Working Paper 2020-94

What are the Necessary and Sufficient Conditions for Front-Line Employees' Need Fulfilment?

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Abstract

Purpose This paper's purpose is to offer in-depth insight into the operation of the front line between customers' employees and suppliers' employees. We want to better understand the interplay between job demands, job resources, customer resources, and customer demands that enhance the need fulfilment of the front-line employee.

Design/methodology/approach This study uses a configurational approach to gain insight into the complexity of these relationships. This paper uses, on one hand, the Job Demands–Resources (JD–R) framework to characterize the job and, on the other hand, Self Determination Theory (SDT) based on need fulfilment, which forms the motivational mechanism of people's behaviour. To examine a dataset of 143 dyads, we use qualitative comparative analysis (QCA) to identify single necessary and sufficient conditions and sufficient configurations of the four factors for high need fulfilment.

Findings We report the impact of the individual customer's employee on the individual need fulfilment of the supplier's employee. Need fulfilment of the front-line employee is not only influenced by job demands and resources, but also by customer demands and resources. From our empirical work, we provide evidence for the causal complexity, including three paths leading to the outcome variables.

Keywords: Job Demands–Resources model, Customer Demands–Resources model, Self-Determination Theory, front-line employees, need fulfilment, Qualitative Comparative Analysis

What are the necessary and sufficient conditions for front-line employees' need fulfilment?

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INTRODUCTION

The optimal functioning of employees working on the front line with the customer is of key importance for organisations that want to make customer centricity a competitive advantage. Companies increasingly strive to be perceived by their customers as customer-centric (Lee *et al.*, 2014; Shah *et al.*, 2006). Front-line employees (FLEs), who form the link with the customer, play a crucial role in this strategy. It is important for employers to design these (FLE) jobs and work environments in line with people's needs (Grant *et al.*, 2010; Morgeson and Campion, 2002), as they are a crucial building block of both the customer-centric strategy and the organisation's welfare policy.

In this study, we rely on two theories: Job Demands–Resources (JD–R; Bakker and Demerouti, 2007; 2017; Schaufeli and Bakker, 2004) as a framework to characterize the job, and Self-Determination Theory (SDT; Deci and Ryan, 2000), or Basic Psychological Need Fulfilment, which forms the motivational mechanism of people's behaviour. The JD–R model describes the different job components and their effect on the FLE. Recent research on SDT and well-being shows a positive causal relationship between satisfaction of the three basic psychological needs (autonomy, relatedness, competence)[1] and job resources (JR), job demands (JD), and employee well-being on the job (Broeck *et al.*, 2008; Deci *et al.*, 2017; DeHaan and Ryan, 2014; Van den Broeck *et al.*, 2016). Cooman *et al.* (2013) found that job demands thwart, and job resources promote, the fulfilment of psychological needs.

Front-line employees are the first representatives involved in the company–customer interface. Accordingly, the core content of their job consists of company and customer elements. The FLE's job consists, to a large extent, of customer contact. However, the JD–R framework is focused on the organisation, itself, and not on external stakeholders, such as the customer. The original JD–R does not consider the customer.

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[1] Each individual strives to have these three basic needs fulfilled. First, the basic need for autonomy denotes the desire to feel volitional and to experience a sense of choice and psychological freedom when carrying out an activity (DeCharms, 1968; Deci and Ryan, 2000). Second, the need for belonging or relatedness is defined as feeling connected to others. The basic need for relatedness is satisfied when people experience a sense of communion and develop connections with others (Deci and Ryan, 2000). Third, the basic need for competence is defined as individuals' inherent desire to feel effective in interacting with the environment and to engage in challenging tasks to test and extend one's skills (Deci and Ryan, 2000).

The FLE and the customer contact-person (CCP) work in different organisations. In the experience of the FLE, the customer is part of their job. However, the concept of a job, as presented by Bakker and Demerouti (2017), has intra-organisational dimensions: a social component, task component, and emotional component, among others. These dimensions are focused within the boundaries of the organisation in which the FLE and CCP are located. However, some of the demands and resources in the FLE's job come from outside the organisation.

The impact of customers on the job of an FLE can be both a resource and a demand. Customers often confront FLEs with inappropriate and demanding behaviours (Gettman and Gelfand, 2007; Zablah *et al.*, 2012). On the other hand, customers can also be a source of emotional support for FLEs (Zimmermann *et al.*, 2011). Vargo and Lusch (2004) describe the stimulating interaction that can occur between customer and supplier. In this interaction, collaboration between the FLE and CCP is crucial. Customers provide valuable information that can lead to product improvement and development.

There are few studies that have approached the JD–R framework from the interaction with the customer. Stock and Bednarek (2014) were the first to extend the JD–R framework towards the customer. They integrate customer behaviours as demands and resources into the customer demand and resources framework. They show how customer demands and customer resources interact, but the interaction between JD–R and CD–R have not yet been analysed. Moreover, all studies are correlational in nature, so they do not examine the relationships in a configurational way to study causal complexity.

Cooman *et al.* (2013) linked job demands and job resources to need satisfaction; however, we do not know of any studies that link these two aspects (job and customer) to need satisfaction.

JD–R and CD–R together offer a more complete picture of the context in which the FLE functions. In this way, we valorise the relational component of the FLE's job. By measuring on a dyadic level, we can study interpersonal processes and interdependence (Gonzalez and Griffin, 2012). Job demand and resources are one of the most important sources of need fulfilment (Broeck *et al.*, 2008). We want to get an insight into the interdependent complex relationship between supplier and customer and how this has an impact on need fulfilment. The basic idea of SDT is that the proactive, growth- and development-oriented individual interacts with their surrounding social word when striving for the fulfilment of their needs.

With this paper, we want to better understand the systemic relationship between job demands, job resources, customer resources (CR), customer demands (CD), and front-line employee needs fulfilment (ENF).

Our research question (RQ) is: What is the role of job and customer demand and resources in explaining FLE need fulfilment? Alternatively, in a configurational language, What are the necessary and sufficient conditions for need fulfilment?

With this study, we aim to contribute in three ways. First, we contribute to the JD–R literature by analysing the association between job characteristics and the customer; specifically, we extend the job design to the impact of the customer. Second, we add to the SDT literature the process through which demands (of the job and the customer) and resources (of the job and the customer) relate to the need fulfilment of the employee. Third, we make a methodological contribution by using a configurational approach—to better capture the systemic relationships—combined with a qualitative analysis (focus groups)—to gain insight into the causal complexity.

CONCEPTUAL FRAMEWORK

In the case of a service relationship between two companies, the functioning of the front line between the customer and the supplier, the mutual interaction that happens on the front line, is an inherent part of the job of the FLE. This interaction involves job elements and customer elements as well as demand elements and resource elements. Together they are some of the most important sources of basic psychological need fulfilment (Broeck *et al.*, 2008); in other words, they produce an outcome, namely, the basic psychological need fulfilment of the FLE. After all, the fulfilment of basic psychological needs is a joint outcome of the interactions of the individual with their surrounding social world (Gagné and Deci, 2005). For the front-line employee, in their work environment, these interactions consist of their job and of the customers they serve. This brings us to the combination of the four dimensions of the FLE's job—JD, JR, CD, and CR—that commonly occur together. Those four dimensions are conceptually distinct characteristics and important elements of the job design of an FLE. In order to consider not only the context of the FLE's organisation, but also the impact of the client, we contribute to the development of a framework that better covers the FLE job and how these dimensions together explain the ENF. We now turn to a description of each of the chosen concepts. We start with the outcome, Employee Need Fulfilment.

Employee Need Fulfilment

The central proposition of SDT is that optimal functioning in terms of, for instance, well-being and behaviour, depends on the satisfaction of three basic, universal psychological needs (Gonzalez and Griffin, 2012). First, the basic need for *autonomy* denotes one's desire to feel volition and experience a sense of psychological freedom of choice when performing an activity (DeCharms, 1968; Deci and Ryan, 2000). Second, the need for *belonging* (or relatedness) is defined as the feeling of being connected to others. This basic need is satisfied when one experiences a sense of communion and develops connections with others (Deci and Ryan, 2000). Third, the basic need for *competence* is defined as one's inherent desire to feel effective when interacting with the environment and engaging in challenging tasks to test and extend one's skills (Deci and Ryan, 2000).

Basic psychological need fulfilment forms the underlying motivational mechanism that energises and directs people's behaviour (Deci and Ryan, 2008; Deci *et al.*, 2001; Gagné and Deci, 2005), which in turn leads to strong performance and ideal well-being (Deci *et al.*, 2017). Cooman *et al.* (2013) linked job demands and job resources to need satisfaction. We want to understand how the two aspects (job and customer) relate to need satisfaction of the FLE.

We retained four variables as conditions. We describe each condition and why it is interesting to include it in the analysis. The JD–R model is one of the leading frameworks for understanding employee well-being and ill-being. The model is well established in industrial psychology and has been applied to explain important job-related outcomes, such as employee engagement, job satisfaction, and burnout (Bakker *et al.*, 2014; Bakker and Demerouti, 2007; Gabler *et al.*, 2017; Schaufeli and Bakker, 2004). The model considers two psychological processes that explain employee job strain and motivational outcomes. On one hand, job demands utilise employees' mental and physical energy, thereby creating job strain; on the other hand, job resources improve work motivation, thereby fostering employees' growth and development.

Job Demands

A job demand can be described as an action that a person is expected to perform in the context of their job. A demand contains many characteristics, each of which causes a different type of load on employees. Unfavourable job characteristics, categorized as job demands, are those 'aspects of the job that require sustained physical and/or psychological (cognitive and

emotional) effort. They are associated with certain physiological and/or psychological costs' (Bakker *et al.*, 2004, p. 86). Job demands are influenced by time and work pressure, the interference between work and family, and organisational changes (Bakker *et al.*, 2003). Job demands are not necessarily or always perceived as negative or burdensome by employees. For example, many task requirements can have a motivating effect through, for example, the creation of meaning, satisfaction, and involvement; the passing of skills through learning processes; and so on. When the burden of a job demand exceeds an employee's ability to compensate for this burden (e.g. imbalance), this increases the likelihood of a negative impact on well-being (Tadić *et al.*, 2015; Tims *et al.*, 2013).

Job Resources

The ability of an employee to cope with (the load resulting from) job requirements is often described as 'resources'. Favourable job characteristics, labelled job resources, are the 'physical, psychological, social, or organisational aspects of the job that are (1) functional in achieving work goals; (2) reduce job demands and the associated physiological and psychological costs; or (3) stimulate personal growth and development' (Bakker *et al.*, 2004, p. 86). Job resources can relate to the degree of autonomy, variety, and decision-making power of employees; the social support they receive; and whether they feel that they can use their knowledge, skills, and abilities (Bakker *et al.*, 2003). Resources can be situated at the organisational level (i.e. the interpersonal or social level) or at the task level (i.e. the organisation of work). For example, task-related resources can include the core dimensions included in Hackman and Oldham's (1976) job characteristics model.

In the context of work, various studies within the SDT framework have focused on the role of job characteristics as defined in the JD–R (Van den Broeck *et al.*, 2008). Job demands require considerable physiological and psychological energy, which distracts employees from the satisfaction of their needs. Job resources, on the other hand, can create conditions for growth and the achievement of goals, and thus facilitate the need for satisfaction (Bakker and Demerouti, 2007). JD and JR are essential building blocks of job design and have an impact on need fulfilment.

However, the question remains: to what extent is the job or the customer responsible for fulfilling the needs of the FLE? The same goes for the extent to which the resources or the demands are responsible for fulfilling the needs of the FLE. We therefore address whether *job demands* are a sufficient or necessary condition for FLE need fulfilment, or whether they—in

combination with other dimensions of the 'FLE job'—explain FLEs' need fulfilment. The same applies for *job resources*. Are they a sufficient or necessary condition for FLE need fulfilment, or must they be understood in combination with other dimensions of the 'FLE job' to explain FLE need fulfilment?

Although the JD–R model provides valuable insights into the positive and negative aspects of the job-related environment as antecedents of front-line employees' state, it does not focus on external stakeholders, such as customers. As a result, the underlying mechanisms by which customers affect front-line employees or customer satisfaction remain unexplored.

Customer interactions are fundamental to the job of front-line employees (Dormann and Zapf, 2004; Yagil *et al.*, 2008). The CD–R model builds on the basic idea of the JD–R model and integrates customers' behaviours as demands and resources (Bakker *et al.*, 2003).

Customer Demands

Customer demands are the extent to which front-line employees encounter customers expressing negative behaviours. They occur at the customer interface and include behaviours such as hostility and complaining about front-line employees.

Customer Resources

Customer resources are the extent to which front-line employees perceive their customers as supportive of personal or work-related goals. Customers can provide emotional support during interactions with front-line employees, such as by valuing front-line employees' work effort (Zimmermann *et al.*, 2011). Drawing on these and other emotional inputs, front-line employees gain energy that can influence their emotional state or achievement of personal goals (Hee Yoon *et al.*, 2004; Hobfoll, 1989). Customers also can serve as important resources by providing valuable feedback and information (Vargo and Lusch, 2004; 2008). By introducing knowledge, accurately describing wishes, or offering opportunities for improvement, customers enable front-line employees to deliver better services and facilitate their work-related goal achievement (Payne *et al.*, 2008). This is why we distinguish between emotional and cognitive customer resources as antecedents of a front-line employee's state (Stock and Bednarek, 2014).

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METHOD

To gain insight into the interplay between the four dimensions and to understand better the associations between JD, JR, CD, and CR and ENF, we take a configurational approach because we assume causal complexity (Greckhamer *et al.*, 2018; Parente and Federo, 2019). There are four reasons to adopt a configurational framework in this study. The first reason is conjunction, which refers to the notion that multiple, independent causal attributes jointly produce an outcome. In our research, FLEs work for various customer organisations. An organisation itself is a complex amalgam of multiple attributes (Meyer *et al.*, 1993). That is why we have to investigate organisations with methods that take complexity into account. Need fulfilment, influenced by the surrounding complex world, rarely has a single cause but can result, in the context of work, from the interdependence of the four conditions. Need fulfilment can be the result of multiple interactions of the conditions.

The second reason is equifinality because there is the possibility that different combinations of conditions yield the same outcome. In our case, many contexts (FLEs, CCPs, customer organisations, FLE teams, etc.) influence the status of the condition, but with possibly the same result. Different relevant causal paths can lead to the same result (Marx *et al.*, 2013). In a configurational approach, causal factors are not examined in terms of their additive net effect (covariance) but as necessary and sufficient conditions that collectively lead to an outcome. We know from Cooman *et al.* (2013) that job demands thwart, and job resources promote, the fulfilment of psychological needs, but how the interplay will function, together with the customer demands and customer resources, is part of this study.

The third reason is causal asymmetry, pertaining to the possibility that both the presence and absence of conditions are associated with the same outcome. However a correlational analysis assumes symmetry. It is not because A is caused by B that not-A is caused by not-B. The absence of a condition is considered a separate condition. This is perfectly possible because, in our complex environment, other reactions are possible to the absence of a condition. Conditions that are found to be causally related in one configuration may be unrelated or even

inversely related in another. The absence of a resource can have a different impact on need fulfilment than the presence of a resource. Causal asymmetry will, for example, better capture that job demands are not necessarily or always perceived as negative or burdensome by employees. A last reason is set relationships, which we use in place of variables and correlations. Cases are members of the set (full, non-, or fuzzy member), and we examine the intersection of sets using Boolean algebra (Fiss *et al.*, 2013). Instead of correlation-based techniques that rely on linear relationships and examine the net effects of individual factors, qualitative comparative analysis (QCA) explores the multidimensionality and interplay of factors to identify their joint effects. We use set theory to investigate unions of set memberships by analysing how the presence or absence of different conditions combine within a bundle or configuration to consistently influence an outcome of interest (Federo, 2019). This approach is a response to the recent pleas in management science for more configurational analysis instead of correlational analysis (Cambré *et al.*, 2013).

Sample and procedure

The unit of analysis of this study is the FLEs of organisations with a service, where as part of that service, there is direct contact between FLEs of the supplier and the CCP in a B2B environment. This study took place in Belgium in cooperation with a leading payroll administration and HR service provider that gave us access to its FLEs and their corresponding customers. These FLEs are in regular contact with their customers, and specifically, with the CCP responsible for payroll administration. Our dyadic sample in this research consisted of 24 employees and their corresponding 143 CCPs.

24 employees

In our research, there exists a one-to-many relationship. One FLE could have more than one customer. Specifically, there were 60 FLEs and 216 customers in the dyads. Of those 60 FLEs, 34 served more than one customer. We have taken serving more than one customer as a selection criterion. We invited those 34 FLEs to participate in this research, and 24 accepted. They provided input for our QCA study and were active in six focus groups.

Six focus groups

In total, six focus groups were conducted at four locations (see table 1). Each focus group was audiotaped and transcribed. The topics discussed were used to gain insights into the specific mechanisms between FLEs and CCPs. First, we explained the rules of the focus group and

where the research was situated. Then, we explained the questions. Prior to the discussion, we gave the participants a written overview of all questions. For five minutes, they were able to write down the essence of their answers. This was done to avoid group bias (Bryman and Bell, 2015). The discussion began with open questions, and each time we asked for examples. We then focused on questions derived from the research.

Location	**Number of participants (Oct 2018–Nov 2018)**
Roeselare	4
Antwerp 1	4
Antwerp 2	3
Hasselt	4
Leuven 1	5
Leuven 2	4

Table 1. Locations and attendees from the six focus groups

Survey

We received 234 responses and were able to match 216 customer CCPs with their corresponding FLE (from the supplier). For our 24 employees, there were 143 (out of 216) corresponding customers. These 143 customers were the customers serviced by the corresponding 24 employees and are the subject of our analysis. This survey took place during the fourth quarter of 2018.

Job demands and job resources are individual-level variables of the FLE. They do not change for every customer. For these two independent variables, we have 24 responses (the JD and JR questionnaires were completed separately during our focus groups).

Customer demand, customer resources, and employee need fulfilment are variables measured at the customer level. The FLEs completed one questionnaire for each of their corresponding customers. For these three independent variables, we have 143 responses. Because we focus on the dyads, we work with 143 records (not with 24). Together with the six focus groups, they form the sample for this study.

Measures

We first explain the scales of the four conditions and our outcome variables, then we discuss the calibration. For all conditions, an exploratory factor analysis (EFA) was carried out using SPSS. For each condition, the items loaded on one factor, except for the outcome variable,

which loaded on two factors. All items are presented in appendix 1, the dataset is included in appendix 6, and the pattern matrix for the outcome variable is in appendix 2.

Job demands were measured using the COPSOQ III (Kristensen *et al.*, 2005) medium-length questionnaire. We have a heterogeneous sample, and we selected two job demands that are present across various jobs and organisations and are frequently studied within the JD–R model. We follow the same reasoning as Broeck *et al.* (2008) and focus here on quantitative workload demands and emotional demands.

For each dimension we took the most important items (score Core and Middle in the COPSOQ III questionnaire) from the medium-length questionnaire. Only for quantitative demands did we use the short questionnaire (three items). We measured a total of six items for job demands. All items loaded on one factor, and the alpha reliability was .899.

Job resources were also measured using the COPSOQ III (Kristensen *et al.*, 2005) medium-length questionnaire, except for the dimension on feedback, for which we used the questionnaire designed by Broeck *et al.* (2008).

Here, we again have a heterogeneous sample, and we selected three job resources that are presented across various jobs and organisations and are frequently studied within the JD–R model. For the selections of the dimensions, we follow well-established reasoning (Broeck *et al.*, 2008; Schaufeli and Bakker, 2004) and focus on positive feedback, quality of leadership, and social support from colleagues and supervisor.

For each dimension, we took the most important items (score Core and Middle in the COPSOQ III questionnaire) from the medium-length questionnaire. Only for quality of leadership did we use the short questionnaire. We measured 10 items for job resources. All items loaded on one factor, and the alpha reliability was .852.

Customer demands were measured using Stock and Bednarek's (2014) scale, which was originally developed by Dormann and Zapf (2004) to measure customer-related stressors. In their study, Stock and Bednarek (2014) exclusively retained those items that capture stressors independent from FLEs' tasks, and are directly associated with the FLE–CCP relationship. In our study, we departed from this list of nine items by holding a workshop with 15 FLEs to verify which items were most representative of the context in which their work was conducted and the types of relationships they typically formed with customers according to the type of

services provided. Based on this workshop, four items were included to assess customer demands experienced by the employee with the focal customer in mind; for example, one survey item states 'This customer argues all the time'. An exploratory factor analysis confirmed that all four items were loaded onto a single factor, and the reliability was very good (α = .870).

Customer resources were measured using the scale developed by Stock and Bednarek (2014) that comprises eight items (e.g. 'The interaction with this customer gives me a lot of energy'). EFA confirmed that all eight items were loaded onto a single factor, and the scale's reliability was excellent (α = .894).

For *need fulfilment*, we measured each FLE's satisfaction with their fulfilment of the three basic psychological needs (autonomy, belonging, and competence) through the relationship with each respective customer based on the validated, shortened version of the work-related basic need satisfaction (WBNS) scale (Broeck *et al.*, 2008). The items were worded differently to capture each FLE's perspective regarding their need fulfilment in relation to each CCP. In order to ensure that these changes captured the conceptualisation of basic need fulfilment and maintained strong face validity from an employee perspective, these changes were made via an iterative validation process in which both employees (who did not participate in the main research) and academic experts in the fields of methodology, SDT, human resources management and service management were involved.[2]

This scale comprises nine items that capture the perceived degree of fulfilment for autonomy, competence, and belonging at work, each of which was measured by three items; for example, a sample item in the original WBNS that reads, 'I feel free to do my job the way I think it could best be done,' became 'I feel free to do my job for this customer the way I think it could

[2] We set up a twofold process. One step was the validation we did with users, and the second was the validation with six academic experts in methodology and service management. The validation process with the users involved three steps. First, we did an individual validation with five users. Second, we organised two workshops with eight users to examine the practical relevance of the items. Third, we further validated the items with the users following an iterative approach based on the feedback of the experts. In the validation process with the experts, we first identified the experts, asked for their feedback, assembled the feedback, and then re-discussed the items with the experts. We made adaptations and conducted retests with the users and the experts. In the workshops, we have built in real reflections with the respondents. We have always asked about the meaning and perception of the questions. We also tested practicability and usability.

best be done,' in our study. We conducted another EFA, and the items loaded on two factors. We named one factor 'autonomy and competence' (AC), which included the loadings of the six items that measure autonomy and competence. The second factor we named 'belonging' (B), and it included the loadings of the three items that measure belonging. These two factors achieved excellent Cronbach's alpha scores ($\alpha = .927$ and $\alpha = .874$).

This means that we have two outcome variables, therefore, we duplicated our analysis. First, we analysed the conditions with factor AC, and then we analysed the conditions with factor B. To summarize our four conditions, we have six (JD), ten (JR), four (CD), and eight (CR) items, or a total of 28 items. All conditions and the outcome variables were measured using validated 5-point Likert scales, which have been used in prior research.

Calibration

In this study we use the fuzzy set QCA approach (Ragin, 2008). Fuzzy means that we can make differentiations between 0 and 1 by expressing the degree of presence of the concept in a specific case. For that reason, an important step is the calibration of the sets membership.

All operations were completed in R version 3.4.4 using the packages QCA and SetMethods (Duşa, 2018; Oana and Schneider, 2018). This software calibrates all scores based on three anchors (the exclusion anchor, the crossover point, and the threshold for complete inclusion in the set). The scores brought together in the sets formed the input for the calibration function in QCA.

The criteria to calibrate conditions must be external to the data (Fiss *et al.*, 2013). In the direct method, we have to define when a case is a full member (score 1), a non-member (score 0), and the point of maximum indifference about the set membership (the crossover point ; score .5). In this study, we used the logic behind a Likert scale to define the three anchor points. A score of 3 on a 5-point Likert scale became the .5 logical anchor.[3] We defined score 1 as fully out and score 5 as fully in.

[3] We actually used 3.01 to avoid scores on the diagonal.

Additionally, a robustness check was performed (Schneider and Wagemann, 2012) to evaluate the process of calibration and the choice of consistency levels. We performed several other anchors and checked score 4 as a logical crossover (.5 logical anchor).[4]

We also used the indirect method of Cheli and Lemmi (1995). They addressed the fuzzy and relative poverty measures and proposed a method called TFR (totally fuzzy and relative) based on rank orders. This technique uses an empirical cumulative distribution function on the observed data. TFR creates from skewed data a normalized version by applying a transformation to recode scores between 0 and 1. We applied this in QCA software. Numerous options and combinations have been analysed (see appendix 3 and appendix 4). The number of cases linked to the configurations is also very high. Furthermore, we did not drop or add cases. Overall, we conclude that our analysis is robust. No meaningful deviations occur based on the variation of the anchors, the high number of cases (frequency threshold), or the method used (direct or TFR).

RESULTS

Analysis of Necessity

Unlike correlations, sets are asymmetric. If a condition X is necessary for an outcome Y, the inverse relationship does not automatically hold for their absence. For this reason, we perform the analysis of necessity separately for the presence of the outcome Y and for its absence.

We first test whether any condition is necessary for employees' need fulfilment. Causal necessity shows that the outcome is a subset of the causal condition. The inclusion or consistency score (*incl*) renders the proportion of the set Y that is included in the set X (condition X). A full inclusion gives an *incl* score of 1. Conventionally, to consider a condition to be necessary for the outcome, the *incl* score has to be higher than .90 (Ragin, 2006; Schneider, 2018; Thomann, 2019). Furthermore, the coverage score is a measure of how trivial a necessary condition is. In an Euler diagram, trivialness is the proportion of the area within condition X that is covered by the set Y. For fuzzy sets, coverage/necessity means that all (most) cases are located below the diagonal. Coverage is calculated by the covN score. In addition, we test the relevance of necessity by the RoN score. The closer values are to the

[4] Here we checked 3.99 to avoid scores on the diagonal.

diagonal and the further they are from the right side of the plot, the more relevant a condition X becomes as a necessary condition. A perfect RoN is met when cases are found in the upper-right and lower-left part of an XY plot divided into four quadrants (Duşa, 2018). We show in figure 1 the corresponding necessity plot for the condition, JR, and the outcome variable, NeedsAC.

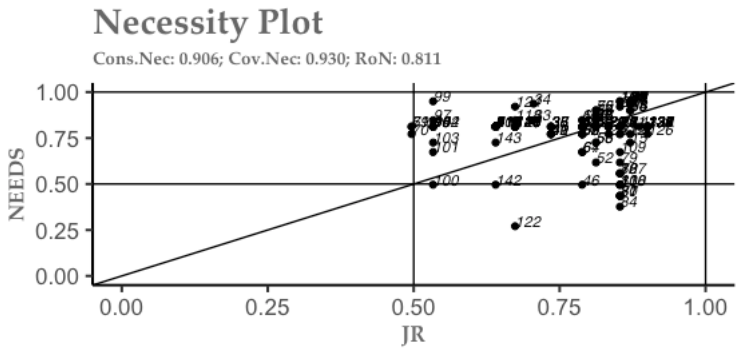

Figure 1. Necessity plot of Job Resources for the outcome variable, NeedsAC

Coverage and relevance should be higher than .60 (Ragin, 2006; Schneider, 2018; Thomann, 2019). In tables 2 and 3, we present the analysis of the necessary conditions and their corresponding inclusion and coverage scores for the two outcome variables. In appendix 3, we include all 10 settings for which we performed the QCAfit function.

For the outcome variable, NeedsAC, only Job Resources meets the criterion of .90 consistency, a coverage and a relevance higher than .60. For the outcome variable, NeedsB, Job Resources and Customer Resources almost meet the criterion of .90 consistency, a coverage and a relevance higher than .60. The negation of the conditions (negative output is true) led to no necessary condition for both outcome variables.

We conclude that there is only one necessary condition of Job Resources for the NeedsAC outcome variable. All conditions will be included in the subsequent analysis of sufficiency.

Conditions	**Consistency(inclN)**	**Coverage(covN)**	**Relevance(RoN)**
Job Demands	.667	.931	.918
Job Resources	**.906**	**.930**	**.811**
Customer Demands	.155	.980	.997
Customer Resources	.783	.986	.977
~ Job Demands	.544	.985	.989
~ Job Resources	.293	.998	.999

~ Customer Demands	.981	.883	.549
~ Customer Resources	.464	.981	.988

Table 2. Analysis of necessary conditions for the outcome variable, NeedsAC, with settings crossover = 3.01, necessity is true, and negative out is false

Conditions	**Consistency(inclN)**	**Coverage(covN)**	**Relevance(RoN)**
Job Demands	.762	.881	.867
Job Resources	.919	.781	.579
Customer Demands	.177	.929	.990
Customer Resources	.870	.907	.865
~ Job Demands	.571	.857	.900
~ Job Resources	.348	.982	.995
~ Customer Demands	.990	.738	.352
~ Customer Resources	.518	.906	.947

Table 3. Analysis of necessary conditions for the outcome variable, NeedsB, with settings crossover = 3.01, necessity is true, and negative out is false

Analysis of Sufficiency

The truth table is the analytical tool we use to perform the analysis of sufficiency of the causal combinations. This is done via QCA using R software. Each configuration in the truth table has a consistency score, *inclS*. This is the sum of the fuzzy intersection between X and Y divided by the sum of all values in X, and it reflects how much of X is included in Y. Furthermore, we use the PRI score (proportional reduction in inconsistency). A high PRI score is needed to decide in which subset (in the case of simultaneous subsets) the relations occur. Furthermore, in the sufficiency relation, the coverage indicates how much of the entire outcome Y is explained by the causal condition X. CovS shows how much of the outcome Y is explained (// R-squared) by a set. CovU shows how much of that explanation can be uniquely attributed to that set. In other words, suppose you have two sufficient conditions, X and T, that cover part of Y. CovS is the union of the sets of X and T, and CovU of X is the part of X that is not covered by T (X~T).

We performed all analyses for each outcome variable (NeedsAC and NeedsB). The four conditions resulted in 2^4 or 16 potential combinations of the causal conditions. We used the truthTable function and applied a minimization on the output (minimize function). For the complete truth tables, we refer the reader to appendix 5. All truth table configurations with cases are used. This resulted (see tables 5 and 6) in three configurations of conditions leading to high need fulfilment. These three configurations are exactly the same for the two outcome

variables. As all cases are used, and there are no logical remainders, further minimization is not possible; all conditions are minimized and, as a result, the conservative solution is identical to the intermediate and parsimonious solutions. Also, the prime implicants chart (PI) is the same for both outcome variables. This PI chart (see table 4) is a matrix with the configurations of conditions on the rows and the utilized expressions of the truth table on the columns.

Condit./TT row	**5**	**6**	**7**	**11**	**13**	**14**	**15**
JR and cr	X	X	-	-	X	X	-
JR and cd	X	-	X	-	X	-	X
JR and CR and cd	-	-	-	X	-	-	X

Table 4. Prime implicants chart—conditions versus utilized truth table combinations for both outcome variables

Rows with consistency scores (*inclS*) that exceed .80 are considered sufficient for the outcome (Ragin, 2006; Schneider, 2018; Thomann, 2019). For both outcome variables, *inclS* is higher than .90. In large-N studies, the frequency threshold should be such that a large number of the cases are used (Greckhamer *et al.*, 2013). In this study, the frequency threshold is set to 1. Seven rows pass the consistency threshold. The remaining nine rows have no cases in the configuration and are, therefore, not considered for the outcome.

The solution formula consists of three sufficient terms or pathways that cover, or explain, 91.8% (for NeedsAC) and 93.6% (for NeedsB) of all the instances. This indicates that, for the outcome employee need fulfilment, our model does have explanatory power. All terms have relatively high consistency and raw coverage values, and PRI scores > .65. The unique coverage of each term is low because several cases are members of more than one sufficient term; 81 cases are multiple-covered (57%).

In appendix 4, we provide all 10 settings for which we performed the sufficiency analysis. In figure 2, we illustrate for the outcome variable, NeedsB, the sufficiency plot for each pathway. In tables 5 and 6, we show the solution configurations for the two outcome variables. For both outcome variables, we present the conservative solution.

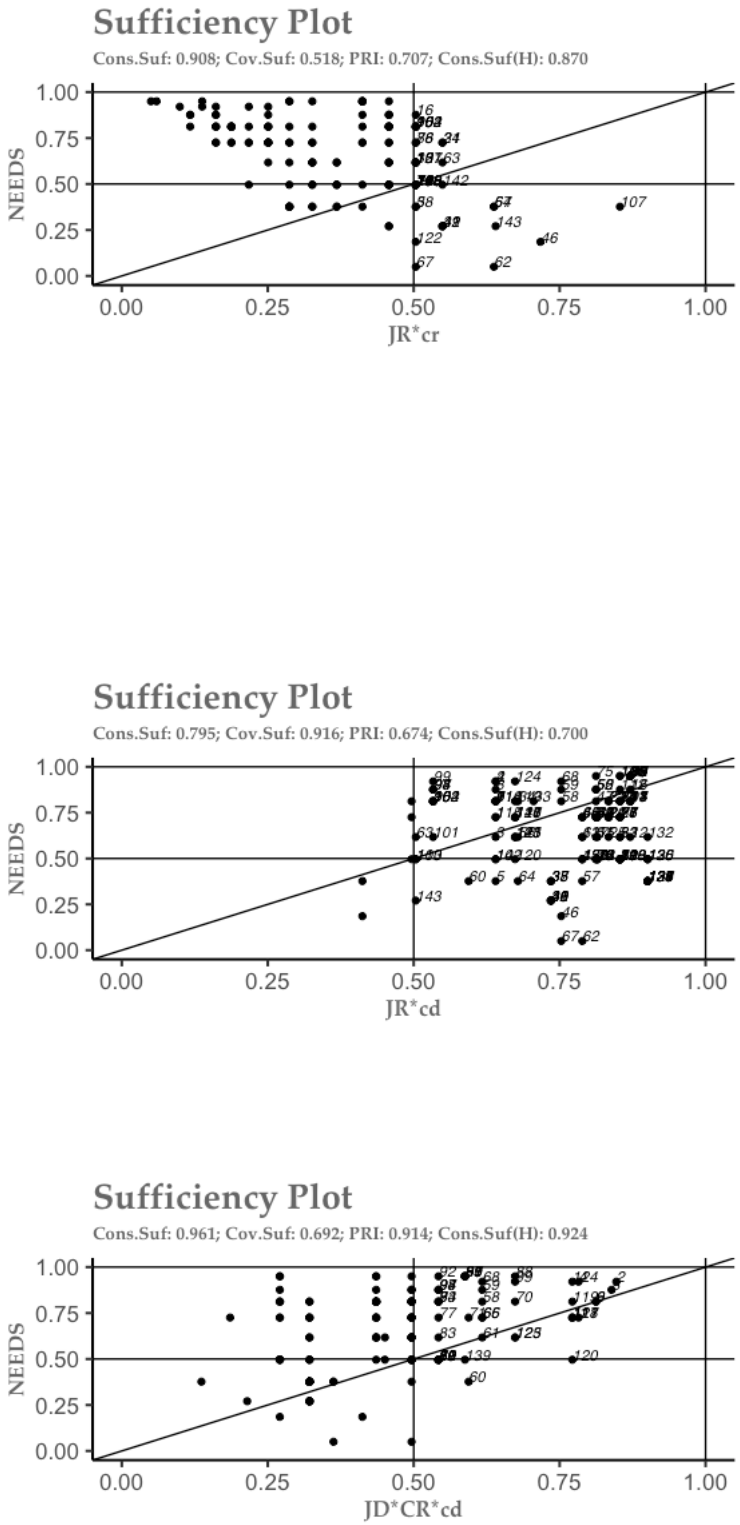

Figure 2. Sufficiency plots of the three pathways to the outcome variable, NeedsB

Conditions/Configurations	**1**	**2**	**3**
Job Demands			●
Job Resources	●	●	
Customer Demands		⊗	⊗
Customer Resources	⊗		●
Consistency (inclS)	.982	.939	.989
PropRedIncons (PRI)	.961	.917	.981
Raw Coverage	.464	.897	.590
Unique Coverage	.003	.275	.018
# cases (% of sample)	40 (28%)	138 (96%)	46 (32%)
Overall Solution Consistency	.937		
Overall Solution PRI	.914		
Overall Solution Coverage	.918		

Table 5. Solution configurations explaining outcome 1 (NeedsAC), crossover 3.01

Note. Full circles indicate the presence of a condition. Crossed-out circles indicate the absence of a condition. All truth table configurations are used, and all conditions are minimized.

Conditions/Configurations	**1**	**2**	**3**
Job Demands			●
Job Resources	●	●	
Customer Demands		⊗	⊗
Customer Resources	⊗		●
Consistency (inclS)	.908	.795	.961
PropRedIncons(PRI)	.707	.674	.914
Raw Coverage	.518	.916	.692
Unique Coverage	.000	.209	.019
# cases (% of sample)	40 (28%)	138 (96%)	46 (32%)
Overall Solution Consistency	.791		
Overall Solution PRI	.673		
Overall Solution Coverage	.936		

Table 6. Solution configurations explaining outcome 2 (NeedsB), crossover 3.01

Note. Full circles indicate the presence of a condition. Crossed-out circles indicate the absence of a condition. All truth table configurations are used, and all conditions are minimized.

For both outcome variables we obtain the same pathways. The first and third solutions show a low unique coverage. However, these solutions do have a large number of empirical cases. The pathways differ in empirical strength, but this does not mean that one path is better than another. The pathway with the highest coverage (most cases) is the second path, but all paths have a high coverage and represent a high number of cases. Figure 3 provides a graphical

representation of the QCA solution formula and visualizes the interplay between the variables.

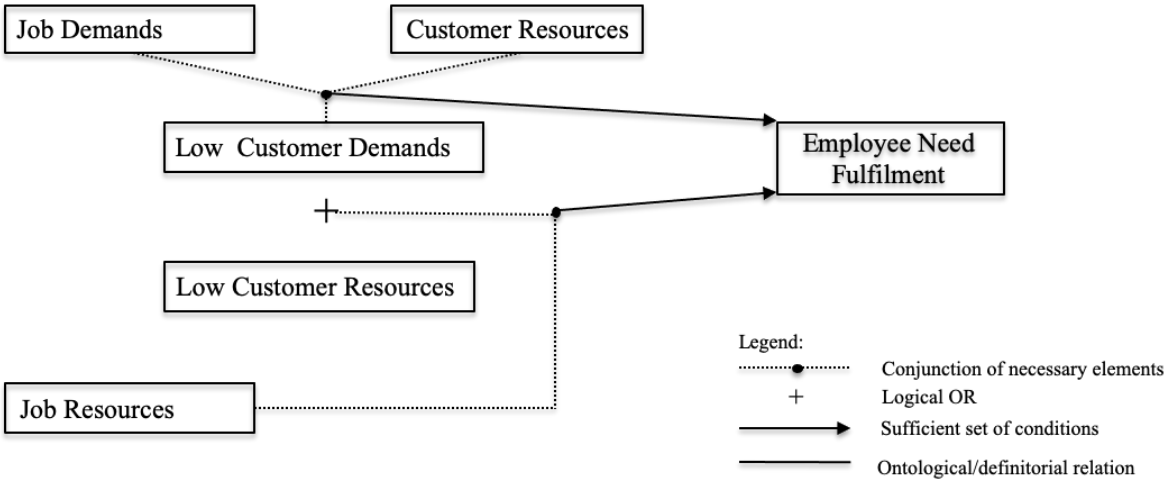

Figure 3. Graphical illustration of the solution formula

In figure 4, we present the solution formula in three star charts. We use star charts to compare the 'shape of recipes' of the three pathways. This gives a good picture of the diversity of the three recipes.

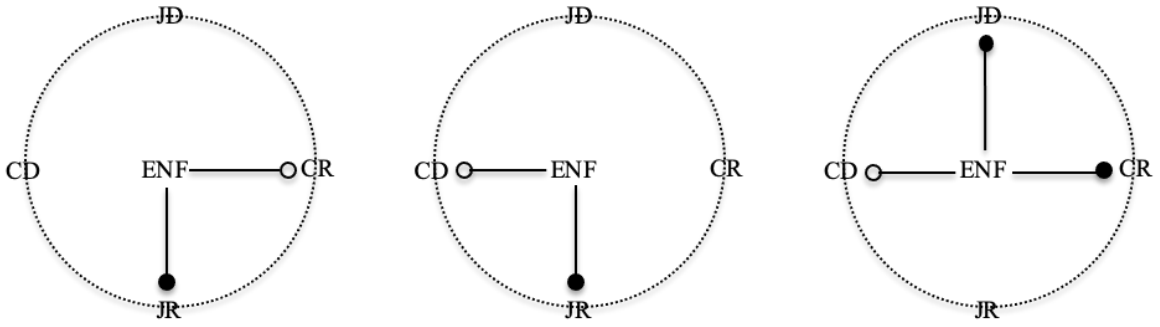

Figure 4. Star charts of the solution formula

Note. Full circles indicate the presence of a condition. Blank circles indicate the absence of a condition.

DISCUSSION

Based on our findings, we can draw some conclusions. We provide a number of illustrative examples below, based on the focus groups with FLEs (see the methods section above for more details).

First, no single condition of our model can explain both outcome variables. Job Resources explains need fulfilment of autonomy and competence but not need fulfilment of belonging. Instead, we identify specific combinations that are sufficient for both outcome variables (conjunctural causation). We show that need fulfilment results from the interdependence of multiple conditions. Between two and three conditions are required in each configuration, and all four conditions are needed overall. Additionally, we find different combinations (equifinality), and three configurations lead to the same outcome. These configurations are the same for both outcome variables. We further found that one condition, customer resources, is causally related in condition 3, unrelated in condition 2, and equally inversely related in condition 1 (asymmetry). The high coverage of the overall solution term for both outcome variables demonstrates that our model performs well when explaining employee need fulfilment.

Second, this study contributes to the JD–R literature by bringing the customer into the debate. Expanding the demands and resources with customer elements provides a better insight into the way in which the FLEs' needs are fulfilled. As cited by respondents R1 and R2, respectively: 'My autonomy consists of how and when I approach things for the customer', and 'I feel less competent if I first have to do research to answer a customer, and the customer is pushy to get an answer right away'.

Previous research has mainly focused on the impact of different demands and resources but not on the interplay (Bakker and Demerouti, 2007; Cooman *et al.*, 2013). In our study, we moved away from this correlational approach. By bringing the customer in, and by analysing the interplay and its effects on ENF, we believe we have contributed to the JD–R literature.

Third, this study also contributes to the SDT literature. We studied ENF from a dyadic perspective and demonstrated the impact of the individual customer employee on the need fulfilment of the supplier employee. ENF is influenced not only by job demands and resources, but also by customer demands and resources. The ENF changes according to the customer for whom they are currently working. As noted by respondent R3, 'I need to feel how every customer wants to work. I can make suggestions, but sometimes a client doesn't respond, and then I have to let it go. Other clients do go along with it, and then I get trust from those clients'.

Fourth, through our empirical work, we provide evidence for the causal complexity, as we found three paths leading to the outcome variables. The *first path* reveals that high job resources with low customer resources lead to ENF. It is the only path with the condition, low customer resources. A high job resource tolerates low customer resources, and even then the combination leads to ENF. The cases in this configuration path (job resources and no customer resources) are also covered by another path (for 95% in path 2: job resources and no customer demands). This is a consequence of the minimization completed by the software. It could be said that there is an overlap and that there is actually a larger path: job resources, no customer demands, and no customer resources.

The *second path* reveals that high job resources and low customer demands lead to ENF. This is a logical path that follows the JD–R logic. Cooman *et al.* (2013) found, in a correlational way, that job demands thwart, and job resources promote, the fulfilment of psychological needs. This path confirms such reasoning. As mentioned by R4, 'By forwarding questions (as FLE) to the second line, I just got the time to do what I have to do, I always ran out of time for that'.

The *third path* indicates that high customer resources with high job demands and low customer demands lead to ENF. This suggests that a challenging job, where a lot is expected (high job demand), in combination with a customer who supports the FLE, leads to ENF. This is in line with findings that front-line employees with high customer orientation appraise job demands as less threatening (Babakus, Yavas, and Ashill, 2009). As noted by two respondents, R5 and R6, respectively: 'I have a positive relationship with the client. If I sometimes give a wrong answer, my contact person will be able to turn a blind eye to it, so that it doesn't escalate every time', and 'You get a lot back from clients, but the job is also very stressful'.

From a theoretical perspective, it could be said that, given the fact that the job develops to a large extent on the relationship with the customer, in supporting the high job demand (the target, the pressure, etc.) the customer plays a huge role as a resource (Vargo and Lusch, 2004; Zimmermann *et al.*, 2011). As respondents described, in a lot of those direct customer jobs, challenging targets and the weight of the job comes largely from the organisation, but how you feel, or whether or not you find pleasure in your work, comes from the 'supporting' customer (high customer resources). As said by R7, 'I get energy from clients when I can teach them new things and when I get a compliment afterwards that they have learned

something'. Likewise, R8 noted, 'If clients tell me more than is strictly necessary, it gives me energy. Some customer contact persons call me regarding their personal situation'.

Fifth, we found that job resources is not a sufficient condition for ENF when there is a combination of high job demands, high customer resources, and low customer demand. In the absence of high customer resources, high job demands, and low customer demands (which is the case in solutions 1 and 2), job resources are important for ENF.

Sixth, the fact that no specific condition returns in all three pathways demonstrates the complexity and supports equifinality thinking (Fiss, 2011). It shows that the interplay between the variables is more important than the variables themselves.

Seventh, we found that job resources is a necessary condition for the outcome NeeedsAC but not for NeedsB. The FLE needs for belonging are broader than just the job resources in the job context. The aspect of the customer cannot be neglected, as it is part of the FLE's activities. The customer appears to be a viable coping resource in front-line employee need fulfilment of belonging, as indicated by the different configurations. As quoted by some of the respondents, including R9, 'Client involvement is a very important part of my job. It gives a lot of satisfaction'. R10 stated, 'I am the confidant for the customer. The client is very happy when I am back after my absence, even if he was well served by others in my absence'.

Eighth, the fact that for all pathways a combination of job and customer conditions is needed proves that a mix of the conditions is required.

Ninth, the QCA results show the same sufficient configurations of conditions for high needs fulfilment measured by the two outcomes, 1) autonomy and competence and 2) belonging. We see no difference between the need fulfilment of autonomy and competence and the need fulfilment of belonging of the FLE.

Management implications

There is a multitude of empirical support for self-determination theory that states that when basic needs (ABC) are met, people are full of energy, take initiative faster, and face problems more easily. With this paper, we bring insight to the impacts of the customer and the job on the fulfilment of the basic needs of the supplier front-line employee. Until now, need fulfilment has mainly been examined from the context of the organisation itself, and this research shows that ENF is also related to customer demands and resources. In today's

context (digitization, labour shortage in the West, burn-out and well-being, etc.; *The Economist*, 2019), in-depth insight into the operation of the front line between the customer and the supplier is important

Our findings have consequences for the employees of customers and suppliers. The configurational approach shows that the relationship between the conditions is important. Focus on job resources alone is insufficient and possibly counterproductive. High job demands can be perfect if there is a high level of satisfaction or appreciation of the customer. Likewise, job demands is a relative concept. A good relationship with the customer allows employees to process more job demands. This requires the supplier to think differently about the relationship with the customer (e.g. how can they deploy higher customer resources?). This has a dual effect, higher ENF of the supplier and better service, due to the higher job demands that the FLE can handle. When faced with a complex reality that has several solutions, nuance is more than necessary, and with homogeneous measures, we overshoot our goal. High job demands can be achieved if the customer can be seen as a resource—this means managing the customer and managing the employee to turn them into a resource. Organisations invest a lot of money in training to build 'competence'. They have a strong training department and a knowledge centre focused on competence. In stark contrast, organisations do not spend time training to enhance 'belonging'. FLEs do what they think is effective. For example, how does an FLE deal with a difficult customer or CCP? One FLE might respond 'let him simmer', while another FLE is soon inclined to take over the duties of the CCP. We also find affective outcomes in the customer relationship involving belonging, so we should be focused not only on the cognitive aspects of these questions, but also the affective concerns.

Customer resources also involves making the customer a part of innovation and co-creation—in a society where every product becomes a service, it is critical to feel the pulse of the customer—but in a way that 'nourishes' work and does not lead to burnout of the front-line employee. The customer is also not a king at the expense of everything—again, the FLE needs to be trained in how to deal with unacceptable customer behaviour. The role of the supervisor is also crucial in recognizing the signals and supporting the front-line employee.

Limitations and Suggestions for Future Research

In this study, we focus on FLEs of the customer and the supplier and not on the organisations themselves. We followed a dyadic approach between the employees (micro). In parallel,

measuring the effects from an organisational perspective (macro) would clarify the relationship between micro and macro. This means more conditions, which in turn makes interpretation more difficult. After all, the number of combinations increases exponentially with each condition. Our findings mainly provide insight into the 'what'—what are the configurations that explain ENF? More research is needed to find out why these combinations lead to ENF and according to which process (how) this happens.

To test for causality, the concept of time is essential and should be used in future research. The development of tQCA is a crucial challenge and will bring greater insight into the causal structure.

The external validity of our research should be evaluated in other contexts. Here, we only examined the dyadic relationships of an HR service provider in a B2B context. Extending the research to other sectors is necessary to generalize the conclusions.

Conclusion

This paper studied the necessary and sufficient conditions for front-line employees' need fulfilment and brought insight to the complex relationships between job demands and resources and customer demands and resources. We found evidence for the causal complexity, as we found three paths leading to the outcome variable.

Customer resources is a condition that occurs in all three solution paths, and in an asymmetric way. High job demands together with high customer resources and low customer demands can lead to need fulfilment. In this way, we bring nuance to the idea that demands usually thwart need fulfilment. This underlines the importance of the interplay between the variables.

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APPENDIX 1 Measures and items

Measures and items

OUTCOME VARIABLE (Employee Need Fulfilment) 1 (work-related basic need satisfaction [WBNS] scale, Broeck *et al.*, 2010)

Autonomy satisfaction

- I feel like I can be myself at my job for this customer.
- The tasks I must do for this customer at work align with what I really want to do.
- I feel free to do my job for this customer the way I think it could best be done.

Competence satisfaction

- I feel competent at my job for this customer.
- I am good at the things I do at my job for this customer.
- I have the feeling that I can even accomplish the most difficult tasks at work for this customer.

OUTCOME VARIABLE 2 (work-related basic need satisfaction [WBNS] scale, Broeck *et al.*, 2010)

Belonging satisfaction

- At work, I feel the customer and I are part of a group.
- I can talk with this customer about things that really matter to me.
- This customer I work with is a close friend of mine.

CONDITION 1 Job demands COPSOQ III

- Is your workload unevenly distributed, so it piles up?
- How often do you not have time to complete all your work tasks?
- Do you get behind with your work?

- Does your work get you in emotionally disturbing situations?
- Do you have to deal with other people's personal problems as part of your work?
- Is your work emotionally demanding?

CONDITION 2 Job resources COPSOQ III & Van Den Broeck

- I mainly get positive feedback about my working method.
- I mainly get positive feedback about the results of my work.
- I mainly get positive feedback about the amount of work I do?

To what extent, would you say that your immediate superior..:

- Make sure that team members have good development opportunities?
- Is good at work planning?
- Is good at solving conflicts?
-
- How often is your immediate supervisor willing to listen to your problems at work, if needed?
- How often do you get help and support from your immediate supervisor, if needed?
- How often do you get help and support from your colleagues, if needed?
- How often are your colleagues willing to listen to your problems at work, if needed?

CONDITION 3 Customer demands: 4 items (Stock and Bednarek, 2014; Dormann and Zapf, 2004)

- This customer argues all the time.
- This customer is unpleasant.
- This customer is hostile.
- My work rhythm is steadily interrupted by this customer.

CONDITION 4 Customer resources: 8 items (Stock and Bednarek, 2014; Dormann and Zapf, 2004; Zimmermann *et al.*, 2011)

- The interaction with this customer is a personal enrichment for me.
- Through interaction with this customer, I develop myself personally.
- This customer gives me emotional support.
- The interaction with this customer gives me a lot of energy.
- This customer supports me in delivering my performance.
- This customer gives me valuable professional feedback.
- The interaction with this customer is a professional enrichment for me.
- This customer gives me valuable information.

APPENDIX 2 Factor Analysis of the items

(SPSS : Extraction Method: Principal Axis Factoring and Rotation Method: Oblimin with Kaiser Normalization).

Loadings for outcome variable needs on 2 factors:

Pattern Matrix[a]

	Factor	
	1	2
Aut1	.659	
Aut2	.610	
Aut3	.735	
Comp1	.919	
Comp2	.979	
Comp3	.904	
Belong1		.774
Belong2		.849
Belong3		.839

APPENDIX 3 Details of different settings : Necessary Conditions

An overview of our necessary conditions

Setting	Conditions	Incl (consistency)	CoverageN(necessity)	Relevance RON	**nr**
1 NEED c=2,99 DM	JR	0,920	0,898	0,744	**1**
	CR	0,828	0,988	0,979	
	Ny cr	0,968	0,649	0,830	
1 NEED c=3,1 DM	JR	0,918	0,896	0,743	**2**
	CR	0,825	0,987	0,979	
	Ny cr	0,969	0,649	0,827	
1 NEED TFR	CR	0,809	0,795	0,800	**3**
1 NEED c=3,99	JR	0,836	0,800	0,816	**4**
	Ny cr	0,983	0,780	0,736	
2 N AC c= 2,99	JR	0,908	0,931	0,812	**5**
2 N AC c= 3,01	JR	0,906	0,930	0,811	**6**
2 N AC c=3,99	jd	0,815	0,729	0,701	**7**
	JR	0,817	0,843	0,850	
	cr	0,853	0,753	0,712	
	Ny cr	0,978	0,714	0,682	
2 N B c=2,99	CR	0,873	0,908	0,864	**8**
2 N B c=3,01	CR	0,870	0,907	0,865	**9**
2 N B c=3,99	Ny cr	0,931	0,836	0,788	**10**

APPENDIX 4 Details of different settings : Sufficient Conditions

Setting	Conditions	nr
1 NEED c=2,99 DM	> sol_yc n OUT = 1/0/C: 143/0/0 Total : 143 M1: JR => NEEDS inclS PRI covS covU --- 1 JR 0.898 0.852 0.920 - --- M1 0.898 0.852 0.920 All config used	**1**
1 NEED c=3,1 DM	> sol_yc n OUT = 1/0/C: 143/0/0 Total : 143 M1: JR*cr + JR*cd + JD*CR*cd => NEEDS inclS PRI covS covU --- 1 JR*cr 0.972 0.924 0.483 0.002 **2 JR*cd 0.907 0.864 0.911 0.259**	**2**

	3 JD*CR*cd 0.992 0.985 0.623 0.019 ---------- **M1 0.904 0.861 0.932** All config used	
1 NEED TFR	> sol_yc n OUT = 1/0/C: 40/103/0 Total : 143 M1: jd*jr*CR + JD*CR*cd => NEEDS inclS PRI covS covU ---------- 1 jd*jr*CR 0.913 0.701 0.362 0.091 2 JD*CR*cd 0.907 0.784 0.539 0.267 ---------- M1 0.883 0.742 0.629 No ? in TT	**3**
1 NEED c=3,99	> sol_yc n OUT = 1/0/C: 51/92/0 Total : 143 M1: jd*CR*cd + JD*cr*cd + (JD*jr*cd) => NEEDS M2: jd*CR*cd + JD*cr*cd + (jr*CR*cd) => NEEDS ----------	**4**

```
      inclS PRI  covS  covU  (M1)  (M2)

-----------------------------------------------------

1 jd*CR*cd 0.979 0.886 0.647 0.075 0.195 0.075

2 JD*cr*cd 0.879 0.533 0.597 0.048 0.048 0.090

-----------------------------------------------------

3 JD*jr*cd 0.925 0.576 0.567 0.001 0.008

4 jr*CR*cd 0.986 0.911 0.645 0.001     0.008

-----------------------------------------------------

 M1    0.893 0.650 0.810

 M2    0.897 0.659 0.810



> sol_yp <- minimize(TT_y,

+         details = TRUE,

+         include = "?")

> sol_yp



n OUT = 1/0/C: 51/92/0

 Total   : 143



M1: JD + CR => NEEDS



   inclS PRI  covS  covU

----------------------------------

1 JD 0.830 0.499 0.635 0.108

2 CR 0.977 0.894 0.732 0.204

----------------------------------

 M1 0.855 0.595 0.839
```

2 N AC c= 2,99	> sol_yc <- minimize(TT_y, + details = TRUE) > sol_yc n OUT = 1/0/C: 143/0/0 Total : 143 M1: JR => NEEDS inclS PRI covS covU --- **1 JR 0.931 0.907 0.908** - --- M1 0.931 0.907 0.908 All config used	**5**
2 N AC c= 3,01	> sol_yc n OUT = 1/0/C: 143/0/0 Total : 143 M1: JR*cr + JR*cd + JD*CR*cd => NEEDS inclS PRI covS covU --- 1 JR*cr 0.982 0.961 0.464 0.003 **2 JR*cd 0.939 0.917 0.897 0.275**	**6**

	3 JD*CR*cd 0.989 0.981 0.590 0.018 ---------- **M1 0.937 0.914 0.918** All config used	
2 N AC c=3,99	> sol_yc <- minimize(TT_y, + details = TRUE) > sol_yc n OUT = 1/0/C: 98/45/0 Total : 143 M1: jr*cd + jd*CR*cd + JD*cr*cd => NEEDS inclS PRI covS covU ---------- 1 jr*cd 0.857 0.480 0.736 0.101 2 jd*CR*cd 0.984 0.917 0.603 0.071 3 JD*cr*cd 0.889 0.579 0.559 0.045 ---------- M1 0.838 0.543 0.853 > sol_yp <- minimize(TT_y, + details = TRUE, + include = “?”) > sol_yp	**7**

	n OUT = 1/0/C: 98/45/0 Total : 143 M1: JD + jr + CR => NEEDS inclS PRI covS covU --- 1 JD 0.836 0.518 0.593 0.062 2 jr 0.857 0.480 0.736 0.097 3 CR 0.974 0.884 0.676 0.078 --- M1 0.812 0.522 0.880	
2 N B c=2,99	> sol_yc n OUT = 1/0/C: 143/0/0 Total : 143 M1: JR => NEEDS inclS PRI covS covU --- 1 JR 0.784 0.663 0.921 - --- M1 0.784 0.663 0.921 All config used	**8**

2 N B c=3,01	> sol_yc n OUT = 1/0/C: 143/0/0 Total : 143 M1: JR*cr + JR*cd + JD*CR*cd => NEEDS inclS PRI covS covU --- 1 JR*cr 0.908 0.707 0.518 0.000 2 JR*cd 0.795 0.674 0.916 0.209 3 JD*CR*cd 0.961 0.914 0.692 0.019 --- M1 0.791 0.673 0.936 All config used	**9**
2 N B c=3,99	> sol_yc n OUT = 1/0/C: 24/119/0 Total : 143 M1: jd*CR*cd + jr*CR*cd => NEEDS inclS PRI covS covU --- 1 jd*CR*cd 0.891 0.567 0.674 0.061 2 jr*CR*cd 0.930 0.669 0.696 0.082 ---	**10**

```
 M1    0.898 0.616 0.757



> sol_yp <- minimize(TT_y,

+         details = TRUE,

+         include = "?")

> sol_yp



n OUT = 1/0/C: 24/119/0

 Total   : 143



M1: CR => NEEDS



   inclS PRI  covS  covU

---------------------------------

1 CR 0.898 0.633 0.770  -

---------------------------------

 M1 0.898 0.633 0.770
```

APPENDIX 5 Thruth Tables for the two outcome variables

OUT: output value

n: number of cases in configuration

incl: sufficiency inclusion score

PRI: proportional reduction in inconsistency

NEEDS AC

	JD	JR	CR	CD	OUT	n	incl	PRI
7	0	1	1	0	1	57	1.000	1.000
11	1	0	1	0	1	3	0.998	0.995
6	0	1	0	1	1	1	0.998	0.979
5	0	1	0	0	1	17	0.994	0.984
13	1	1	0	0	1	21	0.994	0.986
15	1	1	1	0	1	43	0.990	0.982
14	1	1	0	1	1	1	0.986	0.845
1	0	0	0	0	?	0	-	-
2	0	0	0	1	?	0	-	-
3	0	0	1	0	?	0	-	-
4	0	0	1	1	?	0	-	-
8	0	1	1	1	?	0	-	-
9	1	0	0	0	?	0	-	-
10	1	0	0	1	?	0	-	-
12	1	0	1	1	?	0	-	-
16	1	1	1	1	?	0	-	-

cases

7

11,13,14,17,18,19,20,21,22,23,25,26,27,28,30,32,33,34,35,36,37,40,43,44,45,47,48,49,50,51,52,53,54,55,56,75,76,105,106,111,112,114,115,116,126,127,128,129,130,131,132,133,134,135,136,140,141

11 69,70,71

6 107

5 12,15,16,24,29,31,38,39,41,42,46,108,109,110,113,142,143

13 3,5,57,62,63,64,67,72,73,74,78,86,95,96,100,101,102,103,104,137,138

15 1,2,4,6,7,8,9,10,58,59,60,61,65,66,68,77,79,80,81,82,83,84,85,87,88,89,90,91,92,93,94,97,98,99,117,118,119,120,121,123,124,125,139

14 122

NEEDS B

JD	JR	CR	CD	OUT	n	incl	PRI
11	1	0	1	0	1	3	0.985 0.936
15	1	1	1	0	1	43	0.965 0.919
13	1	1	0	0	1	21	0.949 0.810
6	0	1	0	1	1	1	0.945 0.284
14	1	1	0	1	1	1	0.943 0.329
5	0	1	0	0	1	17	0.926 0.659
7	0	1	1	0	1	57	0.906 0.774
1	0	0	0	0	?	0	- -
2	0	0	0	1	?	0	- -
3	0	0	1	0	?	0	- -
4	0	0	1	1	?	0	- -
8	0	1	1	1	?	0	- -
9	1	0	0	0	?	0	- -
10	1	0	0	1	?	0	- -
12	1	0	1	1	?	0	- -
16	1	1	1	1	?	0	- -

cases

11 69,70,71

15 1,2,4,6,7,8,9,10,58,59,60,61,65,66,68,77,79,80,81,82,83,84,85,87,88,89,90,91,92,93,94,97,98,99,117,118,119,120,121,123,124,125,139

13 3,5,57,62,63,64,67,72,73,74,78,86,95,96,100,101,102,103,104,137,138

6 107

14 122

5 12,15,16,24,29,31,38,39,41,42,46,108,109,110,113,142,143

7
11,13,14,17,18,19,20,21,22,23,25,26,27,28,30,32,33,34,35,36,37,40,43,44,45,47,48,49,50,51,52,53,54,55,56,75,76,105,106,111,112,114,115,116,126,127,128,129,130,131,132,133,134,135,136,140,141

Appendix 6 The dataset

Calibration in the R-script

> calibJD <- calibrate (as.vector(S[, 'JD']), method = 'direct', logistic = TRUE, thresholds = "e=1, c=3.01, i=5")

> calibJR <- calibrate (as.vector(S[, 'JR']), method = 'direct', logistic = TRUE, thresholds = "e=1, c=3.01, i=5")

> calibCD <- calibrate (as.vector(S[, 'CD']), method = 'direct', logistic = TRUE, thresholds = "e=1, c=3.01, i=5")

> calibCR <- calibrate (as.vector(S[, 'CR']), method = 'direct', logistic = TRUE, thresholds = "e=1, c=3.01, i=5")

> # 2 Needs factors AC and B, we do separate needs AC and afterwards needs B

> calibNEEDSAC <- calibrate (as.vector(S[, 'NEEDSAC']), method = 'direct', logistic = TRUE, thresholds = "e=1, c=3.01, i=5")

FLE	JD	JR	CR	CD	NEEDSAC	NEEDSB
Leuven 1_144	4,166666667	3,4	3,875	2	4	3,666666667
Leuven 1_145	4,166666667	3,4	4,25	1,5	4	4,666666667
Leuven 1_146	4,166666667	3,4	3	1,5	4	3,333333333

Leuven 1_147	4,166666667	3,4	3,875	1,25	4	4,666666667
Leuven 1_148	4,166666667	3,4	3	1,5	4	2,666666667
Leuven 1_149	4,166666667	3,4	4	1,25	4	4
Leuven 1_150	4,166666667	3,4	3,125	2	4	4
Leuven 1_151	4,166666667	3,4	4,125	1,25	4	4,333333333
Leuven 1_152	4,166666667	3,4	4	1,25	4	4
Leuven 1_153	4,166666667	3,4	3,125	1,5	4	3
Leuven 1_68	2,833333333	4,3	4	1	4,833333333	4
Leuven 1_69	2,833333333	4,3	3	1	3,833333333	3,333333333
Leuven 1_70	2,833333333	4,3	4	1	5	4
Leuven 1_71	2,833333333	4,3	4	1	4,5	4
Leuven 1_72	2,833333333	4,3	3	2	3,666666667	3,333333333
Leuven 1_73	2,833333333	4,3	3	1	5	4,333333333
Leuven 1_74	2,833333333	4,3	4	1	4,833333333	4
Leuven 1_75	2,833333333	4,3	3,625	1	4,833333333	5
Leuven 1_76	2,833333333	4,3	4,875	1	5	5
Leuven 1_161	2,5	4,1	3,75	1	4	3,666666667
Leuven 1_162	2,5	4,1	3,75	1	4	3,666666667
Leuven 1_163	2,5	4,1	3,75	1	4	4
Leuven 1_165	2,5	4,1	3,125	1	4	4
Leuven 1_166	2,5	4,1	2,875	1	3,833333333	3,666666667

Leuven 1_168	2,5	4,1	3,375	1,25	4	3,333333333
Leuven 1_225	2,833333333	4,2	3,75	1	4	3,666666667
Leuven 1_226	2,833333333	4,2	3,75	1	4	3,666666667
Leuven 1_227	2,833333333	4,2	3,75	1	4	4
Leuven 1_228	2,833333333	4,2	3	1,25	4,666666667	3
Leuven 1_229	2,833333333	4,2	3,125	1	4	4
Leuven 1_230	2,833333333	4,2	2,875	1	3,833333333	3,666666667
Leuven 1_231	2,833333333	4,2	3,375	1,25	4	3,333333333
Leuven 1 bpo_128	2,833333333	3,6	4,125	2,25	4,166666667	4
Leuven 1 bpo_129	2,833333333	3,6	4,125	2,5	4,833333333	4
Leuven 2 _169	2,5	3,7	3,625	1	4	2,666666667
Leuven 2 _170	2,5	3,7	3,125	1	4	2,333333333
Leuven 2 _171	2,5	3,7	3,375	1	4	2,666666667
Leuven 2 _172	2,5	3,7	3	1	4	2,666666667
Leuven 2 _173	2,5	3,7	2,875	1	3,833333333	2,333333333
Leuven 2 _174	2,5	3,7	3,125	1	3,833333333	2,333333333
Leuven 2 _175	2,5	3,7	2,875	1	3,833333333	2,333333333
Leuven 2 _176	2,5	3,7	2,875	1	3,833333333	2,333333333
Leuven 2 _50	2	4,4	3,25	2	4	3,666666667
Leuven 2 _26	2,333333333	3,9	3,75	1	4	3,666666667

Leuven 2 _27	2,333333333	3,9	3,5	2	4	3
Leuven 2 _30	2,333333333	3,9	2,375	2,25	3	2
Hasselt_213	3	4	4,375	1	4,166666667	4
Hasselt_214	3	4	3,375	1	4,166666667	3
Hasselt_215	3	4	3,25	1,5	4	3,666666667
Hasselt_216	3	4	4,375	1	4,5	4,333333333
Hasselt_217	3	4	3,5	1	4	3,333333333
Hasselt_218	3	4	4,125	1,5	3,333333333	4,333333333
Hasselt_219	3	4	4,125	1,25	3,666666667	3,666666667
Hasselt_220	3	4	3,625	1,75	4,333333333	3,666666667
Hasselt_221	3	4	4,375	1,25	4,333333333	4,333333333
Hasselt _222	3	4	3,125	2,5	3,666666667	3,333333333
Hasselt _130	3,333333333	3,9	2,625	1,75	3,833333333	2,666666667
Hasselt _131	3,333333333	3,9	3,5	2,25	3,833333333	4
Hasselt _132	3,333333333	3,9	3,75	2,25	4	4,333333333
Hasselt _133	3,333333333	3,9	3,375	2,75	3,833333333	2,666666667
Hasselt _134	3,333333333	3,9	3,625	1,5	4	3,333333333
Hasselt _135	3,333333333	3,9	2,625	2	3,833333333	1
Hasselt _136	3,333333333	3,9	2,875	3	4	3,333333333
Hasselt _137	3,333333333	3,9	2,625	2,5	3,5	2,666666667
Hasselt _138	3,333333333	3,9	3,5	2	3,833333333	3,666666667

Hasselt _139	3,333333333	3,9	4,125	1,5	4,166666667	3,666666667
Hasselt _140	3,333333333	3,9	3	2,25	3,5	1
Hasselt _141	3,333333333	3,9	4,125	2,25	4	4,666666667
Hasselt _158	3,5	3	3,125	2	4	3
Hasselt _159	3,5	3	3,875	2,5	3,833333333	4
Hasselt _160	3,5	3	3,625	2,75	4	3,666666667
Antw 1_98	3,166666667	4,2	3	2	4	3
Antw 1_99	3,166666667	4,2	3	2	4	3
Antw 1_100	3,166666667	4,2	3	2	4	3
Antw1 BPO_142	3	4	4,25	1	4,5	5
Antw1 BPO_143	3	4	3,375	2	4,166666667	3
Antw1 _109	5	4,2	3,125	1,25	2,833333333	3,666666667
Antw1 _110	5	4,2	3	1,25	3,166666667	3,666666667
Antw1 _111	5	4,2	3,125	1,25	3,333333333	3
Antw1 _112	5	4,2	3,125	1,25	2,833333333	3
Antw1 _113	5	4,2	3,125	1,25	2,833333333	3
Antw1 _114	5	4,2	3,125	1,25	3,166666667	3
Antw1 _115	5	4,2	3,125	1	3	3,333333333
Antw1 _117	5	4,2	3,125	1,25	2,666666667	4
Antw1 _59	4,666666667	4,3	3,25	1	5	5
Antw1 _60	4,666666667	4,3	3	2	4,5	3,666666667

Antw1 _61	4,666666667	4,3	3,25	1	5	5
Antw1 _62	4,666666667	4,3	3,5	1,25	5	5
Antw1 _63	4,666666667	4,3	3,25	1	5	5
Antw1 _64	4,666666667	4,3	3,25	1	5	5
Antw1 _65	4,666666667	4,3	3,25	1	5	5
Antw1 _66	4,666666667	4,3	3,125	1	5	5
Antw1 _67	4,666666667	4,3	3,125	1,25	4,5	4
Antw1 _77	3,5	3,1	3,125	1	4	4,333333333
Antw1 _78	3,5	3,1	3	2	4	4
Antw1 _79	3,5	3,1	3	2	4	4
Antw1 _80	3,5	3,1	3,125	1	4,166666667	4,333333333
Antw1 _81	3,5	3,1	3,125	1	4	4,333333333
Antw1 _82	3,5	3,1	3,75	1	5	4,666666667
Antw1 _83	3,5	3,1	3	3	3	3
Antw1 _55	5	3,1	3	2	3,5	3,333333333
Antw1 _56	5	3,1	3	1,5	4	4
Antw1 _57	5	3,1	3	2	3,666666667	4
Antw1 _58	5	3,1	3	2	4	4
Antw2_118	2,333333333	4,2	5	1	5	5
Antw2_119	2,333333333	4,2	3,625	1	5	5
Antw2_121	2,333333333	4,2	1,75	3,25	3,166666667	2,666666667

Antw2_122	2,333333333	4,2	3	1	3	3
Antw2_123	2,333333333	4,2	3	1	3,5	3
Antw2_124	2,333333333	4,2	3	1	3	3
Antw2_125	2,333333333	4,2	3,25	1	4	4
Antw2_127	2,333333333	4,2	3,25	1	3,833333333	4,333333333
Antw2_198	2,333333333	3,4	3	3	4	3
Antw2_199	2,333333333	3,4	3,625	2	4	4
Antw2_200	2,333333333	3,4	3,5	2	4	3,666666667
Antw2_201	2,333333333	3,4	3,75	1,5	4	4
Antw2_37	3,833333333	3,5	4	1	4	3,666666667
Antw2_38	3,833333333	3,5	4	1	4,166666667	3,666666667
Antw2_39	3,833333333	3,5	4,125	1	4	4
Antw2_45	3,833333333	3,5	3,875	1	4	3
Antw2_47	3,833333333	3,5	3,875	1	4	3,666666667
Antw2_49	3,833333333	3,5	3	3,25	2,333333333	2
Antw2_52	3,833333333	3,5	3,5	1	4	3,333333333
Antw2_53	3,833333333	3,5	4,5	1	4,666666667	4,666666667
Antw2_54	3,833333333	3,5	3,5	1	4	3,333333333
Antw2_185	2,5	4,5	3,625	1,25	3,833333333	3
Antw2_187	2,5	4,5	3,625	1,5	4	2,666666667
Antw2_188	2,5	4,5	3,625	1,5	4	2,666666667

Antw2_189	2,5	4,5	3,625	1,5	4	2,666666667
Antw2_190	2,5	4,5	3,5	1,25	4	3
Antw2_191	2,5	4,5	3,5	1,5	4	2,666666667
Antw2_192	2,5	4,5	3,75	1,25	4	3,333333333
Antw2_194	2,5	4,5	3,25	1,5	4	2,666666667
Antw2_195	2,5	4,5	3,625	1,5	4	2,666666667
Antw2_196	2,5	4,5	3,375	1,5	4	3
Antw2_197	2,5	4,5	3,5	1,5	4	2,666666667
Roeselare_154	3,333333333	3,9	3	2	4	3,333333333
Roeselare_156	3,333333333	3,9	3	2	4,166666667	3
Roeselare_157	3,333333333	3,9	3,25	2	4	3
Roeselare_211	2,833333333	3,5	3,125	1,5	4	3,666666667
Roeselare_212	2,833333333	3,5	3,125	1,25	4	3,333333333
Roeselare_223	3	3,4	2,875	2	3	3
Roeselare_224	3	3,4	2,125	3	3,666666667	2,333333333