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Exploring necessary conditions in HRM research: Fundamental issues and methodological implications

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Abstract

Although the notion that HRM activities are necessary conditions for achieving certain outcomes is widespread in HRM research, most empirical studies follow an additive sufficiency logic. That is, they analyse whether HRM activities increase an outcome, assuming that they can compensate for one another. However, this does not correspond to the idea of necessity where single HRM activities are required for an outcome to occur and cannot be compensated when absent. We discuss the differences between sufficiency and necessity logics in terms of theory, methodology, and practical relevance. Also, we suggest using a new approach and analysis technique in HRM research: necessary condition analysis. We illustrate the application of the method by analysing data on the relationship between ability-, motivation-, and opportunity-enhancing HRM practices (i.e., high-performance work practices) and employee performance. This illustrative example highlights that necessary conditions require particular theoretical attention and suitable empirical methods. The paper concludes by showing the value of studying necessary conditions, because such analyses allow straightforward recommendations to be given of high relevance for HRM practice, which differ from and add to recommendations based on additive sufficiency logic and analyses.

KEYWORDS

AMO framework, HPWPs, NCA, necessary condition analysis, necessity, sufficiency

1 | INTRODUCTION

Human resource management (HRM) research usually analyses how different HRM activities influence individual or organisational outcomes. The respective relationships can be theorised following two different logics. In a *sufficiency logic*, single HRM activities are sufficient but not necessary to increase an outcome; if one HRM activity is not in place, the outcome may be reduced, but other HRM activities can be still effective, and may compensate for the missing activity. In contrast, a *necessity logic* implies that an outcome can only be achieved if a specific HRM activity is in place. Thus, the necessary HRM activity represents a constraint, a bottleneck, or a critical factor that must be implemented at the right level to allow a desired outcome level to exist. Indeed, if this necessary HRM activity is not in place, the outcome cannot be achieved, and investments in other related HRM activities are pointless.

The notion that HRM activities are necessary for achieving specific outcomes is present in different theoretical elaborations of HRM scholars. For example, researchers state (intentionally or unintentionally) that financial incentives are *necessary* to motivate senior executives (Pepper, Gore, & Crossman, 2013), commitment is *necessary* for low employee absenteeism (Hausknecht, Hiller, & Vance, 2008), specific knowledge and skills are *necessary* for innovation (De Winne & Sels, 2010), fit between HRM and competitive strategy is *necessary* for organisational success (Paauwe & Boselie, 2007), or more generally, that an adequate set of human resources is a *necessary condition* for business survival (Boxall, 2007).

However, to date, we have very limited empirical evidence to support such necessity. This lack of knowledge relates to the analytical strategies employed in HRM research. Indeed, regression-based methods that are usually applied to analyse HRM's effects refer to sufficiency logic, in terms of $Y = a + b_1 \cdot X_1 + b_2 \cdot X_2 + b_3 \cdot X_3 + \ldots + \epsilon$.[1] In this logic, each input (e.g., a specific HRM activity) is sufficient to increase the outcome, but not necessary: A lack of an input reduces the outcome, but it will not prevent the outcome if other inputs (e.g., other HRM activities) compensate for it. This does not correspond to necessity logic, according to which the outcome will not exist and will not be impacted by the levels of other inputs if a single necessary input is missing or below a certain level (Goertz, 2003b). Thus, regression-based methodologies do not allow one to test for necessary conditions.

To date, the distinction between the sufficiency and necessity logics seems not widely acknowledged in HRM research, which has typically treated them as interchangeable, both from a theoretical and an empirical perspective. This is problematic, because the two logics have fundamentally different theoretical reasonings, and should be empirically tested using different methods. Thus, we need more clarity on the differences between sufficiency and necessity logics. Notably, this may not only help scholars in very different HRM research fields, it is also of high practical value. Indeed, exploring sufficient relationships points out which HRM activities *on average* help to increase an outcome of interest. In contrast, exploring necessary conditions can accommodate practitioners' interests in terms of which (levels of) activities are required for achieving a specific outcome (level).

We seek to highlight that necessity logic differs from sufficiency logic and should be adequately treated in HRM research. Thus, we first elaborate the particularities of sufficiency and necessity logics. Then, we suggest using a new approach and analysis technique, that is, *necessary condition analysis* (NCA; Dul, 2016; Dul, van der Laan, & Kuik, 2018), which is able to identify necessary conditions in empirical data. We will demonstrate the differences between the sufficiency and necessity logics with an illustrative example based on data on the relationship between high-performance work practices (HPWPs; Appelbaum, Bailey, Berg, & Kalleberg, 2000) and employee performance. The illustrative example shows that NCA-based results (which captures whether HPWPs are *necessary* for a certain level of employee performance) differ from regression-based results (which capture whether HPWPs are *sufficient* for

increasing employee performance on average). We will then discuss these differences and their implications in terms of theory, methodology, and practical relevance.

2 | SUFFICIENCY VERSUS NECESSITY LOGIC

The notion of necessity is widespread in HRM research. Table 1 provides several examples of statements about necessary conditions in different HRM research fields. However, even if authors refer to certain causal mechanisms as necessary conditions, we argue that necessary conditions are often not properly treated, because scholars do not always recognise the difference between sufficiency and necessity. Figure 1 illustrates a typical approach in which sufficiency and necessity logics are used interchangeably. In this approach, a statement about necessity is first introduced in a paper's introduction, theory, or hypotheses section. This statement is then reformulated as a traditional hypothesis with an unspecified association between cause and outcome (i.e., without specifying that the cause is considered to be necessary). The hypothesis is tested using variants of the general linear model (e.g., correlation, regression, or structural equation modelling), which account for additive sufficiency, but not for necessity. Finally, the confirmation of the hypothesis is interpreted as a support for the necessary statement. However, such an approach is not accurate, because sufficient and necessary relationships are conceptually distinct and pose very different hypotheses (Goertz, 2003a). The following example highlights this:

Sufficient condition hypothesis: The use of financial incentives increases senior executives' motivation.

Necessary condition hypothesis: The use of financial incentives is necessary for senior executives' motivation.

The sufficient condition hypothesis refers to sufficiency logic, according to which the use of financial incentives (pay for performance) is sufficient for increasing higher motivation of senior executives (on average). Indeed, senior executives may be less motivated if firms do not use financial incentives, but this does not have to be the case if firms use

TABLE 1 Examples of statements about necessary conditions in HRM research (emphases added)

Source	Quote
(Boxall, 2007)	"an adequate set of human resources—a capable group of people with sufficient motivation to work together productively and economically—is a *necessary condition* of business survival" (p. 63)
(Castanheira & Story, 2016)	"Commitment to the organisation and its goals has long been considered an important feature for organisational competitiveness. It is a *necessary condition* so that employees who possess valued capabilities do not choose to leave to join competing firms" (p. 986 f.)
(Dany, Guedri, & Hatt, 2008)	"Building on the resource-based view, we suggest that HRM integration is a *necessary but not sufficient condition* for HRM positively to impact organisational performance. An equally *necessary condition* is to provide HRM specialists with a prominent role compared to LMs in order to ensure the required proper quality of implementation of decided HRM policies" (p. 2095)
(De Winne & Sels, 2010)	"A unique set of knowledge and skills, receptivity to new ideas and opportunity recognition skills are all *necessary ingredients* for innovation" (p. 1864)
(Hausknecht et al., 2008)	"organisational commitment may be a *necessary but insufficient* condition for low absenteeism" (p. 1226)
(Paauwe & Boselie, 2007)	"Not only is fit between HR and competitive strategy a *necessary condition* for organisational success, but so too is institutional fit" (p. 181)
(Pepper et al., 2013)	"financial incentive is a *necessary but not sufficient condition* for motivating senior executives" (p. 45)
(Swart & Kinnie, 2010)	"knowledge assets are *necessary but not sufficient* to gain a competitive advantage" (p. 64)

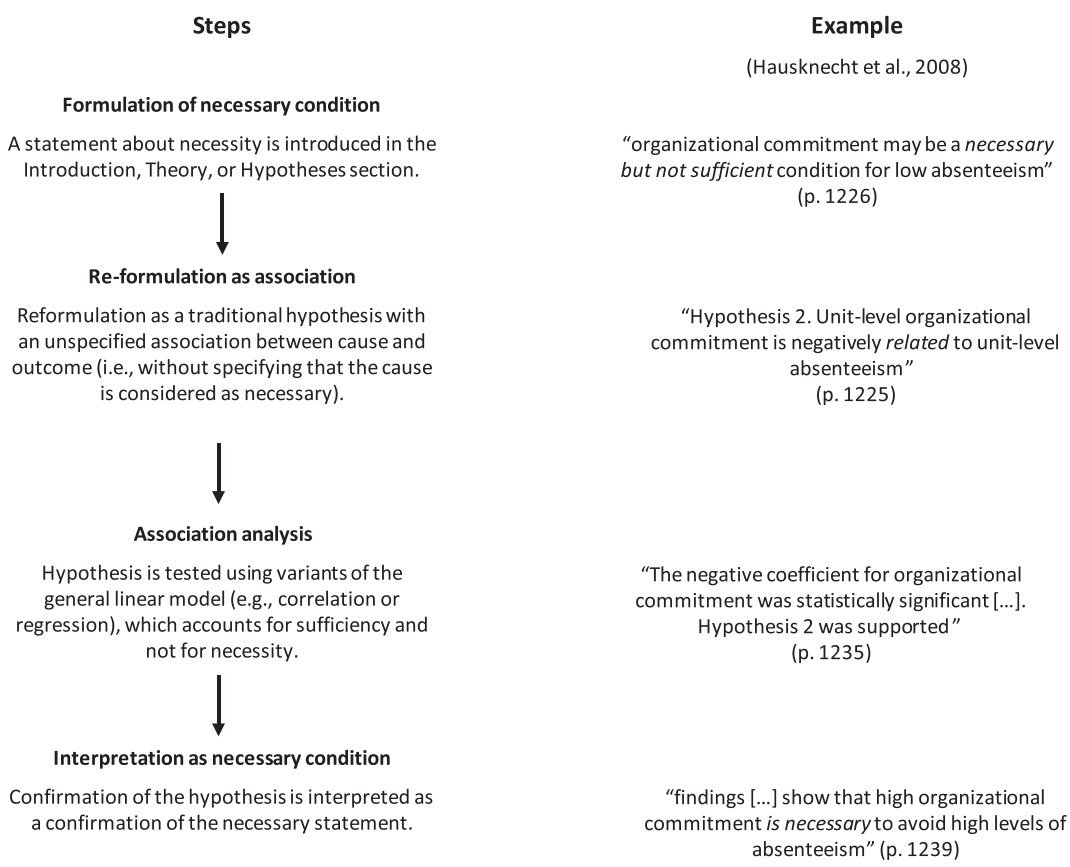


FIGURE 1 Ideal-typical approach in that sufficiency and necessity logics are used interchangeably

other HRM practices to increase motivation. For instance, motivation could also be increased via job security, a job design that gives executives autonomy, career opportunities, acknowledgement, and so forth.

In contrast, the necessary condition hypothesis refers to a constraint, bottleneck, or critical factor for an outcome. The absence of the necessary condition cannot be compensated by other factors; thus, if the necessary condition is not in place, there is guaranteed failure. In our example, the assumption of necessity implies that if firms do not use financial incentives, senior executives' motivation will not be present. Other attempts to ensure their motivation (e.g., through job security, autonomy, career opportunities, and acknowledgement) will have no effect as long as firms do not also use financial incentives. Absence of the necessary condition blocks the outcome. Notably, necessity cannot be equated with sufficiency. Necessity logic usually implies that a single determinant is *necessary*; that is, without the necessary determinant, the outcome will be absent, but other determinants may also be needed to achieve the outcome. For example, financial incentives may not be the only necessary condition for senior executives' motivation, other factors like autonomy or career opportunities may also be necessary.

The differences between sufficiency and necessity logics is reflected in the use of a particular terminology. The idea of sufficient relationships is usually expressed or implied in statements like "If X then Y," "X is associated/correlated with Y," "X has a positive effect on Y," or "X makes Y more likely to occur." In contrast, necessary condition hypotheses use expressions such as "Only if X then Y," "X must be there for Y to succeed," "X makes Y possible," or "X is a precondition/prerequisite for Y."

Another difference between the two logics concerns the related model complexity. Empirical models following a sufficiency logic are usually complex, because they must include all relevant variables for properly predicting the

outcome. In contrast, models to express necessity can be *parsimonious*. This is possible because the necessity of one X for Y does not depend on other factors. A necessary condition operates in isolation from the rest of the causal structure, because a single necessary determinant can stop the (desired level of the) outcome from being possible and can therefore individually predict the outcome's absence. Including or omitting other variables (e.g., control variables) in the model does not change the influence of the single necessary determinant of interest (Dul, 2019). For our example, this implies that the possible necessity of financial incentives does not depend on other factors. Other factors may also contribute to senior executives' motivation (e.g., autonomy or career opportunities), but this does not affect the necessity of financial incentives.

Notably, a necessary condition is not a moderator. A moderator refers to a contingent or multiplicative relation between independent variables in relation to a dependent variable (e.g., Gardner, Harris, Li, Kirkman, & Mathieu, 2017). In other words, moderation is about the interaction between two (or more) variables when influencing an outcome. This could be, for example, a strengthening or a weakening effect (i.e., a variable can increase or weaken the effect of another variable on the outcome). At first sight, it might look that the moderator is a necessary condition for an outcome, but it is not. In order to illustrate this, consider the formula for a regression line with an interaction term: $Y = a + b_1 \cdot X + b_2 \cdot M + b_3 \cdot X \cdot M + \epsilon$ (with M being the moderator, a the intercept, b the slopes, and ϵ the error term). This equation shows that M might influence the (average) effect of X on Y (through the interaction term). However, M is not a necessary condition for Y, because Y can still be positive even with M being zero. This does not correspond to necessity logic according to which the absence of a necessary condition will prevent the outcome to exist, independent of other factors.

Necessary conditions can, similar to sufficiency relationships, refer to different *concept levels*, that is, dichotomous, discrete, and continuous (Dul, 2016). Figure 2 shows graphical representations of three basic types of necessary conditions, where both X and Y have the same concept level. The X-axis represents the condition, the Y-axis represents the outcome, and the dots represent observations.

The dichotomous case (Figure 2, left) describes a situation in that the presence of X is necessary for the presence of Y. The necessity is illustrated though an empty space in the upper left corner because the outcome Y = 1 is only possible if X = 1. However, the outcome can be either Y = 1 (present) or Y = 0 (absent) under the condition of X = 1 (present). Therefore, X is necessary but not sufficient for Y. In our example about senior executives' motivation, we referred to such a dichotomous expression about necessity: We simply assumed that the presence of financial incentives is necessary for the presence of senior executives' motivation. A more precise expression of necessity is possible with discrete and continuous necessary conditions where necessity can be described in degree. For example, in the case of a discrete necessary condition (Figure 2, middle) we could reformulate the necessary conditions hypothesis in such a way that a certain level of financial incentives is necessary for a certain level (e.g., high level) of senior executives' motivation. In that case, we would specify a specific level of the condition and a specific level of the outcome. With even more detail, the same is possible for continuous necessary condition (Figure 2, right), where a critical level of the outcome (e.g., a certain level of profit increase) can only be achieved with a certain level of the condition (e.g., a certain level of profit participation for senior executives).

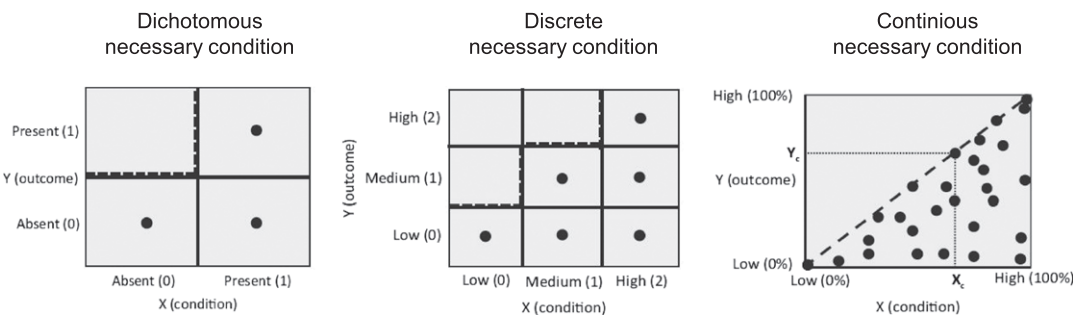


FIGURE 2 Types of necessary conditions. (Source: Dul, 2016)

Notably, necessity assumptions are not restricted to these three basic types of necessary conditions, because dichotomous, discrete, and continuous concept levels can also be combined (Dul, 2019). Furthermore, the logic of necessity does not only refer to cases in that the presence of X is necessary for the presence of Y. Combining presence and absence of X and Y allows for very different statements, like *The absence (or low level) of X is necessary for the presence of (or high level) of Y* (e.g., The absence of bullying and harassment is necessary for employee well-being) or *The presence (or high level) of X is necessary for the absence (or low level) of Y* (e.g., The presence of health and safety regulations is necessary to avoid accidents). Therewith, HRM research can formulate all kinds of necessity assumptions. The next question is, how HRM research can explore necessary conditions.

3 | HOW CAN HRM RESEARCH EXPLORE NECESSARY CONDITIONS?

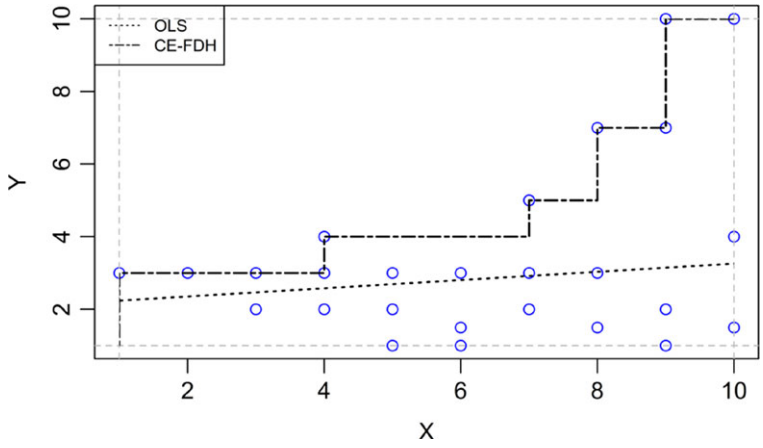
Necessary conditions can be analysed with a novel approach and analysis technique, that is, NCA (Dul, 2016; Dul et al., 2018).[2] NCA differs fundamentally from conventional methods (e.g., correlation, regression, or structural equation modelling) because it does not focus on average trends of multiple predictors but identifies single necessary causes. Therewith, NCA does not compete with traditional methods; it complements them.

Basically, instead of drawing a regression line "through the middle" of the data in a scatter plot, NCA looks for empty spaces in the upper left-hand corner of the scatter plot. Thus, NCA draws a ceiling line "on top" of the data. To draw ceiling lines, NCA can use different techniques. Two currently recommended techniques are based on ceiling envelope (CE) and ceiling regression (CR). The CE technique puts a piecewise linear envelope along the upper left observations. For ceiling envelopment, different envelopment techniques can be used: (a) ceiling envelopment with varying returns to scale (CE-VRS) that assumes that the ceiling is convex, resulting in a piecewise linear convex ceiling function, and (b) ceiling envelopment with free disposal hull (CE-FDH) that assumes that the ceiling is non-decreasing, resulting in a non-decreasing step function. CR smooths the piecewise linear function obtained by the CE techniques by using ordinary least squares (OLS) regression through the corners of the piecewise linear functions. Thus, CR-VRS draws a line through the CE-VRS corners, and CR-FDH draws a line through the CE-FDH corners. Because CE-FDH is more flexible and does not require many assumptions, it is currently the recommended ceiling technique for dichotomous and discrete (with few levels) necessary conditions. CR-FDH is recommended for discrete (with many levels) and continuous necessary conditions.

Figure 3 (left side) shows an example of the CE-FDH ceiling line; it also shows the ceiling line compared with the OLS regression line. In this (fictitious) example, the OLS regression line indicates a very small effect that is not significant. Based on this information, a researcher may conclude that there is no relationship between X and Y. However, the ceiling line indicates that high Y levels can only be achieved if X reaches a certain value. Thus, X is a necessary condition for Y.

The ceiling line marks the boundary between the zone with and without observations. The larger the empty zone—also called the ceiling zone (C)—the larger the limit (constraint) that the condition puts on the outcome. Thus, the size of the ceiling zone compared with the size of the entire area that can have observations—also called the scope (S)—represents the *effect size* of a necessary condition. This can be expressed as $d = C/S$ with d being the effect size. The range of d can be from 0 to 1 ($0 \leq d \leq 1$). Following Dul (2016), $0 < d < 0.1$ can be characterised as a small effect, $0.1 \leq d < 0.3$ as a medium effect, $0.3 \leq d < 0.5$ as a large effect, and $d \geq 0.5$ as a very large effect. Thus, the effect size of $d = 0.1$ has been used as a threshold to consider an effect as theoretically and practically meaningful (e.g., see Karwowski et al., 2016; van der Valk, Sumo, Dul, & Schroeder, 2016). Because the overserved effect size may be the result of random chance, NCA also allows to perform an approximate permutation to test for statistical significance (Dul et al., 2018). Considering both information, one can state that there is a meaningful necessary condition if the effect size d is larger than 0.1 and statistically significant.

The interpretation of an NCA can be facilitated by the use of *bottleneck tables*, which are particularly helpful when one wants to analyse multiple necessary conditions for the same outcome. A bottleneck table is a tabular



Bottleneck Table
(CE-FDH)

Y (Percentage range)	X (Actual value)
0	NN
10	NN
20	NN
30	4
40	7
50	8
60	8
70	9
80	9
90	9
100	9

FIGURE 3 Ceiling line (ceiling envelopment with free disposal hull [CE-FDH]) and bottleneck table.
Note: Fictitious data, $d = 0.580$, $p = 0.001$ [Colour figure can be viewed at wileyonlinelibrary.com]

representation of the ceiling line of one (in the case of a single NCA) or several (in the case of multiple NCA) necessary conditions. It indicates which level of the necessary condition(s) is (are) needed for a certain level of the outcome, according to the ceiling line. Figure 3 (right side) shows an example of a bottleneck table. The outcome levels are expressed as a percentage of the observed range: 0 is the minimum observed value, and 100 the maximum observed value. The condition levels are expressed as actual values. The bottleneck table for the example shows that for a level of the outcome Y = 20%, no minimum value of X is required for that outcome to occur (NN = not necessary). However, for Y = 50%, a minimum value of 8 is required for X, and for Y = 70%, a minimum value of 9 is required for X. In other words, high levels of Y can only be achieved with a certain level of X. If these minimum levels of X are not achieved, the various levels of the outcome will not occur.

Notably, the validity of NCA results depends (as in most other empirical research methods) on the adequacy of the theory, measurement, and research design (Dul, 2016). NCA is not immune to a problematic theory (e.g., if the cause and the outcome are not clearly defined); the results can be influenced by the use of unreliable measures and measurement errors (e.g., the true size of the empty zone can differ from the estimated size when there is measurement error in observations near the ceiling line), and a weak research design (e.g., the sample is not representative). Thus, researchers should ensure that standard methodological requirements are met when using NCA.

NCA can be performed with a free software package for R (for a quick guide on how to apply NCA with R, see Dul, 2018). The NCA software's main functions are to draw scatter plots with ceiling lines, calculate NCA parameters (e.g., ceiling zone, scope, and effect size), and the bottleneck tables. We will now show the application of NCA using the relationship between ability-, motivation-, and opportunity-enhancing HRM practices and employee performance as an illustrative example.

4 | ILLUSTRATIVE EXAMPLE: IS HIGH PERFORMANCE POSSIBLE WITHOUT HPWPS?

4.1 | HPWPs and employee performance

A prominent example of necessary conditions can be found in the ability, motivation, and opportunity (AMO) framework (Appelbaum et al., 2000), a well-known and widely used theoretical reference to conceive HPWPs and to

explain the link between HRM and employee performance (Guest, 2011). The AMO framework is rooted in "classical" industrial psychology and originally focused on the individual level (e.g., Blumberg & Pringle, 1982; Maier, 1946; Vroom, 1964). Thereby, performance was at first a function of only ability and motivation, but necessity has been present in the reasoning from the very start. For example, Cummings and Schwab (1973, p. 46) argue that "[s]omeone with no ability to complete a task cannot successfully perform no matter how highly motivated he may be to do so. Likewise, at least some modest amount of motivation is required, regardless of one's ability to do a task, before we can expect successful performance". Later, Blumberg and Pringle (1982, p. 564) suggest adding opportunity as a third factor to account for "situational constraints," which is generally accepted.

In its original formulation, the AMO framework assumed that an employee's ability, motivation, and opportunity are "singly necessary and jointly sufficient" for their individual performance (Scholten, 1996, p. 98). Thus, without one of the components, the other components will have no effect. This notion of necessity is still present in the theoretical elaborations of HRM scholars who employ the AMO framework for theorising about the relationship between HPWPs (intended as A-, M-, or O-enhancing HRM practices) and employee performance. For instance, MacDuffie (1995, p. 199) called the AMO components "conditions" for economic performance, which suggests necessity. Lepak, Liao, Chung, and Harden (2006) pointed to the necessity of providing opportunities to perform, because "even if employees have the ability and are motivated to work toward organizational objectives, organizations must provide them with appropriate opportunities to use their skills" (p. 233). Similarly, the necessary conditions perspective seems to inform the ideas of Jiang, Lepak, Han, et al. (2012), who argued that "the impact of one HRM policy domain [i.e. A-, M-, and O-policy domain] on employee performance is dependent on the *presence* and effectiveness of other policy domains in place" (p. 78).

The necessity of AMO-enhancing HRM practices for employee performance can be explained in different ways. First, in regard to A-enhancing HRM practices (e.g., extensive training and selective hiring), it can be argued that these practices are necessary in order to develop the human capital of employees (e.g., Batt & Colvin, 2011; Takeuchi, Lepak, Wang, & Takeuchi, 2007). Being human capital necessary for individual performance (e.g., Maier, 1946), a certain application level of A-enhancing HRM practices should be necessary for high employee performance. Second, certain application levels of M- and O-enhancing HRM practices are also necessary for high employee performance, for more behavioural reasons. Indeed, M-enhancing HRM practices (e.g., performance-based compensation, incentives and benefit, promotion opportunities, and job security) provide employees with motivation that links their work efforts to external rewards (e.g., Deci, Connell, & Ryan, 1989). Being a minimum level of motivation necessary for obtaining desired work behaviours (e.g., Cummings & Schwab, 1973), a certain application level of M-enhancing HRM practices is necessary for high employee performance. In the same line of reasoning, O-enhancing HRM practices (e.g., job design, or organisational participation) improve the organisational conditions in which employees live and work (e.g., Ryan & Deci, 2000) and therefore, being external working conditions necessary for discretionary effort by employees (e.g., Blumberg & Pringle, 1982; Peters & O'Connor, 1980), a certain application level of those practices is necessary for high employee performance.

The AMO framework provides a good example to highlight the differences between the sufficiency and the necessity logics. Additive sufficiency logic would imply that the absence of HRM practices in one domain (the A, M, or O domain) can be compensated by HRM practices in other domains. For instance, a missing application of HRM practice regarding recruitment and training (the A domain) could be compensated through the application of M-enhancing HRM practices. However, this does not correspond to the necessity implied in the original AMO framework (Van Rhee & Dul, 2018), and then extended by HRM scholars to HRM practices (e.g., Lepak et al., 2006; Jiang, Lepak, Han, et al., 2012). Therefore, in the following, we ask whether certain application levels of HRM practices in each AMO domain are necessary to achieve a high employee performance level.

To answer this question, we will test two models. In the first model (Figure 4, Model 1), we follow a more traditional approach, assuming that AMO-enhancing HRM practices are directly necessary for employee performance. The second model (Figure 4, Model 2) also considers intermediate outcomes. Building on Jiang, Lepak, Hu, and Baer

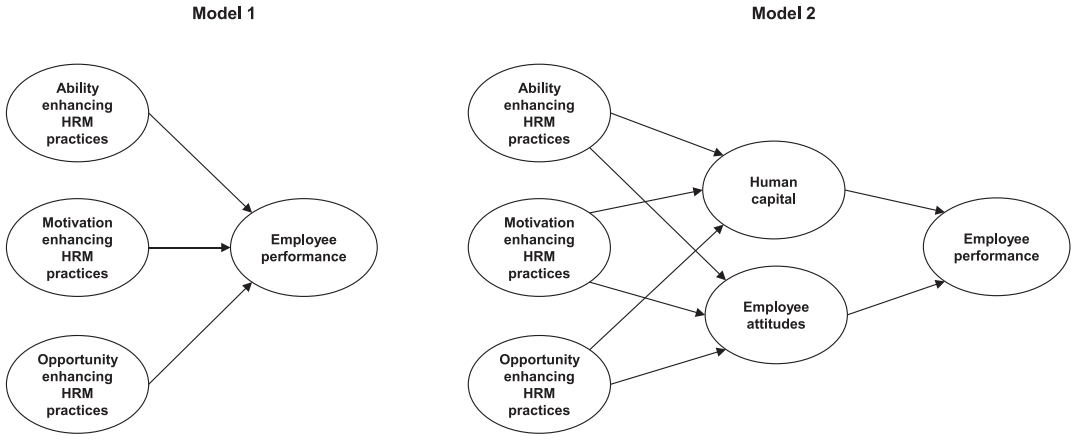


FIGURE 4 Ability-, motivation-, and opportunity-enhancing HRM practices and employee performance. Note: In sufficiency logic, an arrow means "produces"; in necessity logic, an arrow means "allows"

(2012), we assume that AMO-enhancing HRM practices are necessary for human capital and employee attitudes, which in turn are necessary for employee performance.

4.2 | Data

The following analysis is based on data collected via highly structured computer-aided telephone interviews with chief executives and HR managers of firms in Germany. Because the implementation of HRM practices is usually done at the group level (Wright & Nishii, 2013), chief executives and HR managers are crucial informants to ask about AMO-enhancing HRM practices. Furthermore, chief executives and HR managers usually have a good knowledge about outcomes at different levels (Huselid & Becker, 2000). In addition, such a research setting allowed us to collect data from a large number of firms.

The data collection targeted firms with at least 20 employees in the following sectors: chemicals and pharmaceuticals, mechanical engineering, banking and insurance, and professional services (legal and accounting services, and business consultancies). We drew contact information from the German Chamber of Industry and Commerce database that all German firms (with the exception of craft businesses, free professions, and farms) are required by law to join. The number of randomly sampled firms in these sectors was 5,388 out of a population of 8,100 firms. Of the firms contacted, 1,175 took part, a response rate of 21.8%. A first analysis of the data revealed that 76 firms did not meet the selection criteria (size and industry) or gave invalid answers. Thus, usable data were available for 1,099 firms.

The questionnaire acknowledged that firms may operate multiple HRM systems in one organisation. If firms stated that they differentiate their HRM for different employee groups, all questions relating to HRM referred to the employee group that is most important for the firm's economic success (as suggested by Osterman, 1987; see also Delery & Doty, 1996). If HRM was not differentiated for different employee groups, we formulated questions such that they encompassed all a firm's employees. Thus, our analyses refer to the group level, and each firm is represented with its most important HRM system in terms of the value production of the employees working under this system.

4.3 | Measures

4.3.1 | High-performance work practices

Our independent variables are HPWPs, conceived here as AMO-enhancing HRM practices. A basic drawback of the strategic HRM literature is that there is still no agreement on which practices constitute HPWPs (e.g., Langevin-

Heavey et al., 2013; Posthuma, Campion, Masimova, & Campion, 2013). Here, we follow Jiang, Lepak, Hu, and Baer (2012) and included comprehensive recruitment/selection, and continuous training as *A-enhancing HRM practices*; profit-based pay, extensive benefits, clear career paths, and job security as *M-enhancing HRM practices*; and task variety, semi-autonomous work groups, empowerment, and information-sharing as *O-enhancing HRM practices*. We measured all items by the extent of the informants' agreement with statements along a five-item scale (from 1 = *strongly disagree* to 5 = *strongly agree*). To analyse to what extent AMO-enhancing HRM practices are necessary for employee performance, we created an additive index using the single variables in each AMO domain.

4.3.2 | Human capital and employee attitudes

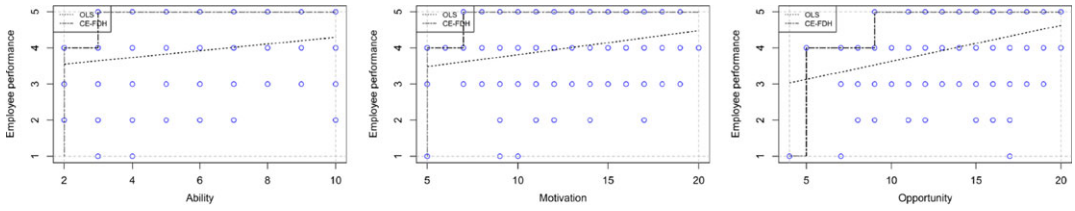
We measured *human capital* as a formative construct with two indicators: qualified employees and up-to-date knowledge. We also measured *employee attitudes* as a formative construct with three indicators: motivation, job satisfaction, and organisational commitment. Because we wanted to capture different aspects of employee attitudes, and to have a manageable questionnaire that avoids mental fatigue, we used single items for motivation, job satisfaction, and organisational commitment (from 1 = *does not apply at all* to 5 = *fully applies*).

4.3.3 | Employee performance

We measured employee performance with one indicator for the performance of the employee group that is most important for a firm's economic success. We used a single indicator, to have a simple measurement instrument that applies to different organisational contexts, because our study includes firms from different sectors. Also, employee performance at the group level should be easily and uniformly imagined by chief executives and HR managers, which justifies the use of a single-item measure (Bergkvist & Rossiter, 2007; Huselid & Becker, 2000).

4.4 | Results

Figure 5 shows the scatter plots with the ceiling lines and bottleneck tables for the assumed relationships in Model 1. Necessary conditions are indicated by an empty area in the upper-left corner of the scatter plot. The results in Figure 5 show that these areas are fairly small for A- and M-enhancing HRM practices, but more pronounced for O-enhancing HRM practices. The effect sizes (CE-FDH) are d = 0.031 (p = 0.114) for A-enhancing HRM practices,



Performance (%)	Ability (%)	Motivation (%)	Opportunity (%)
0	NN	NN	NN
10	NN	NN	6.2
20	NN	NN	6.2
30	NN	NN	6.2
40	NN	NN	6.2
50	NN	NN	6.2
60	NN	NN	6.2
70	NN	NN	6.2
80	12.5	13.3	31.2
90	12.5	13.3	31.2
100	12.5	13.3	31.2

FIGURE 5 Ceiling lines (ceiling envelopment with free disposal hull [CE-FDH]) and bottleneck tables in the illustrative example (Model 1) [Colour figure can be viewed at wileyonlinelibrary.com]

d = 0.033 (p = 0.296) for M-enhancing HPWP, and d = 0.125 (p = 0.002) for O-enhancing HRM practices. Because the effect sizes for A- and M-enhancing HRM practices are small and not significant, we can conclude that those HRM practices are not necessary for high employee performance. In contrast, the effect for O-enhancing HRM practices is larger than 0.1 and significant, which indicates a meaningful necessary condition.

Performing NCA on the relationships proposed in Model 2 revealed a more comprehensive picture. Figure 6 shows the corresponding scatter plots with the ceiling lines (bottleneck tables are not displayed for Model 2). Considering human capital as intermediate outcome, the results show a significant effect for M- and O-enhancing HRM practices (d = 0.067, p = 0.001 and d = 0.195, p = 0.000), whereas the effect for A-enhancing HRM practices is not significant (d = 0.031, p = 0.056). Similar, considering employee attitudes as intermediate outcome, the results show a significant effect for M- and O-enhancing HRM practices (d = 0.050, p = 0.010 and d = 0.109, p = 0.003), whereas the effect for A-enhancing HRM practices is not significant (d = 0.000, p = 1.000). In both instances, only O-enhancing HRM practices show an effect size larger than 0.1 indicating a meaningful necessary condition. In contrast, looking at the relationships between human capital, employee attitudes, and employee performance, we found that human capital and employee attitudes are necessary for employee performance (d = 0.250, p = 0.000 and d = 0.281, p = 0.000).

To illustrate the difference between NCA and regression analysis, we also applied standard OLS regression analysis. Thereby, we include the following control variables: firm size, firm age, industry, strong order fluctuations, and pressure of competition, endowment of the HRM department (number of full-time equivalents per employee in the personnel department), HRM's strategic orientation, differentiated HRM for different groups of employees, existence of collective employee representation, and collective bargaining agreements.

Figure 7 shows both the NCA-based results, compared with the results from regression analysis. The regression-based results show a significant positive effect of all three AMO domains. Model 1's results show that O-enhancing HRM practices have the strongest effect on employee performance, followed by M- and A-enhancing HRM practices. Thus, although A- and M-enhancing HRM practices are not necessary for employee performance, they can increase employee performance on average. Further, Model 2 highlights that human capital and employee

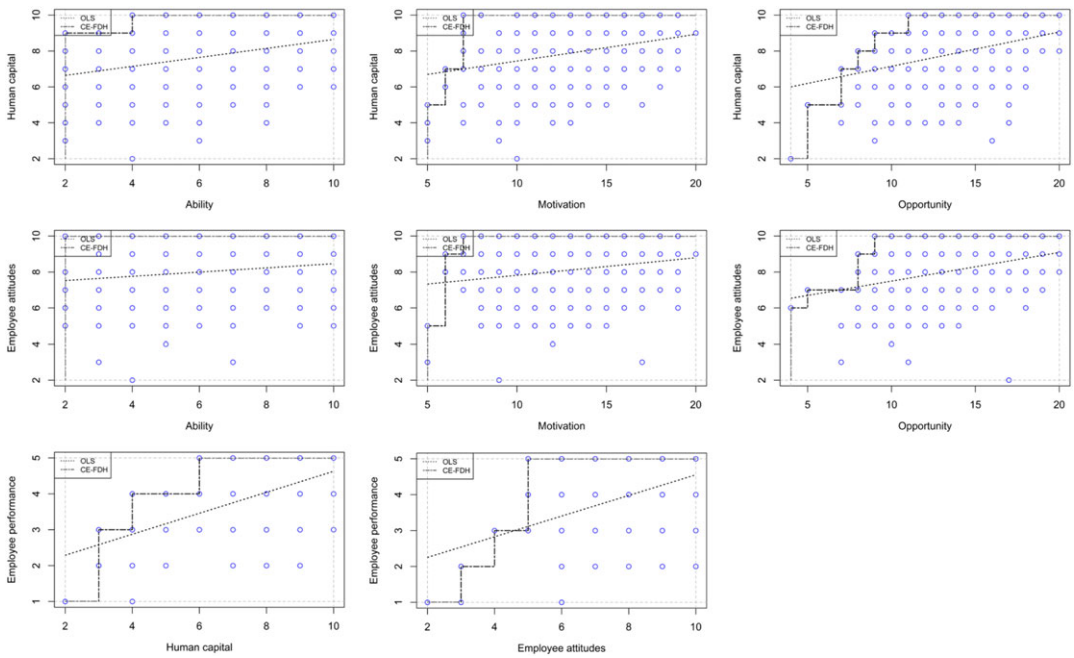


FIGURE 6 Ceiling lines (ceiling envelopment with free disposal hull [CE-FDH]) in the illustrative example (Model 2) [Colour figure can be viewed at wileyonlinelibrary.com]

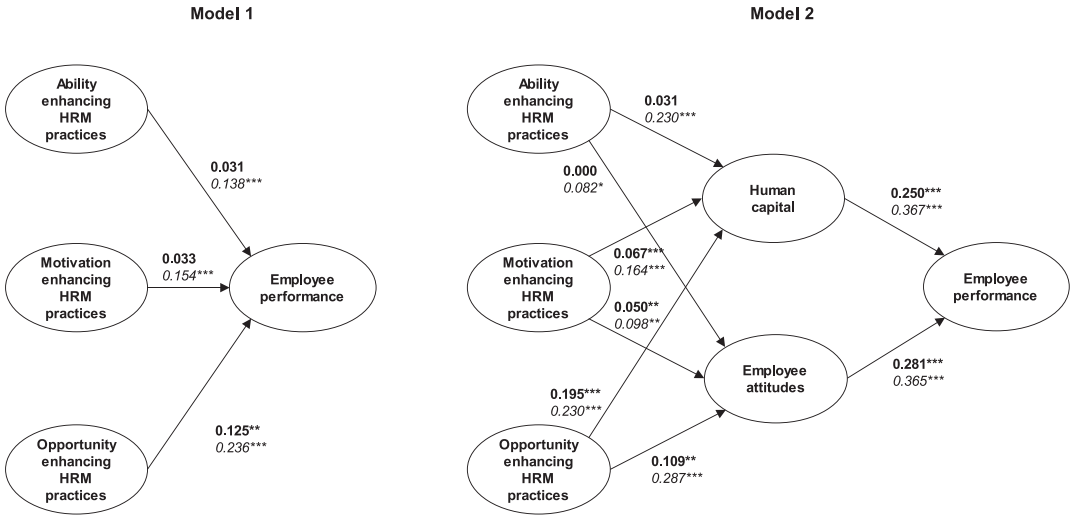


FIGURE 7 Necessary condition analysis-based results compared with results obtained from regression analysis. Note: Values in bold = effect size *d* obtained from necessary condition analysis; values in italics = beta coefficients obtained from separate regression analysis with human capital, employee attitudes, and employee performance as independent variable; significance levels: * = 5%; ** = 1%; *** = 0.1%

attitudes are positively influenced by the AMO-enhancing HRM practices and—in turn—increase employee performance.

4.5 | Limitations of the illustrative example

Our illustrative example shows how NCA can be applied in HRM research. However, we should mention some limitations that could be addressed by future studies on the necessity of AMO-enhancing HRM practices for employee performance. First, the stated effects cannot be traced back to causal relationships because the study design is cross-sectional instead of longitudinal. Second, our performance measure is a perceptual one. However, several researchers have been able to show that there are strong correlational relationships between perceptual and hard performance measures (e.g., Su & Wright, 2012). Third, the set of the AMO-enhancing HRM practices here considered could be extended, given the existence in HRM research of several alternative conceptualisations. Fourth, the illustrative example is based on a single-respondent approach, which is the HR manager of the organisation. This is not ideal but still legitimate, given that the empirical design addressed a specific employee group (i.e., the employee group most important for a firm's economic success), of which chief executives and HR managers should have good knowledge (Huselid & Becker, 2000).

5 | DISCUSSION: ANALYSING NECESSARY CONDITIONS IN HRM RESEARCH

Different HRM research fields refer to the notion of necessity. However, to date, necessary conditions have not been treated properly. We sought to take a first step to change this and to give HRM researchers the opportunity to analyse necessary conditions. We discussed the distinction between sufficiency and necessity logics, presented NCA as a new approach and analysis technique, and showed the method's application using an illustrative example. Building on

this, we will now state some final considerations in terms of theory, methodology, and practical relevance of necessary conditions in HRM research.

5.1 | The need for more theoretical clarity in HRM research about sufficiency and necessity logics

Necessary conditions are conceptually distinct from sufficient relationships, and this distinction must be theoretically considered. Indeed, as debated above, arguments that support that an HRM activity is necessary for an outcome may differ radically from arguments that support that an HRM activity is sufficient for an outcome. Here, our illustrative example highlights that hypotheses about necessary conditions must be theoretically accurate and precise. In accordance with previous HRM contributions, we tested the assumptions that certain application levels of AMO-enhancing HRM practices are necessary for high employee performance (Model 1). Because A- and M-enhancing HRM practices did not prove to be a meaningful necessary condition for employee performance, we must ask why this is the case. A potential explanation may be based in the shift of the AMO framework's application level. The theory's original formulations sought to explain the *individual-level* conditions for performance (i.e., an individual's ability, motivation, and opportunities to perform predict their performance). At this level, the assumptions about necessary conditions are supported by our results, because human capital (i.e., individuals' ability) and employee attitudes (i.e., individuals' motivation) proved to be necessary for employee performance (Model 2). In contrast, HRM research has applied the theory at the *organisational level*, to explain the relationship between organisational practices and employee performance (i.e., the levels of A-, M-, and O-enhancing HRM practices implemented by a firm predict employee performance; Boxall, Guthrie, & Paauwe, 2016). We argue that, in this shift, the notion of necessity has been improperly replicated. Indeed, employees can develop ability and motivation independent from HRM practices—for instance, via informal practices such as recruitment through personal networks, on-the-job training, or intrinsic motivation—and A- and M-enhancing HRM practices are therefore not necessary for employee performance. Thus, our example underlines that HRM researchers must be careful when theorising about necessary conditions. Only if they can establish that a supposed necessary condition does pose a constraint—that is, no other HRM activity is able to compensate for the supposed necessary condition—should statements about necessity be made.

In contrast, we found O-enhancing HRM practices to be necessary for employee performance. We interpret this result in light of the idea that the AMO framework's O component differs from the A and M components. Indeed, while ability and motivation are internal conditions for employee performance, opportunities to participate are an external condition, that is, a condition that does not focus on an employee's internal characteristics but that focus more on the external conditions in which they work. Thus, we argue that it is not possible that employees substitute O-enhancing HRM practices with any other practice within the organisation. Thus, this component of the HRM system proved necessary for employee performance. Again, this finding highlights the need for conceptual clarity when analysing necessary conditions. Statements about necessary conditions should always consider a construct's potential multidimensionality: Although necessary conditions may be true for some dimensions, others may represent sufficient relationships.

In sum, our first recommendation for HRM researchers using statements about necessity is to establish specific theoretical arguments, which must differ from those used for supporting sufficient conditions. Thus, the conceptual differences between sufficiency and necessity logics must be considered. Researchers should not formulate statements about necessary conditions (e.g., *X is necessary for Y*) if they intend to analyse relationships with a sufficiency logic (e.g., *X will increase Y*). In other words, the wording of the hypotheses should be consistent with the employed logic. In addition, researchers should pay attention to the level of analysis as well as the multidimensionality of constructs, because there may be differences regarding the nature of the relationship (i.e., necessary conditions vs. a sufficient relationship). Recognising these aspects will lead to more precise predictions in future HRM research about the relationships between HRM and outcomes.

5.2 | The need for a fit between sufficiency and necessity logics and consequent empirical work

Sufficiency and necessity logics require not only different theoretical arguments but also empirical methods that fit with their nature. Our illustrative example has shown that the results obtained with regression-based methods (focused on testing sufficiency) differ from those obtained with NCA (aimed at testing necessity). Specifically, although high application levels of HRM practices in all the AMO domains improved employee performance on average (as shown by regressions), only the absence or limited application of O-enhancing HRM practices limited employee performance (as shown by NCA results). These differences highlight that researchers should be aware of the different logics implied in different methodologies, because the risk of inappropriate conclusions is concrete. Thus, we strongly recommend that HRM researchers who hypothesise necessary conditions should test them with appropriate methods.

Notably, we do not assume that analysing necessary conditions is a better way to explore the relationships between HRM activities and outcomes. Traditional analyses using sufficiency logic (i.e., correlation, regression) and NCA are equally valid for their own purposes—they simply represent different ways of looking at theory and data, which leads to additional informative value. For instance, in our illustrative example, we can say that firms should invest in all the AMO domains to improve employee performance but should first invest in O-enhancing HRM practices, because these HRM practices limit employee performance. Such a differentiated recommendation would not have been possible if only regression-based methods were applied. Focusing solely on regression-based methods may be risky if there are potential necessary conditions. Indeed, when necessary conditions are not in place, they can individually prevent an outcome's existence. In this case, the sufficiency logic implied in regression-based analysis may not be able to correctly predict the outcome.

5.3 | The practical value of exploring necessary conditions

Exploring whether HRM activities are necessary for achieving outcomes has high practical value. Indeed, as necessary HRM activities act as constraints, bottlenecks, or critical factors, practitioners would know which HRM activities must take the highest priority because without these, no outcome will occur. Conversely, not knowing what HRM practices or bundles are necessary for an outcome, but only which HRM practices or bundles are sufficient (i.e., have an *on average* positive effect on the outcome), may result in suboptimal resource allocation. Accordingly, exploring necessary conditions represents a possibility to gain substantial and practical relevant insights in HRM research, addressing some recent criticisms in this regard (e.g., Kaufman, 2015).

Even concerning this last point of our discussion, our illustrative example is helpful, because it has shown that O-enhancing HRM practices are necessary for employee performance. Building on this finding, we recommend that firms first invest resources in these practices, to prevent low employee performance. Investing first in A- and/or M-enhancing HRM practices could be useless when O-enhancing HRM practices are absent, because the employee performance improvements potentially generated by M- and A-enhancing HPWP could be rendered useless by the too low levels of O-enhancing HRM practices. Recommendations of this kind could be made on a wide set of HRM-related topics, because the notion of necessity is not restricted to specific subfields of HRM research. Importantly, analysing necessary conditions is very relevant for HRM practice, perhaps even more than analysing sufficiency relationships, because without the necessary condition, all other HRM-related investments are useless.

6 | CONCLUSION

We have shown that necessity logic differs substantially from sufficiency logic. Thus, it requires specific theoretical attention and a suitable empirical methodology. We introduced NCA as an opportunity to explore necessary

conditions in HRM research. The application of the method was illustrated by using the relationships between A-, M-, and O-enhancing HRM practices and employee performance as an illustrative example. Building on our discussion of fundamental issues and the findings from the illustrate example, we put forward some key considerations in terms of theory and methodology and emphasised the high practical value of exploring necessary conditions in HRM. HRM research is rich in (partly implicit) ideas of necessary conditions, and it is worth studying them explicitly.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ENDNOTES

[1]The regression equation expresses the average effect of a single X (e.g., X_1) on Y when all other Xs are constant (this effect is represented by the regression coefficient, e.g., b_1). In an XY scatterplot, this average effect of a single X on Y can be represented by the regression line. Individual cases deviate from this regression line; there is random variation around it. However, when interpreting a regression model's results, we typically ignore this random variation and refer to the results as applicable to each case. This interpretation implies that a single X is sufficient to produce an increase in the outcome Y and other Xs can compensate for low levels of this X.

[2]Another technique to analyse relationships of necessity is qualitative comparative analysis (QCA; Ragin, 2000, 2008). In contrast to NCA, QCA uses set theory where X and Y are set membership scores rather than variable scores, and binary logic is employed to capture which bi-valued (present/absent) determinants are necessary for an outcome. In the dichotomous case, crisp set QCA's and NCA's analysis of necessity are similar. However, when the set membership scores have more than two levels (as in fuzzy-set QCA), the necessity analyses are very different and QCA's necessity statements remain binary and ignore variations in degree. Thus, QCA is unable to analyse specific necessary conditions where a certain level of X is necessary for a certain level of Y. Thus, fsQCA usually identifies fewer necessary conditions than NCA. Because statements about necessary conditions usually refer to variations in the extent of HRM activities, we only refer to NCA (for a detailed discussion of the differences between NCA and fsQCA, see Vis & Dul, 2018).

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APPENDIX A

TABLE A1 Measures

Construct	Indicators	Measures
Ability-enhancing HRM practices	Comprehensive recruitment/selection	The recruitment/selection process for these employees is comprehensive.
	Continuous training	There is continuous training for these employees.
Motivation-enhancing HRM practices	Profit-based pay	Compensation/rewards for these employees are based on firm profits.
	Extensive benefits	Compensation/rewards for these employees include an extensive benefits package.
	Clear career paths	These employees have clear career paths in the organisation.
	Job security	These employees have long-term perspectives.
Opportunity-enhancing HRM practices	Task variety	These employees perform jobs that include a wide variety of tasks.
	Semi-autonomous work groups	These employees work in semi-autonomous work groups.
	Empowerment	These employees perform jobs that empower them to make decisions.
	Information-sharing	Superiors and employees engage in intensive information exchange.
Human capital	Qualified employees	We have highly qualified employees.
	Up-to-date knowledge	Our employees are equipped with up-to-date knowledge.
Employee attitudes	Motivation	Our employees are highly motivated.
	Job satisfaction	Our employees show very high job satisfaction.
	Commitment	Our employees show very high commitment.
Employee performance	Performance of the employee group most important for the firm's economic success	Our employees show very high performance levels.

TABLE A2 Descriptive statistics and correlations

		Mean	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Comprehensive recruitment/ selection	3.02	1.241														
2	Continuous training	3.94	1.032	0.289***													
3	Profit-based pay	2.97	1.151	0.059*	−0.081***												
4	Extensive benefits	2.92	1.140	0.157***	0.182***	0.036											
5	Clear career paths	2.72	1.206	0.287***	0.331***	0.008	0.175***										
6	Job security	4.38	0.743	0.029	0.213***	−0.032	0.137***	0.152***									
7	Task variety	3.88	0.846	0.197***	0.188***	0.026	0.012	0.138***	0.178***								
8	Semi-autonomous work groups	2.98	1.187	0.125***	0.093***	0.035	0.031	0.120***	0.085***	0.211***							
9	Empowerment	3.11	0.965	0.249***	0.172***	0.122***	0.087***	0.180***	0.152***	0.333***	0.152***						
10	Information-sharing	3.90	0.780	0.158***	0.218***	0.057*	0.090***	0.168***	0.260***	0.244***	0.129***	0.325***					
11	Qualified employees	4.06	0.698	0.187***	0.256***	0.018**	0.125***	0.163***	0.294***	0.229***	0.074**	0.212***	0.307***				
12	Up-to-date knowledge	3.84	0.737	0.277***	0.303***	0.023	0.112***	0.216***	0.259***	0.264***	0.135***	0.270***	0.283***	0.512***			
13	Motivation	3.95	0.705	0.139***	0.204***	0.069**	0.098***	0.119***	0.221***	0.296***	0.100***	0.283***	0.373***	0.372***	0.370***		
14	Job satisfaction	3.64	0.691	0.137***	0.181***	0.046	0.139***	0.163***	0.325***	0.212***	0.063**	0.275***	0.365***	0.359***	0.346***	0.538***	
15	Commitment	4.17	0.718	0.024	0.108***	−0.012	0.075**	−0.007	0.326***	0.110***	0.051*	0.116***	0.199***	0.208***	0.148***	0.347***	0.403***
16	Employee performance	4.02	0.677	0.205***	0.200***	0.071**	0.089***	0.162***	0.255***	0.288***	0.126***	0.263***	0.303***	0.461***	0.490***	0.554***	0.439***

*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.