.14	4.00
17	2.43	2.29	3.57	3.50
18	3.29	5.71[b]	4.43	4.50
19	2.29	5.57	3.00	3.50
20	1.57	3.57	4.14	5.00[b]
21	3.57	3.86	4.71	5.00[b]
22	3.57	5.00	4.43	5.00[b]
23	2.57	5.43	4.43	4.00
24	2.00	1.86[a]	3.43	4.00
25	2.71	4.71	3.57	3.50
26	3.00	3.71	3.29	3.00[a]
27	1.14	2.71	3.86	3.50
28	3.71	3.29	4.00	5.00[b]
29	3.57	3.43	3.14	4.00
30	3.43	3.71	3.86	3.50
31	3.14	2.71	4.07	4.00
32	3.14	3.71	3.86	3.50
33	2.57	3.14	3.86	4.00
34	2.57	3.00	3.00	4.00
35	3.14	3.14	4.29	4.50
36	1.43	2.14	2.57	3.00[a]
37	3.29	3.71	4.71	4.50
38	1.57	2.00	2.86	4.00
39	2.86	2.57	3.86	4.00
40	3.29	3.57	3.71	3.00[a]
41	2.00	2.71	2.43[a]	3.00[a]
42	4.00	4.00	4.57	5.00[b]
43	3.14	5.29	4.43	4.00
44	3.86	4.29	3.71	4.00
45	5.00[†]	4.86	4.95	5.00[b]
46	2.57	3.14	3.71	4.00
47	3.43	5.00	4.29	4.50
48	2.57	3.29	4.57	5.00[b]

[a] Empirical minimum.
[b] Empirical maximum.

Table 2
Descriptive statistics of the variable scores.

	Innovation	Contractual detail	Goodwill trust	Competence trust
Scale minimum	1	1	1	1
Empirical minimum	1	1.86	2.43	3
Scale maximum	5	7	5	5
Empirical maximum	5	5.71	5	5
Mean	2.90	3.50	3.85	4.10
SD	0.92	1.05	0.66	0.63

Please cite this article as: van der Valk, W., et al., When are contracts and trust necessary for innovation in buyer-supplier relationships? A Necessary Condition Analysis. Journal of Purchasing and Supply Management (2016), http://dx.doi.org/10.1016/j.pursup.2016.06.005

average of the item values and ranges from 1 to 7. The observed scores vary from 1.86 (empirical minimum) to 5.71 (empirical maximum).

For goodwill trust an existing seven-item, five-point Likert scale based on the work of Aulakh et al. (1996) and Green (2003) was used. It measures whether or not the parties *intend* to fulfill their role in the collaboration (e.g., will not withhold information needed to perform well and will not exploit temporary weaknesses of the other to their own advantage). The scale value is the average of the item values and ranges from 1 to 5. The observed scores range from 2.43 to 5.

Competence trust was measured using a two item, five-point Likert scale, which measures whether the parties trust that both have the right resources and whether they acknowledge each other's reputation and abilities (Lui and Ngo, 2004). The scale value is the average of the item values and ranges from 1 to 5. The observed scores vary between 3 and 5.

Expectation maximization was used to replace a small number of missing values (Tsikriktsis, 2005). Since the reflective measures were previously established and validated, reliability of the reflective measures was done by calculating only the Cronbach's alpha for the various scales (0.919 for innovation; 0.878 for goodwill trust and 0.693 for competence trust). The formative construct (i.e., contractual detail) was validated following guidelines as put forward by Diamantopoulos and Winklhofer (2001) and Petter et al. (2007). Subsequently, NCA was applied to the data listed in Table 1 to draw different ceiling lines and the NCA software (version 1.1) was used to calculate several associated parameters, as explained in the next section.

5. Results

Fig. 1 shows the scatterplot for contractual detail versus innovation. This scatterplot contains an empty space in the upper left corner above the space with observations, suggesting the possible presence of a necessary condition. Two ceiling lines are drawn (Dul, 2016b). First, use of the ceiling envelopment technique (CE-FDH, hereafter CE) results in a non-decreasing step function through the upper-left data points, enveloping all of the data below the line (see Fig. 1, which serves as an example). CE assumes a non-decreasing (piecewise) linear ceiling that maximizes the ceiling zone (i.e., the area above the ceiling line) with

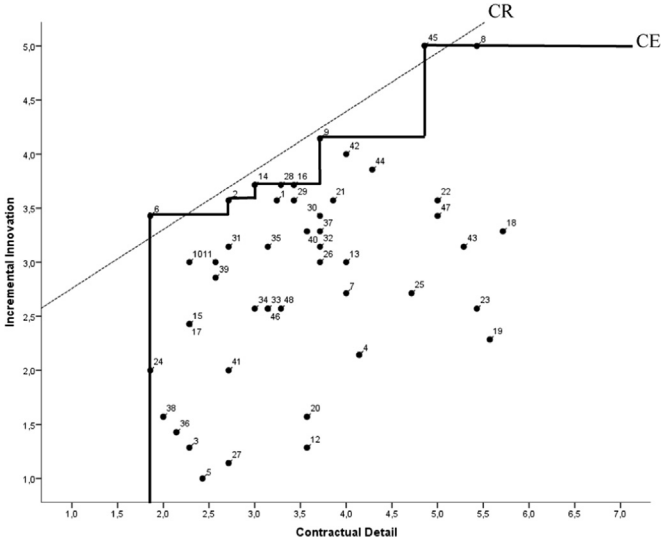

Fig. 1. Scatterplot for Contractual Detail and Innovation (CR (straight ceiling line): y = 2.213 + 0.545x).

Table 3
Results of necessary-condition analyses.

Construct	Method	Accuracy	Ceiling zone	Scope	Effect size (*d*)
Contractual detail	CE	100%	3.661	15.438	0.24[a]
	CR	96%	2.900	15.438	0.19[a]
Goodwill trust	CE	100%	3.165	10.292	0.31[b]
	CR	92%	2.630	10.292	0.26[a]
Competence trust	CE	100%	2.576	8.005	0.32[b]
	CR	94%	1.718	8.005	0.22[a]

[a] $0.1 \leq d < 0.3$: "medium effect".
[b] $0.3 \leq d < 0.5$: "large effect".

no observations in the empty space. As the ceiling zone is left completely empty, CE is 100% accurate (recall from Section 3.1 that a higher accuracy usually results in smaller ceiling zones).

Subsequently, the NCA software (Dul, 2016a) was used to calculate the associated ceiling parameters accuracy, ceiling zone, scope, and effect size (*d*) (Table 3). Second, a smoothing technique applied to the CE line (Dul, 2016b) (CR-FDH, hereafter CR) is used as the ceiling line. CR is a non-decreasing linear function (i.e., the straight ceiling line in Fig. 1) that can be used for additional calculations. The ceiling zone associated with the CR line contains some data points (see Fig. 1; i.e., 6 and 45) and is hence not 100% accurate.

As Table 3 illustrates, the results obtained through CR and the results obtained through CE are similar, and for simplicity we discuss the CR results only. For contractual detail versus innovation, the total space in which observations can be empirically observed (i.e., scope) is 15.438. The CR technique results in a ceiling zone of 2.900, and the associated effect size (i.e., the ceiling zone divided by the scope) is $2.900/15.438 \approx 0.19$. Based on the guidelines of Dul (2016b) for the magnitude of an effect size ($0 < d < 0.1$ "small effect", $0.1 \leq d < 0.3$ "medium effect", $0.3 \leq d < 0.5$ "large effect", and $d \geq 0.5$ "very large effect), this is a medium effect size.

A similar approach was adopted for the other two conditions and again Table 3 is used to describe the results. Regarding goodwill trust being necessary for innovation (Fig. 2a), a medium effect size of 0.26 is found. For competence trust versus innovation (Fig. 2b), again a medium effect size of 0.22 is found.

5.1. Combined effects of contract and trust

When the variables are considered to be continuous in nature, the CR ceiling technique can add more detail to the analysis by considering the levels of the variables in combination and identifying the required levels of each of the three conditions given the level of innovation. For this discussion, the set of observations is divided into three groups with respect to the distribution of the empirical innovation data.

"Low innovation" is the level of innovation that can be achieved by about half of the relationships. Innovation level 3 is selected for this threshold, which is the observed integer that is the closest to the 50th percentile. More precisely, low level of innovation level corresponds to an innovation level 0–52% of the range between the lowest and highest observed level of innovation[4] (scale score ≤ 3). Furthermore "high innovation" is the level of innovation than

[4] Note that the lowest level of innovation (i.e., 1.00) corresponds to 0% of the range between the lowest and the highest observed levels of innovation (5.00), and that the highest level of innovation corresponds to 100% of the range between the lowest and the highest observed levels. Similarly an innovation level of 3 is midway between the observed lowest and highest levels of innovation and hence corresponds to 50% of the range.

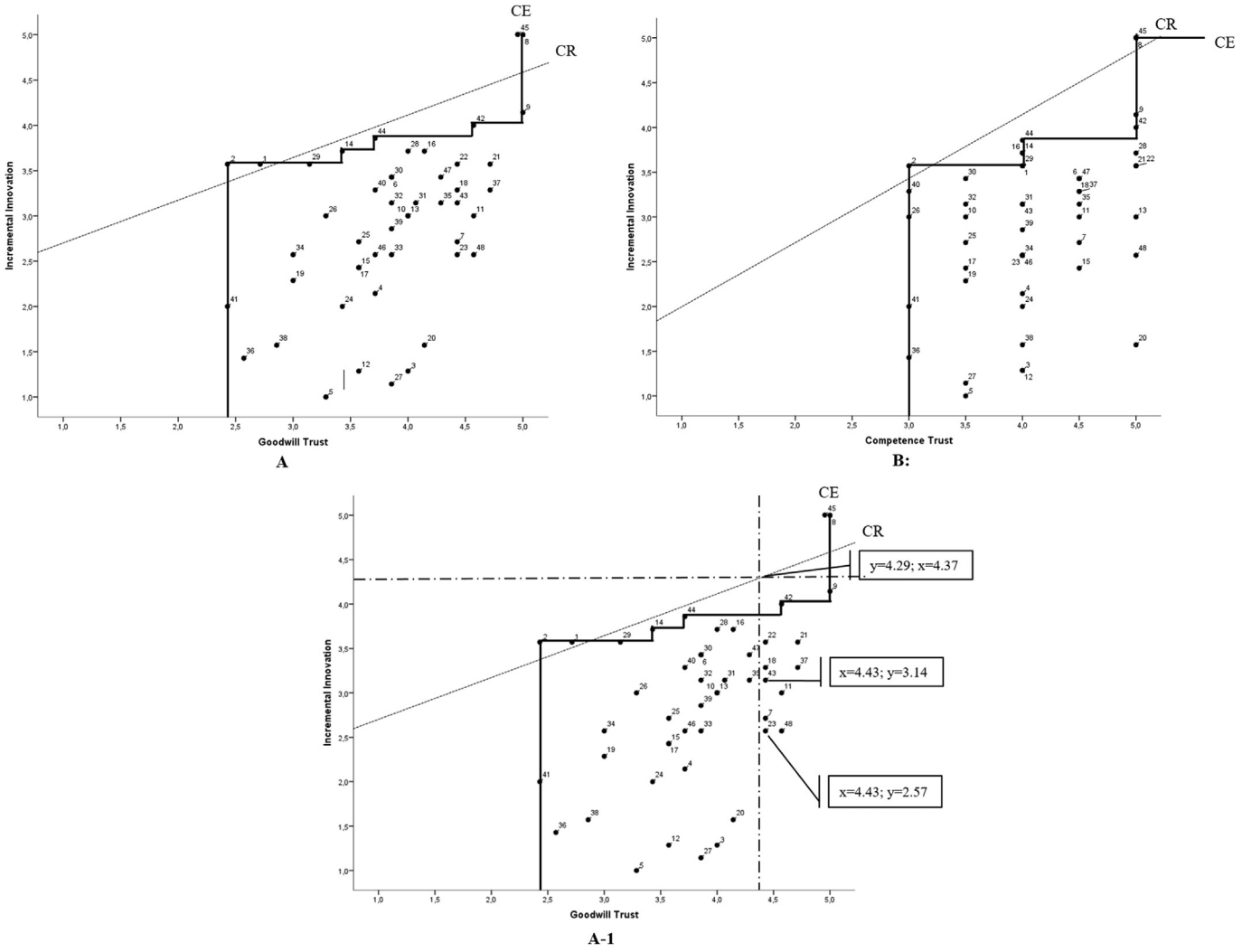

Fig. 2. A: Scatterplot for Goodwill Trust and Innovation (CR: y=2.231+0.471x). B: Scatterplot for Competence Trust and Innovation (CR: y=1.282+0.716x). A-1: Stylized scatterplot for Goodwill Trust and Innovation.

can be achieved by about 10% of the observations with the highest levels of innovation (most successful relationships). Innovation level 4 was selected as the threshold because this integer is the closest to the 10th percentile (6%). More precisely, high level of innovation range corresponds to an innovation level of 79–100% of the range between the observed lowest and highest level of innovation (scale score >4). Finally, we consider the innovation levels of the remaining forty-two percent data points ($3<$ scale score ≤ 4) to be the medium innovation range.

Table 4 is a "bottleneck table" (Dul, 2016b), which specifies the threshold levels of the three necessary conditions that are separately necessary for reaching a certain desired level of innovation. These threshold levels are also expressed as percentages of the condition's range between the lowest and highest observed values in the dataset, and are obtained using the CR ceiling line functions displayed in Figs. 1, 2a and 2b. Table 4 shows for low levels of innovation (up to 52%) none of the conditions are necessary. Consequently, if this finding can be generalized, organizations pursuing a medium innovation level in their service outsourcing relationships will not have to put any of the conditions in place unless their desired levels of innovation exceed 60%. Then, as Table 4 indicates, they need at least 8.4% of contractual detail and at least 2.3% of goodwill trust. Finally, organizations that aim for high innovation (79% or higher) need low to high levels of contractual detail (17.9–84.6%), low to high levels of goodwill trust (18.8–84.9%), and low to high levels of competence trust (12.1–96.0%).

To illustrate: Fig. 2a-1, which is a stylized version of Fig. 2a, indicates that an innovation level of 4.29 requires a level of goodwill trust of at least 4.37. If it is lower, an innovation level of 4.29 cannot be achieved. However, a value of 4.37 does not guarantee that an innovation of 4.29 will be achieved: data points 23 and 43 for example have levels of goodwill trust of 4.43, but innovation levels of 2.57 and 3.14 respectively. When considering the levels of the other conditions, for both relationships competence trust does not meet its threshold level of 4.20 (see Fig. 2b, which shows competence trust scores of 4.00 for both relationships 23 and 43). Thus, if the managers of the organizations involved in these relationships aim for an innovation level of 4.29, they should try to increase their level of competence trust. This can be done for example by choosing a supplier with better problem-solving behavior than the current supplier (i.e., improving the supplier's qualities) or by enhanced internal communication about the supplier's problem-solving (i.e., improving the perceptions of the supplier's qualities). Key however is that it would be ineffective to raise the level of any (necessary or sufficient) cause in the presence of bottlenecks: rather, managers should first raise the level of the bottleneck condition to the threshold required for a certain desired (level of the) outcome, and only thereafter focus on

Please cite this article as: van der Valk, W., et al., When are contracts and trust necessary for innovation in buyer-supplier relationships? A Necessary Condition Analysis. Journal of Purchasing and Supply Management (2016), http://dx.doi.org/10.1016/j.pursup.2016.06.005

Table 4
Bottleneck Levels (in %) using CR (NN=not necessary).

Innovation	Contractual detail	Goodwill trust	Competence trust
0	NN	NN	NN
5	NN	NN	NN
10	NN	NN	NN
15	NN	NN	NN
20	NN	NN	NN
25	NN	NN	NN
30	NN	NN	NN
35	NN	NN	NN
40	NN	NN	NN
45	NN	NN	NN
50	NN	NN	NN
55	NN	NN	NN
60	8.4	2.3	NN
65	17.9	18.8	12.1
70	27.5	35.3	26.1
75	37.0	51.8	40.1
80	46.5	68.4	54.1
85	56.0	84.9	68.1
90	65.5	84.9	82.0
95	75.1	84.9	96.0
100	84.6	84.9	96.0

Notes:
- The percentages listed refer to the percentage of the condition's range between the lowest and highest observed values in the dataset.
- The bold lines indicate the boundaries between the three innovation ranges identified based on the distribution of the empirical innovation data.

increasing the level of known sufficient causes.

In contrast to situations in which the threshold level of a certain condition is not met, situations can exist in which the actual level of a condition exceeds the threshold level, something which Dul (2016b) refers to as condition inefficiency. For example, Relationship 48 is associated with a level of goodwill trust of 4.57 and a level of competence trust of 5; both exceed their thresholds for an innovation level of 4.29. The organizations in this relationship are thus dealing with condition inefficiency for goodwill trust and for competence trust. Relationship 48 currently only has an innovation level of 2.57, and further investigation shows that the current level of contractual detail (3.29) is below the level required (3.81) to enable an innovation level of 4.29. The managers of the organizations involved therefore need to shift attention from trust to contractual detail. In general, managers who are confronted with condition inefficiency could redirect their attention to investing in the bottleneck conditions, perhaps even at the expense (to some extent) of the condition displaying inefficiency. As such, the analysis provides valuable insight into the extent to which organizations make efficient use of their resources.

6. Discussion and conclusion

6.1. Contribution and implications

This research has two theoretical implications. First, the Necessary Condition Analysis reveals that, *in this dataset*, contractual detail, goodwill trust, and competence trust are all necessary for medium to high levels of innovation. More specifically, the results show that different innovation outcomes require organizations to achieve in their relationships different threshold levels of contractual detail, goodwill trust, *and* competence trust (Table 4). If any of these thresholds is not met, the innovation outcomes achieved will be lower, even if the other thresholds are met or even exceeded. As such, applying NCA to an existing dataset provides a new understanding of the combined roles of contracts and trust as it demonstrates that both conditions are necessary (at different levels) for achieving (different levels of) innovation. This insight advances the body of knowledge that views contracts and trust as factors that *on average* (but not always) increase innovation. The results may also shed additional light on the issue of diminishing returns from investing in contracts and trust. While Wang et al. (2011) and Bidault and Castello (2010) argue that too much detail or too much trust is not conducive for innovation, the results suggest that meeting the threshold levels is necessary for

Please cite this article as: van der Valk, W., et al., When are contracts and trust necessary for innovation in buyer-supplier relationships? A Necessary Condition Analysis. Journal of Purchasing and Supply Management (2016), http://dx.doi.org/10.1016/j.pursup.2016.06.005

obtaining high returns, while anything beyond the threshold would be a matter of condition inefficiency. As such, the findings seem to suggest that the diminishing returns identified in prior studies may very well be caused by other (possibly omitted) factors that negatively affect innovation.

The second theoretical implication is that for medium and high levels of innovation, contracts and trust act as complements rather than substitutes since these innovation levels require the presence of both conditions. This adds to the existing but mixed research on the combined effect of trust and contracts on relational outcomes: while some researchers view contracts and trust as substitutes (i.e., trust *or* contracts produce the desired outcome) (Dyer and Singh, 1998; Gulati et al., 2005), others consider contracts and trust to be complements (i.e., trust *and* contracts jointly produce the desired outcome) (Poppo and Zenger, 2002). The current findings suggest that contracts and trust *jointly allow* for the outcome, which constitutes a somewhat alternative interpretation of complementarity. Low innovation levels do not require the presence of any of the conditions. Apparently, complementarity occurs only in a specific domain; i.e., the "medium to high performance" domain. As such, the current findings contribute to our understanding of the conditions under which contracts and trust act as substitutes or complements (as researched by e.g., Klein-Woolthuis et al. (2005), Lui and Ngo (2004), and Lumineau and Henderson (2012)).

From a managerial perspective, there are two key insights. First, this article provides insight into which conditions need to be met when seeking supplier-led innovation in service outsourcing relationships, as well as in the required *levels* of these conditions. Second, this article provides insights into the extent to which organizations make efficient use of their resources. In case of lower than desired innovation performance, this article directs managerial attention to those conditions that actually should be put in place or strengthened in order to achieve the desired, higher level of innovation. In contrast, organization that have over-invested in certain conditions, may redirect their efforts to more important matters, which are the bottlenecks, i.e., the conditions that are below the necessary threshold levels for achieving the desired outcome.

All these new theoretical and practical insights are obtained because a novel approach and data analysis method (NCA) is used that is based on necessity-thinking. A theoretical necessity model is parsimonious, because such a model only includes the variables of direct interest (no control variables are needed). The application of NCA for testing such a model is straightforward. The necessity of individual conditions for an outcome are evaluated with separate binary analyses (as shown with the scatter plots), and these analyses can be easily combined into a bottleneck table. With the NCA approach, the findings are new because existing knowledge in purchasing and supply management in general, and on the topic of this article in particular is solely based on sufficiency-based research. Even authors that seem to allude to necessity thinking (in the context of this research, Lazzarini et al., 2004; Malhotra and Lumineau, 2011 for example discuss "crucial" factors) eventually conduct and present results of sufficiency-based studies. This existing large body of knowledge can be enriched by adding the necessity logic presented here.

6.2. Limitations and future research

Like any study, this study suffers from certain limitations. First, the sample has limitations with regard to scope and size. Regarding scope, the sample has been drawn from a specific industry and country, i.e., the Dutch maintenance industry. Regarding size, the number of cases in the sample from this industry is relatively small. For statistical inference from a limited sample to the specific population from which the sample was obtained (in this case the Dutch maintenance sector) a larger N from that population is desirable, while generalization beyond the specific population requires replication studies. Therefore, the substantive findings in this article provide only first indications: wider generalizations cannot be claimed. However, the sample is primarily used to illustrate how NCA may lead to new insights in an important area in the domain of purchasing and supply management. Also here, replications using different samples (i.e., other countries and/or other industries) are needed, as such different samples may result in different ceiling lines just like different samples may result in different regression lines. Similar results in new studies would enhance the confidence in the necessary conditions that were found, and would enable further demarcation of the domain in which the conditions apply. It would also help to understand how robust these conditions are because, for example, high levels of contractual detail may be less important in cultures that place a stronger emphasis on relationships.

Second, NCA has several limitations. NCA shares some limitations with other data analysis techniques such as regression. NCA (like other data analysis techniques) presumes that the variable scores are valid and reliable. The results of the NCA analysis may be flawed when there is measurement error. For making causal inference from observational studies like the one presented here, NCA (like other data analysis techniques) relies on solid theory that makes (necessary) causality between the main concepts plausible. Without experiments, caution is needed when drawing causal conclusions. An important limitation of NCA (which it does not share with other data analysis techniques) is that it is a new technique. NCA has not yet addressed all issues regarding statistical inference and causal inference. For example, whereas the regression technique is more than 100 years old, the research on the statistical properties of estimated ceiling lines (such as biasedness, efficiency, consistency) and estimation of confidence intervals has just been started. Regarding NCA as a tool, details of the specific techniques for drawing ceiling lines and for calculating necessity effect sizes may still develop when new insights become available, and when more studies use the method (for an overview of current studies with NCA and discussions about developments of the NCA tool, see www.erim.nl/nca). Although the NCA *technique* needs to be further explored and developed, the *logic* of NCA is well-developed and provides a fundamentally different view on causality, one which complements traditional thinking and which can provide new theoretical and practical insights.

There are various opportunities for future substantive research. Regarding this specific research context, the concepts studied could be expanded to include other factors that could be necessary for innovation. Examples include additional features of contracts such as contract duration (Panesar and Markeset, 2008), reward schemes (Shepherd and DeTienne, 2005), and creativity (Abbey and Dickson, 1983; Amabile, 1998). Furthermore, the temporal order of the necessary conditions could be investigated (Hak et al., 2013). Some authors argue that trust generally precedes contracts (e.g., Klein-Woolthuis et al., 2005) and that relational dynamics during previous transactions shape the contracts for future transactions (Faems et al., 2008). More precisely, it could be argued that specifically competence trust precedes contracts, as buyers would need to have confidence in a supplier's competences if they are to embark on a contract with them. In contrast, goodwill trust is more likely to emerge during a series of transactions/the course of a relationship. One could thus for example investigate whether a certain level of competence trust is necessary for a certain level of contractual detail.

More generally, the logic of NCA can be deployed to investigate necessity relationships in other areas in the field of purchasing and supply management, such as to enhance our understanding of the

Please cite this article as: van der Valk, W., et al., When are contracts and trust necessary for innovation in buyer-supplier relationships? A Necessary Condition Analysis. Journal of Purchasing and Supply Management (2016), http://dx.doi.org/10.1016/j.pursup.2016.06.005

development of purchasing maturity or implementation of sustainable purchasing practices in organizations, what contracting capabilities are required for purchasing performance, or the prerequisites for successful partnerships, to give a few examples.

NCA can discover and express conditions in terms of necessity for attaining certain outcomes, and is a useful addition to current research toolkits. Substantively, studying necessity advances a fundamentally different understanding of the relationship between causal factors and outcomes: the causal factor is necessary for the outcome to occur; conversely, if the condition is not in place at the right level the outcome will not occur. From a managerial point of view, managers that focus (also) on necessary conditions may be more efficient and more effective than managers that focus their attention just on a wide range of factors that only partially explain outcomes. With knowledge about necessary conditions, managers can better focus their efforts, and will be more effective in reaching performance outcomes.

Acknowledgements

The research underlying this article was conducted with support from the NEVI Research Foundation (NEVI Research Stichting; Project: Performance-Based Contarcting in Service Triads). The authors gratefully acknowledge the valuable feedback provided by Christoph Bode, Gerwin van der Laan, and Niels Noorderhaven; the attendants of the ISCM internal speaker series (October 2014); the attendants of the 2014 Annual IPSERA conference in Pretoria (South Africa) and the Journal reviewers. The authors furthermore acknowledge NVDO for their participation in this research and Frank Verbeeten (VU University and Utrecht University) for allowing the use of his incremental innovation scale.

Appendix A. : Measurement

Innovation ($\alpha = 0.919$)
To what extent do you agree with the statements below regarding the activities carried out by the partner within this maintenance contract?
1. The supplier continuously improves the maintenance processes
2. The partner often refines the delivery of existing products and services
3. The partner regularly implements small adjustments to existing products and services
4. The partner improves the efficiency of the products and services that are delivered
5. The partner contributes to a higher degree of usage and effectiveness of the asset
6. The partner improves scope management
7. The partner achieves a higher productivity from the mechanics

Contractual detail (formative construct)
To what extent are the following specifications outlined in this maintenance contract:
1. Timeframe for completion of each stage is specified
2. Number of employees contributed by the supplier
3. The specific persons to be assigned the management and monitoring tasks by the supplier
4. The resources the supplier should use
5. How the supplier should develop certain technologies/resources
6. How the supplier should carry out their duties and activities
7. The freedom to adapt to unforeseen circumstances in the way the supplier thinks best

Goodwill trust ($\alpha = 0.878$)
To what extent do you agree with the following statements regarding the degree of trust between your company and the supplier's:
1. Our relationship with this supplier is characterized by high levels of trust
2. The parties generally trust that each will stay within the terms of the contract
3. The parties are generally skeptical of the information provided to each other [R]
4. The parties will do whatever is necessary to ensure the success of the alliance even if it involves tasks to which they had not agreed previously
5. The parties will not withhold any information that each party needs to perform well
6. The parties will not exploit to their advantage any temporary weakness of the other partycollaboration
7. The parties will work hard to help each other solve a problem if it is a problem that may influence the success of the collaboration

Competence trust ($\alpha = 0.693$)
To what extent do you agree with the following statements regarding the degree of trust between your company and the supplier's:
1. The parties generally trust that both have the right resources (such as capital and labor)
2. The parties acknowledge each other's reputation and abilities

References

Åhlström, P., Westbrook, R., 1999. Implications of mass customization for operations management: an exploratory survey. Int. J. Oper. Prod. Manag. 19 (3), 262–274.
Abbey, A., Dickson, J.W., 1983. R&D work climate and innovation in semiconductors. Acad. Manag. J. 26 (2), 362–368.
Aghion, P., Holden, R., 2011. Incomplete contracts and the theory of the firm: what have we learned over the past 25 years? J. Econ. Perspect. 25 (2), 181–197.
Amabile, T.M., 1998. How to kill creativity. Harv. Bus. Rev. 76 (5), 76–88.
Anderson, S., Dekker, H.C., 2005. Management control for market transactions: the relation between transaction characteristics, incomplete contract design, and

subsequent performance. Manag. Sci. 51 (12), 1734–1752.
Argyres, N., Bercovitz, J., Mayer, K., 2007. Complementarity and evolution of contractual provisions: an empirical study of IT services contracts. Org. Sci. 18 (1), 3–19.
Armstrong, J.S., Overton, T.S., 1977. Estimating nonresponse bias in mail surveys. J. Marketing Res. 14 (3), 396–402.
Aulakh, P.S., Kotabe, M., Sahay, A., 1996. Trust and performance in cross-border marketing partnerships: a behavioral approach. J. Int. Bus. Stud. 27 (5), 1005–1032.
Beneito, P., 2006. The innovative performance of in-house and contracted R&D in terms of patents and utility models. Res. Policy 35 (4), 502–517.
Benton, W.C., Maloni, M., 2005. The influence of power-driven buyer/seller relationships on supply chain satisfaction. J. Oper. Manag. 23, 1–22.
Bidault, F., Castello, A., 2010. Why too much trust is death to innovation. MIT Sloan Management Review, 51, pp. 33–38.
Cao, Z., Lumineau, F., 2015. Revisiting the interplay between contractual and relational governance: a qualitative and meta-analytic investigation. J. Oper. Manag. 33–34, 15–42.
Carr, A.S., Pearson, J.N., 1999. Strategically managed buyer-supplier relationships and performance outcomes. J. Oper. Manag. 17, 497–519.
D.A., Dillman, J.D., Smyth, L.M., Christian, 2009. Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method Wiley, Hoboken, NJ.
Das, T.K., Teng, B.-S., 1998. Between trust and control: developing confidence in partner cooperation in alliances. Acad. Manag. Rev. 23 (3), 491–512.
Das, T.K., Teng, B.-S., 2001. Trust, control, and risk in strategic alliances: an integrated framework. Org. Stud. 22 (2), 251–283.
Diamantopoulos, A., Winklhofer, H.M., 2001. Index construction with formative indicators: an alternative to scale development. J. Mark. Res. 38 (2), 269–277.
Dul, J., 2016b. Necessary Condition Analysis (NCA): logic and methodology of 'necessary but not sufficient' causality. Organ. Res. Methods 19 (1), 10–52.
Dul, J., Hak, T., Goertz, G., Voss, C., 2010. Necessary condition hypotheses in operations management. Int. J. Oper. Prod. Manag. 30 (11), 1170–1190.
Dul, J., 2016a. NCA. R Package Version 2.0. URL: ⟨http://cran.r-project.org/package=Nca⟩. A quick start guide can be found here: ⟨http://repub.eur.nl/pub/78323/⟩ (or) ⟨http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2624981⟩.
Dyer, J., Singh, H., 1998. The relational view: cooperative strategy and sources of interorganizational competitive advantage. Acad. Manag. Rev. 23, 660–679.
Faems, D., Janssens, M., Madhok, A., Van Looy, B., 2008. Toward an integrative perspective on alliance governance: Connecting contract design, trust dynamics, and contract application. Acad. Manag. J. 51 (6), 1053–1076.
Fryxell, G., Dooley, R., Vryza, M., 2002. After the ink dries: the interaction of trust and control in US-based international Joint Ventures. J. Manag. Stud. 39 (6), 865–886.
Gilson, R.J., Sabel, C.F., Scott, R.E., 2009. Contracting for innovation: vertical disintegration and interfirm collaboration. Col. L. Rev. 109 (3), 431–502.
Goertz, G., Hak, T., Dul, J., 2013. Ceilings and floors: where are there no observations? Sociol. Methods Res. 42 (1), 3–40.
Granovetter, M., 1985. Economic action and social structure: the problem of embeddedness. Am. J. Sociol. 91 (3), 481–510.
Green, R., 2003. Measuring goodwill trust between groups of people: three years of an oil industry alliance. Strateg. Change 12 (7), 367–379.
Griffith, D.A., Myers, M.B., 2005. The performance implications of strategic fit of relational norm governance strategies in global supply chain relationships. J. Int. Bus. Stud. 36 (3), 254–269.
Gulati, R., Lawrence, P.R., Puranam, P., 2005. Adaptation in vertical relationships: beyond incentive conflict. Strat. Manag. J. 26, 415–440.
Hak, T., Jaspers, F.P.H., Dul, J., 2013. The analysis of temporally ordered configurations: Challenges and solutions. In: Fiss, P.C., Cambré, B., Marx, A. (Eds.), Configurational theory and methods in organizational research. Emerald, Bingley, UK, pp. 109–127.
Jansen, J.J.P., Van Den Bosch, F.A.J., Volberda, H.W., 2006. Exploratory innovation, exploitative innovation, and performance: Effects of organizational antecedents and environmental moderators. Manag. Sci. 52 (11), 1661–1674.
Karwowski, M., Dul, J., Gralewski, J., Jauk, E., Jankowska, D.M., Gajda, A., Chruszczewski, M.H., Benedek, M., 2016. Is creativity without intelligence possible? A Necessary Condition Analysis. Intelligence. http://dx.doi.org/10.1016/j.intell.2016.04.006.
Klein-Woolthuis, R., Hillebrand, B., Nooteboom, B., 2005. Trust, contract and relationship development. Org. Stud. 26 (6), 813–840.
Lane, P.J., Salk, J.E., Lyles, M.A., 2001. Absorptive capacity, learning, and performance in international joint ventures. Strateg. Manag. J. 22 (12), 1139–1161.
Lazzarini, S.G., Miller, G.J., Zenger, T.R., 2004. Order with some law: complementarity versus substitution of formal and informal arrangements. J. Law, Econ. Org. 20 (2), 261–298.
Levin, D.Z., Cross, R., 2004. The strength of weak ties you can trust: the mediating role of trust in effective knowledge transfer. Manag. Sci. 50 (11), 1477–1490.
Li, J.J., Poppo, L., Zhou, K.Z., 2010. Relational mechanisms, formal contracts, and local knowledge acquisition by international subsidiaries. Strategic Manage. J. 31, 349–370.
Lui, S.S., Ngo, H.-Y., 2004. The role of trust and contractual safeguards on cooperation in non-equity alliances. J. Manag. 30 (4), 471–485.
Lumineau, F., Malhotra, D., 2011. Shadow of the contract: how contract structure shapes interfirm dispute resolution. Strateg. Manag. J. 32 (5), 532–555.
Lumineau, F., Henderson, J.E., 2012. The influence of relational experience and contractual governance on the negotiation strategy in buyer-supplier disputes. J. Oper. Manag. 30, 382–395.
Luo, Y., 2002. Contract, cooperation, and performance in international joint ventures. Strateg. Manag. J. 23 (10), 903–919.
Macaulay, S., 1963. Non-contractual relations in business: a preliminary study. Am. Sociol. Rev. 28, 55–67.
Malhotra, D., Lumineau, F., 2011. Trust and collaboration in the aftermath of conflict: the effects of contract structure. Acad. Manag. J. 54 (5), 981–998.
Mayer, K., 2006. Spillovers and governance: an analysis of knowledge and reputational spillovers in information technology. Acad. Manag. J. 49 (1), 69–84.
Misangyi, V.F., Acharya, A.G., 2014. Substitutes or complements? A configurational examination of corporate governance mechanisms. Acad. Manag. J. 57 (6), 1681–1705.
Nooteboom, B., 1996. Trust, opportunism and governance: a process and control model. Org. Stud. 17 (6), 985–1010.
Nooteboom, B., Berger, H., Noorderhaven, N.G., 1997. Effects of trust and governance on relational risk. Acad. Manag. J. 40 (2), 308–338.
Panesar, S.S., Markeset, T., 2008. Industrial service innovation through improved contractual relationship: a case study in maintenance. J. Qual. Maint. Eng. 14 (3), 290–305.
Petter, S., Straub, D., Rai, A., 2007. Specifying formative constructs in information systems research. MIS Q. 31 (4), 623–656.
Poppo, L., Zenger, T., 2002. Do formal contracts and relational governance function as substitutes or complements? Strat. Manag. J. 23 (8), 707–725.
Roy, S., Sivakumar, K., Wilkinson, I.F., 2004. Innovation generation in supply chain relationships: a conceptual model and research propositions. J. Acad. Mark. Sci. 32 (1), 61–79.
Ryall, M.D., Sampson, R.C., 2009. Formal contracts in the presence of relational enforcement mechanisms: Evidence from technology development projects. Manag. Sci. 55 (6), 906–925.
Sako, M., 1992. Prices, Quality, and Trust: Interfirm Relations in Britain and Japan. Cambridge University Press, New York.
Schepker, D.J., Oh, W.-Y., Martynov, A., Poppo, L., 2014. The many futures of contracts: moving beyond structure and safeguarding to coordination and adaptation. J. Manag. 40 (January), 193–225.
Shepherd, D.A., DeTienne, D.R., 2005. Prior knowledge, financial reward, and opportunity identification. Entrep. Theory Pract. 29 (1), 91–112.
Tsikriktsis, N., 2005. A review of techniques for treating missing data in OM survey research. J. Oper. Manag. 24 (1), 53–62.
Van der Valk, W., Wynstra, F., 2012. Buyer–supplier interaction in business-to-business services: a typology test using case research. J. Purch. Supply Manag. 18 (3), 137–147.
Van Echtelt, F.E.A., Wynstra, J.Y.F., Van Weele, A.J., Duysters, G.M., 2008. Managing supplier involvement in new product development: a multiple-case study. J. Product. Innov. Manag. 25 (2), 180–201.
Vandaele, D., Rangarajan, D., Gemmel, P., Lievens, A., 2007. How to govern business services exchanges: Contractual and relational issues. Int. J. Manag. Rev. 9 (3), 237–258.
Verbeeten, F., 2014. Control systems in outsourced maintenance contracts: the impact on supplier's exploratory innovation, exploitative innovation and routine performance. Unpublished Working Paper, VU University, Amsterdam, the Netherlands.
Wang, L., Yeung, J., Zhang, M., 2011. The impact of trust and contract on innovation performance: the moderating role of environmental uncertainty. Int. J. Prod. Econ. 134 (1), 114–122.

Wendy van der Valk, PhD MSc, is Assistant Professor in Supply Chain Management at Tilburg University, the Netherlands. Her research focuses on (performance-based) contracting, the interplay between contractual and relational governance, and supplier performance, in particular supplier-led innovation, in the context of business service outsourcing. She has written over 80 publications, and has been published in, amongst others, *International Journal of Operations and Production Management*, *Journal of Purchasing and Supply Management*, *Industrial Marketing Management* and *International Journal of Service Industry Management*.

Regien Sumo received her doctoral degree at Eindhoven University of Technology on how formal and informal governance affect innovation in inter-organizational relationships. She graduated 'Cum Laude' for her Msc degrees in Strategic Management and Finance at Tilburg University. During her master's year, she studied Financial Investments at the University of California, Berkeley. Her academic work has been published in high-quality ISI rated journals and numerous renowned international conference proceedings. In the fall of 2013, Regien was a visiting scholar at the University of New York. Her research interests include (in)formal governance, innovation, alliances, mergers and acquisitions and energy finance.

Please cite this article as: van der Valk, W., et al., When are contracts and trust necessary for innovation in buyer-supplier relationships? A Necessary Condition Analysis. Journal of Purchasing and Supply Management (2016), http://dx.doi.org/10.1016/j.pursup.2016.06.005

Jan Dul is professor of Technology and Human Factors at the Rotterdam School of Management, Erasmus University, the Netherlands. His research focuses on work environments for human performance and well-being. Furthermore he has a main research and teaching interest in empirical research methodology. Jan Dul has written more than 140 publications. His work on NCA has appeared in *International Journal of Operations and Production Management*, *Journal of Business Research*, *Organizational Research Methods*, and *Sociological Methods and Research*. He shares his NCA knowledge at seminars, conferences, doctoral courses, as well as during professional development workshops at annual conferences, including the Academy of Management annual meeting.

Roger G. Schroeder, Professor Emeritus, University of Minnesota is one of the founding scholars of empirical research in Operations Management. Professor Schroeder has made noteworthy contributions to research in quality management, operations strategy and high performance manufacturing. He has publications in major academic journals including *Management Science, Journal of Operations Management, Academy of Management Journal, Journal of Supply Chain Management* and *Production and Operations Management.* He is a Fellow of the Decision Sciences Institute and of the Production and Operations Management Society. He has published more than 150 papers and his work has been cited over 20,000 times.

Please cite this article as: van der Valk, W., et al., When are contracts and trust necessary for innovation in buyer-supplier relationships? A Necessary Condition Analysis. Journal of Purchasing and Supply Management (2016), http://dx.doi.org/10.1016/j.pursup.2016.06.005