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Development and Validation of the Work Environment Complexity Scale for Leaders

Teresa Bezler

Giovanni B. Moneta

School of Social Sciences – Psychology, London Metropolitan University,

London, United Kingdom

Gary Pheiffer

Business School, University of Hertfordshire, Hatfield, UK

Author Notes

Correspondence should be addressed to: Dr. Giovanni B. Moneta, School of Psychology – Psychology, London Metropolitan University, Tower Building, 166-220 Holloway Road, London N7 8DB, United Kingdom, Tel. +44 (0)20 7133 2573, e-mail g.moneta@londonmet.ac.uk.

Abstract

Purpose – To develop and validate a Work Environment Complexity (WEC) scale for leaders.

Design/methodology/approach – Both cross-sectional and longitudinal data, gathered in the course of major organizational restructuring, using samples from employees (*n*=305) and leaders (*n*=120) in two health care organizations.

Findings – The research developed and validated a scale of WEC for leaders with two factors: (1) Frequent Change and Events, and (2) Uncertain Work Demands. Comparisons between samples suggest diverging employee and leadership representations of WEC.

Practical implications – Being the first scale to measure the comprehensive construct of Work Environment Complexity, a foundation is laid to measure the amount of complexity in a leader's work and the functioning of leaders with regards to WEC.

Originality/value – This paper contributes to leadership research and practice by clarifying the construct of Work Environment Complexity for leaders empirically and validating a bidimensional scale of WEC.

Keywords Complexity, Work Environment Complexity, Leadership, Organizational Behaviour, Measurement.

Paper type Research paper

Introduction

Organizations have been rapidly evolving from linear, mechanistic systems towards being evermore complex workplaces that challenge leaders. Consequently, complexity has become one of the most significant management themes of the modern organizational age (Burnes, 2005; Dinh *et al.*, 2014; Uhl-Bien and Marion, 2009; Uhl-Bien *et al.*, 2007). This Work Environment Complexity (WEC) therefore needs to be better understood in order to investigate what it means to work and lead in increasing complex work environments (e.g., Marion and Uhl-Bien, 2001; Burnes, 2005; Schneider and Somers, 2006). Organizational research has debated the concept of complexity and its application to leadership, drawing in part from the early roots of complexity theories (e.g., Karp and Helgø, 2008; Stacey, 2011, Uhl-Bien *et al.*, 2007). While they have contributed valuable insights, these discussions are largely of a theoretical nature (e.g., Burnes, 2005), and where empirical research has been done, only singular, fragmented elements of complexity have been examined (e.g., Chung-Yan and Butler, 2011). To date, an agreement on a common definition and hence the establishment of an empirically substantiated construct has not been achieved (Black, 2000; Burnes, 2005). Without this agreement, a clear link between complexity research and leadership research cannot be made (Schneider and Somers, 2006). No questionnaire has yet been developed to investigate an integrated construct of WEC; nor have the potentially differing perceptions of complexity for employees and leaders been explored. It is important to understand what constitutes WEC if we want to derive valid conclusions for organizational management and leadership practice. Given that there seems to be a general agreement of what are the common elements of complex working environments (Lissack, 1999; Stacey, 2011), it should be possible to also measure these elements empirically. Therefore, this study aims to integrate existing debates into a measurable and empirically substantiated construct of WEC. This will enable leaders to quantify complexity, monitor the level of WEC in change processes, and use it in HRM processes.

Defining the Factors of Work Environment Complexity

When evaluating complex work environments, rather than proposing an integrated measurement of WEC, researchers have, to date, discussed and especially measured singular factors of WEC. The most prominent ones are Frequent Change (Black, 2000; Marion and Uhl-Bien, 2001; Burnes, 2005; Hannah et al., 2013), Unpredictability (Tetrick and LaRocco, 1987; Marion and Uhl-Bien, 2001; Rafferty and Griffin, 2006; Karp and Helgø, 2008; Yukl and Mahsud, 2010; Chung-Yan and Butler, 2011), Ambiguity (Denison et al., 1995; Kaiser et al., 2007; Hannah et al., 2013), Uncertainty (Mumford et al., 2000; Hochwarter et al., 2007; Karp and Helgø, 2008), Interdependence/Interaction (Mumford et al., 2000; Burnes, 2005; Rafferty and Griffin, 2006; Griffin et al., 2007; Uhl-Bien et al., 2007; Uhl-Bien and Marion, 2009; Hannah et al., 2013) and Challenging Work Demands (Frese et al., 1996; Morgeson and Humphrey, 2006; Chung-Yan and Butler, 2011; Wang, 2014). However, where research has been fragmented, overlaps are likely. This study consequently aims to identify the core content of an integrated WEC construct, addressing relevant overlaps or limitations of the different facets identified to date.

Frequent Change. Complex work environments are contexts in which individuals are confronted with the need to cope with frequent change. These changing and volatile conditions include transformation and unprecedented decision making situations where transformation is a constant rather than a discrete event (e.g., Rafferty and Griffin, 2006; Hannah *et al.*, 2013).

Unpredictability. Complex work is described as demanding as it is characterised by high unpredictability, which includes confronting workers with many unanticipated challenges, unexpected events, lack of clarity on roles or procedures, and the challenge of making decisions with unclear and unforeseeable consequences (e.g., Karp and Helgø, 2008; Uhl-Bien and Marion, 2009).

Ambiguity. Work environments are described as complex because they are ambiguous and often require the management of contrasting or even paradoxical demands. Ambiguous work situations are also seen as unclear, ill defined, or vague (e.g., Denison *et al.*, 1995). Portrayals of Ambiguity show relevant overlaps with Unpredictability and Uncertainty. When measuring Ambiguity, scholars have, however, taken a specialized approach of weighing opposing item pairs, i.e., versatilities or competing demands (e.g., Kaiser *et al.*, 2007), which is appropriate in specific contexts where these competing demands are known, however, for developing a more general state of Ambiguity in WEC, this seems to not be applicable.

Uncertainty. Uncertainty is described as an unsettling state that emerges from ambiguity, change, or unpredictability and outlines work settings that are unclear, lack information, or confront the individual with competing, ambiguous demands, making it sometimes hard for the individual to cope (e.g., Hochwarter *et al.*, 2007). The construct of uncertainty overlaps with Unpredictability, Ambiguity, and Frequent Change; often the terms Uncertainty and Unpredictability are used synonymously (e.g., Griffin *et al.*, 2007). Furthermore, Uncertainty has been substantiated not as a facet of WEC, but as a psychological state resulting from encountering ambiguous or unpredictable demands (e.g., Bordia *et al.*, 2004; Rafferty and Griffin, 2006)

Interdependence/Interaction. The interaction with or interdependence of other stakeholders is proposed as another factor of complexity, reflecting the connectedness or dependency of one's work with the work of others (e.g., Morgeson and Humphrey, 2006; Rafferty and Griffin, 2006). Often however, as interaction with others in most modern leadership roles is necessary, Interdependence, as such, is not directly measured (e.g., Griffin *et al.*, 2007).

Challenging Work Demands. Finally, many researchers have agreed that the complexity of one's job can be defined through the inherent challenging work demands of the job itself and that this is the opposite of simple, repetitive, and uncomplicated tasks (e.g., Hackman and Oldham, 1975; Frese *et al.*, 1996; Morgeson and Humphrey, 2006; Chung-Yan and Butler, 2011). However, this describes complexity in a narrow sense, falling short of describing the work environment around the job. As such, Challenging Work Demands appears as a relevant, yet not sufficient standalone factor for capturing WEC.

Core Content of Work Environment Complexity

A more detailed look into previous descriptions and conceptualizations reveals several overlaps between the constructs (i.e., Unpredictability overlapping with Ambiguity and Uncertainty), measurement shortcomings (e.g., Ambiguity), as well as conceptual limitations in their suitability for the WEC concept (e.g., Interdependence as a given precondition; Uncertainty as a psychological state/consequence), which will have to be overcome for an integrated construct. The three facets of Frequent Change, Unpredictability, and Challenging Work Demands appear to be conceptually sound, measurable, yet distinct enough from one another. As such, Frequent Change, Unpredictability, and Challenging Work Demands are assumed to constitute the conceptual core of Work Environment Complexity (Hypothesis 1), depicted in Figure 1.

[Insert Figure 1 about here]

Existing measures only tap into singular facets of WEC. Consequently, the present study attempts to develop and validate a scale for measuring WEC as an integrated construct, which also explores the extent to which these facets are independent of one another. Whilst claiming it to be a predominantly leadership concern, previous scholars have been intertwining employee and leader perspectives on WEC (e.g., Griffin *et al.*, 2007). Conceptual clarity requires looking at these two populations separately (e.g., Morgeson and Humphrey, 2006). Thus, it is proposed that the meaning of WEC for leaders and employees will differ, i.e., the same construct cannot be applied to both target groups (Hypothesis 2).

In response to the growing interest in WEC in organisational research, this paper presents three studies aimed at developing and validating a self-report measure of WEC for leaders. The goal is to provide researchers with a scale that is consistent with the original definitions of WEC, has good psychometric properties, and is so short that can be administered in longitudinal studies of change that include other scales and require a compact survey format. The task is intricate for two main reasons. First, a scale may not measure the same construct when administered to different categories of workers, such as leaders and non-leaders. The state-of-the-art approach to this problem is to administer the instrument to different groups and assess its factorial invariance (Hoyle and Smith, 1994) cross-sectionally across the groups (e.g., Brien et al., 2012; Grødal *et al.*, 2017; Sung *et al.*, 2017). Moreover, a scale that has good psychometric properties when administered once may lose validity when administered to the same participants a second time, and hence become useless for longitudinal studies. The state-of-the-art approach to this problem is to assess the factorial invariance of the scale longitudinally (Widaman *et al.*, 2010) including response styles (i.e., the tendency for a scale to elicit consistent idiosyncratic interpretations of its items; Pitts *et al.*, 1996) (e.g., Breevaart *et al.* 2012; Moneta, 2017). As such, in the present research the scale validation process requires a multi-study strategy.

Building on previous scales and after having conducted a pre-test, two separate exploratory factor analyses were used on both an employee (Study 1) and a leadership sample (Study 2) to explore the scale's factor structure. Then, a longitudinal confirmatory factor analysis with another leadership sample (Study 3) was conducted in order to corroborate the scale's construct validity and assess its measurement invariance across time. All study participants were employed in health care organisations in Germany.

Study 1: Pretest and Exploratory Factor Analysis with Employee Sample

Method

Participants and Procedure

A questionnaire survey was distributed to employees in a German hospital that was undergoing a change process. This was chosen as WEC was likely to emerge in a public-sector organization undergoing transformation (Karp and Helgø, 2008), where different job families have to work highly interdependently on challenging, even life-depending tasks. Participation was voluntary, and all 2,100 employees were approached to fill out a survey either online or in paper and pencil form. Three hundred fifty-four employees (16.9%) took part. After eliminating invalid or missing responses, 305 participants were retained; of these, 153 (50,2%) were nurses, 59 (19,3%) were doctors, 49 (16,1%) were in administrative functions, and 44 (14,4%) were in med-tech functions. Due to anonymity reasons of the overall survey, participants were not asked to report personal data such as age and gender.

Preliminary Measure

Based on the identified WEC core content and building on previously established scales, an initial 9-item set was chosen, three items each reflecting one of the facets: Frequent Change, Unpredictability, and Challenging Work Demands. This preliminary measure was administered to a convenience sample of 40 individuals predominantly working in leadership positions in order to secure understanding and to evaluate internal consistency. Two items that did not meet the criteria of sufficient internal scale consistency ($\alpha < .7$) and factor loadings (below .250) in an initial principal factor analysis were removed one at a time, yielding a 7-item instrument for further analyses.

Measure

WEC was measured with the 7-item Work Environment Complexity Scale (WECS) as developed in the pre-test. The WECS consisted of three items from Rafferty and Griffin's (2006) Frequent Change Scale (e.g., Change frequently occurs in my unit), three items from Tetrick and LaRocco's (1987) Predictability of Events Scale (e.g., Unexpected events occur on my job to a great extent), and one item from Morgeson and Humphrey's (2006) Work Design Questionnaire, Subscale Problem Solving (e.g., The work situation involves solving problems that have no obvious correct answer). Items that were not available in German were translated, backtranslated and retranslated as required. Answers ranged from 1 (Disagree strongly) to 5 (Agree strongly).

Statistical Analysis

The factor structure of the WECS scores was analysed in SPSS23 using parallel analysis based on Monte Carlo simulations of 1,000 samples, principal axis explanatory factor analysis (EFA), and by examining the patterns of factor loadings of an oblique factor rotation (Promax, kappa = 4).

Results

In parallel analysis, only the first observed eigenvalue of 2.892 exceeded its upper 95th percentile, indicating one factor was extracted. This accounted for 41.3% of the variance. In the subsequent principal axis factor analysis, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) was .759, indicating good data factorability, and Bartlett's Test of Sphericity (Approximate Chi-Square= 477.4, p<.001) was significant, indicating that factor analysis was appropriate to use on the data (Bartlett, 1954). Two eigenvalues greater than 1 were extracted: 2.892 and 1.082. Factor 1 accounted for 41.3% of the variance, Factor 2 for additional 15.5%. The estimated correlation between the factors was .642, indicating weak discriminant validity. The structure matrix produced unclear factor loadings, as items loading on F2 showed strong cross-loadings on F1. Table 1 displays descriptive statistics and factor loadings for the two-factor and single factor solutions.

[Insert Table 1 about here]

Discussion

The purpose of Study 1 was to initially explore the 7-item WEC Scale's factor structure for employees. Parallel analysis (PA) and principal axis factoring (PAF) produced somewhat diverging results. Further, with high correlation between factors, and the cross-loading content of the second factor in PAF, the WEC Scale in the employee sample displayed an indistinct picture between a one- and two-factor structure.

An explanation for the unclear result may lay in diverging employees' and leaders' interpretations of WEC. Work on individual judgment such as Brunswick's lens model (Bernieri *et al.*, 1996) has argued that the judgment of uncertain situations may vary greatly between groups depending on individuals' interpretations of environmental cues. Further, workplace perceptions of employees and leaders may differ due to distinctive positioning or scopes within the organization (Morgeson and Humphrey, 2006). Having built the content of the WEC Scale based upon research mostly in WEC leadership, it is hypothesized that leaders' judgment of WEC may be more distinct, and reveal more discriminant validity between the two provisionally identified factors.

Study 2: Exploratory Factor Analysis with Leadership Sample

In Study 2, EFA was conducted in order to further explore the scale's factor structure. This time, a sample of leaders only was used, investigating the above proposition of divergent views of WEC between employees and leaders.

Method

Participants and Procedure

A sample of 59 leaders (response rate of 63,1%) was recruited from the same German hospital described in Study 1, this time including only those with formal leadership responsibility were included. After ruling out invalid or missing data, 53 leaders were retained; of these, 19 (35.8%) were nurses, 15 (28.3%) were in administrative functions, 11 (20.8%) were doctors, and 8 (15.1%) were in med-tech functions. Again, age and gender were not asked. Procedure, measure, and statistical analysis were identical to those of Study 1.

Results

Parallel analysis of the 7-item WECS revealed a two-factor structure, as the first two observed eigenvalues exceeded their respective upper 95th percentiles. Factor 1 accounted for 36.0% of the variance, factor 2 for additional 22.8%. In the principal axis factor analysis, a KMO of .663 and significant Bartlett's Test of Sphericity (Approximate Chi-Square= 81.3, $p<.001$) indicated good factorability. Two eigenvalues greater than 1 were extracted: 2.522 and 1.597. The estimated correlation between the factors was .297, indicating good discriminant validity. Compared to Study 1, a clearer pattern of factor loadings emerged, indicating three items each loading on factor 1 and 2, and only one item cross-loading on both factors. Content-wise, Factor 1 can be labelled as *Frequent Change and Events*, as the related items describe the frequency of upcoming changes and unexpected events in work situations, Factor 2 can be labelled as *Uncertain Work Demands*, as the related items describe ambiguous or demanding requirements within the given work. Table 1 presents descriptive statistics and factor loadings for the two-factor and single factor solutions.

Discussion

The WECS for leaders appears to be a two-dimensional instrument. Content-wise, Factor 1 can be labelled as Frequent Change and Events, Factor 2 can be labelled as Uncertain Work Demands. As hypothesized, the results of the two studies suggest diverging perceptions of WEC for employees and leaders. While Study 1 for employees failed to reveal a clear picture of the construct structure, in the leaders' sample of Study 2, WEC was more clearly a two-factor construct. This implies that the scale is applicable especially for measuring WEC from a leadership point of view. However, a limitation of Study 2 lies in the small sample size.

Study 3: Confirmatory Factor Analysis with Longitudinal Leadership Sample

The goal of Study 3 was to corroborate the construct validity of the WEC Scale on a new leadership sample and in a longitudinal manner through confirmatory factor analysis (CFA). This design allowed for a test of factorial invariance to examine the extent to which the scale measures the same construct across administrations repeated over time.

Method

Participants and Procedure

A new sample of leaders was recruited from a different, large private healthcare organization in Germany, including only those with formal leadership responsibility. Two major clinic groups had been recently merged into this organization; therefore, it was undergoing significant change. For each participant, data was gathered at the beginning of the change process (wave 1) and five months later during the change process (wave 2) using an online survey. From all 163 top managers of the organization, 117 leaders participated in wave 1 (71,8%), 107 in wave 2 (65,6%). The data did, however, reveal technical duplicates and incorrect responses, which were ruled out by data screening. This phenomenon can be ascribed to a general dissatisfaction with the ongoing organizational change process resulting for some leaders in a limited motivation to participate (see e.g., Meade and Craig, 2012). Finally, 77 leaders reported valid data on the two points of measurement and were therefore retained; of these, 46 (59.7%) were leaders in medical top management, 31 (40.3%) were leaders in commercial top management. Again, age and gender were not asked.

Measure

All participants completed the scale developed in Studies 1 and 2.

Statistical Analysis

The construct validity of the WEC Scale was evaluated by confirmatory factor analysis (CFA) using LISREL 8.8 (Jöreskog and Sörbom, 2006). The data of both waves were examined in an integrated, longitudinal model. Two latent variables were defined for each wave according to EFA suggestions of studies 1 and 2; as one item (FRCH3) was cross-loaded in Study 2, three alternative models were compared: (Model 1) a two-factor model with item FRCH3 loading on factor 1, (Model 2) a two-factor model with FRCH3 loading on factor 2, and (Model 3) a one-factor model. Item covariance errors were set free among several items as suggested by modification indices, hereby only allowing for modifications within, not between factors (Schumacker and Lomax, 2004).

In a second step, three additional models were tested in order to further assess the factorial invariance of the scale, meaning the extent to which the scale measures the same construct across the two administrations (Hoyle and Smith, 1994; Widaman *et al.*, 2010;

Moneta, 2017): the configural invariance model with longitudinally correlated item errors, the metric invariance model, and the scalar invariance model.

Results

Table 1 shows descriptive statistics for both waves. The Chi-Square test of the confirmatory factor model was non-significant (χ^2= 61.64, df = 66, *p* = 0.63), indicating strict model fit. Further, other goodness-of-fit statistics indicated excellent fit (RMSEA = 0.000, *p*[RMSEA<0.05] = 0.90, CFI = 0.99, NNFI = 0.99), yet SRMR = 0.084, lay just above the proposed cut-off value of <0.05. The model-based estimates of the correlations between Factor 1 and Factor 2 were 0.33 in wave 1 and 0.44 in wave 2. The two alternative models Model 2 (AIC = 185.08) and Model 3 (AIC = 164.66) underperformed in all examined goodness-of-fit indices when compared to Model 1 (AIC = 139.64). Therefore, Model 1, the initial two-factor model, was retained.

Three additional models (labelled 4-6) were tested to assess the factorial invariance of the scale compared to the identified Model 1, which imposed no constraints on the measurement errors and/or factor loadings between the two administrations. Hence, it represents configural invariance, which means that respondents attribute approximately the same meaning to the latent construct of WEC across administrations. Table 2 shows the goodness of fit indexes of the estimated models.

[Insert Table 2 about here]

Model 4 was identical to Model 1 except for it allowed the individual item errors to correlate across the two administrations (e.g., the measurement error of item PRED2 in wave 1 was allowed to covary with the error of PRED2 in wave 2). The model showed excellent fit, and the comparison in fit between this and Model 1 was non-significant (Delta $\chi^2(7)$ =2.56, *p*=0.92), indicating that the scale does not elicit response styles. Further, as this indicates that the error correlation was not a necessary condition for model fit, Model 1 was retained for further testing.

Model 5 was identical to Model 1 except for it constrained the factor loadings to be identical at waves 1 and 2 (e.g., the loading of PRED2 in wave 1 was forced to be identical to the loading of PRED2 in wave 2), therefore testing for metric invariance. Metric invariance means that respondents attribute the same meaning to the latent construct of WEC across administrations. The model showed excellent fit, and the comparison between this and Model 1 was non-significant (Delta $\chi^2(7)$ =2.10, *p*=.95), indicating that the extent to which WEC relates to the items does not change between the administrations.

Model 6 was identical to Model 1 except for it constrained both the factor loadings and intercepts to be identical at waves 1 and 2, thus testing for scalar invariance. Scalar invariance means that respondents attribute the same meaning to the latent construct of WEC across administrations and the level of the items are equal across administrations. The model showed satisfactory fit, and the comparison in fit between this and Model 5 was significant (Delta $\chi^2(12)$ =53.81, *p*<.001), indicating that the scale has metric but not scalar invariance.

Depicted in figure 2, Model 5 was retained as the final model, reaching the best model fit and demonstrating that the scale works invariantly across two points of time except for scale location, which indicates metric invariance. The factor loadings were predominantly strong and the scale was free from response styles. For two items, factor loading exceeded the value of 1.00, which according to Jöreskog (1999) is not unusual when CFA factors are correlated. Cronbach's Alphas were satisfactory for factor one, WEC-1, at time 1 (0.73) and time 2 (0.73), but fell under the cut-off point of .7 for factor 2, WEC-2, at time 1 (.61) and time 2 (.63). The model-based estimate of composite scale reliability (Raykov, 1997) was good for WEC-1 at time 1 (0.83) and time 2 (0.84), but fell under the cut-off point of .7 for WEC-2, at time 1 (.60) and time 2 (.60). In all, the findings support the factorial validity of the 7-item WEC Scale.

[Insert Figure 2 about here]

General Discussion

This study is a contribution towards understanding and measuring the nature of Work Environment Complexity for leaders in modern, complex organizations. By clarifying the core content for a WEC-measure, previously fragmented approaches were integrated to understand what makes an environment complex for individuals in leadership positions. An empirical gap in research was closed by outlining the content of WEC as a comprehensive construct. Findings suggest that leaders in modern organizations face a specific state of WEC characterized by frequent transformation and change, the occurrence of unpredictable events, and skill-wise demanding yet uncertain work requirements, derived from subjects of Frequent Change, Unpredictability, and Challenging Work Content. With this conceptualization, the notion of WEC for leaders has been expanded from a prominent but narrow understanding of job complexity as completing skill-wise challenging tasks to a broader and thus more comprehensive understanding of WEC that also incorporates external influences and challenges for leaders in a workplace such as on-going changes and the unpredictability of future work demands.

Moreover, results of studies 1 and 2 indicate that employees and leaders views of WEC may be divergent. In the employee sample (Study 1), the combination of EFA-methods could not unambiguously identify either a one- or a two-factor solution. Instead, in both study 2 and study 3 leadership samples, a clear two-factor structure emerged, suggesting that the same construct may not have the same meaning for both target groups, and the WEC Scale can be considered as a measurement tool only for studying a leader's WEC. Models of individual judgement (Bernieri *et al.*, 1996; Morgeson and Humphrey, 2006) may explain this apparent difference between employees and leaders, which may be due to their positioning in the organization. Exploring the nature of employee WEC is therefore considered an interesting further path for future research.

Aiming to explore WEC for leaders in particular, this study further contributes empirically by providing an inclusive measurement instrument for the nature of WEC that a leader may face. A 7-item WEC Scale was developed and validated and demonstrated promising psychometric properties not only in cross-sectional but also in longitudinal testing. Two WEC-factors could be identified and empirically confirmed, namely Frequent Change and Events and Uncertain Work Demands. Results revealed that the time 1 and 2 measures of WEC were uncorrelated. This supports the characterization of WEC as a state, as repeated measures were gathered in the course of major organizational change. In such context, if stronger correlations had been found, one could instead claim that WEC is a mind-set or a personality variable. Further, as the set of CFAs demonstrated, the final model withstood the test for metric invariance, indicating that WEC has factorial validity across two repeated administrations. Albeit falling short of scalar invariance, having obtained metric invariance allows for testing causal relationships with the WECS-7 longitudinally (Byrne *et al.*, 1989).

An important contribution of this study's findings is therefore the possibility of quantifying the amount of complexity a leader confronts and the extent to which this amount changes over time. It provides a comprehensive scale for researchers and practitioners that allows for monitoring the level of WEC in general and along an organizational change process. Also, the WEC Scale may be useful for leadership selection as it can give insights into the level of WEC in a leader's work or position, allowing Person-Environment fit.

Having established a conceptual and empirical baseline for the construct, this project has contributed to further empirical and practical research into the function of leadership in WEC. Growing discourse has centred on the topic of how to lead under work conditions of high complexity (e.g., Burnes, 2005; Schneider and Somers, 2006; Uhl-Bien and Marion, 2009). Being able to evaluate the nature and level of WEC allows further exploring appropriate leadership styles, leader attitude, personality dispositions, as well as practical support such as leadership training. Future research could examine the consequences of working under conditions of high WEC, for example on an individual's wellbeing, motivation, engagement, work performance, or health-related issues such as burnout. This study has clarified the construct of WEC and empirically developed an instrument to enable further research on WEC and leadership.

Limitations

As Study 1 has shown, findings cannot be applied to employees, only for leaders' WEC. Further research should explore WEC for employees, possibly developing an alternative model. Secondly, although benefitting from longitudinal and field data, leadership sample sizes were small, and hence further validation on larger samples is recommended. Thirdly, the item PRED3 revealed indistinctively mixed results. While loading inconspicuously well in the pre-test and EFA of Study 1, loadings were inferior in Study 3, simultaneously still reaching excellent overall model fit. A further examination of this item should be made and its fit into the overall construct. Furthermore, the model's second factor WEC-2 showed lower and partially not satisfying internal consistency.

Finally, the present research used data gathered in three different studies and samples from two separate organisations, and used distinct data sets to develop and validate the WEC scale in order to avoid an overestimation of the psychometric properties of the scale. The statistical methodology used is sophisticated and up to the standards used to validate similar scales (e.g., Breevaart *et al.* 2012; Moneta, 2017). However, all study participants across the three studies were employed in the health care industry in Germany. As such, it is not possible to generalize the positive findings from this study on the factorial structure and factorial invariance of the WEC scale to leaders in other organisational and national contexts. Therefore, further research should assess the WEC scale in a range of industries, testing factorial invariance between groups of leaders.

Conclusion

In sum, the present study provides a reasonably valid and reliable WEC Scale that can be used to address a wide range of empirical questions concerning the effects that WEC has on leaders' behaviour and well-being with the aim of identifying optimal ways for leaders to cope with and manage Work Environment Complexity.

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Table 1

Means and standard deviations of the WECS items estimated separately on the data from Study 1, Study 2, and Study 3 and factor loadings estimated using principal axis exploratory factor analysis (EFA) separately on the data from Study 1 and Study 2.

Item	Study 1 (*n* = 305)					Study 2 (*n* = 53)					Study 3			
	X	*SD*	Factor loading			*X*	*SD*	Factor loading			Wave 1 (*n* = 77)		Wave 2 (*n* = 77)	
			F1	F2	Single Factor			F1	F2	Single Factor	*X*	*SD*	*X*	*SD*
1. Change frequently occurs in my unit. (FRCH1)	3.84	.96	.889	.446	.745	4.30	.77	.794	.338	.784	3.38	1.00	3.64	.93
2. It feels like change is always happening. (FRCH3)	3.62	1.03	.694	.447	.672	3.91	1.02	.701	.121	.555	2.75	1.07	2.92	1.09
3. Unexpected events occur on my job to a great extent. (PRED2)	4.05	.99	.676	.765	.768	4.47	.72	.612	.115	.505	3.69	1.03	3.60	1.03
4. I am faced with unexpected decisions concerning my work to a great extent. (PRED3)	4.35	.87	.576	.642	.658	4.72	.57	.360	.378	.479	4.40	.69	4.45	.62
5. In my work it is difficult to identify when changes start and end. (FRCH2)	3.37	.99	.431	.503	.497	3.30	.89	.312	.996	.527	2.82	1.00	2.81	.87
6. The work situation involves solving problems that have no obvious correct answer. (PRSO1)	3.30	1.01	.231	.297	.278	3.15	1.03	.261	.520	.437	2.64	1.00	2.51	.93
7. I can predict what job demands will be placed on me in this situation. (R) (PRED1R)	3.53	1.06	.016	.119	.055	2.72	1.03	-.139	.389	.067	2.74	.89	2.48	.87

Note. (R) = reverse scored. FRCH = item originally from Frequent Change Scale. PRED = originally from Predictability Scale. PRSO = originally from Problem Solving Scale. Primary loadings indicated by dark grey shadow, cross-loadings (secondary loadings < 0.20 difference to primary loading) in light grey shadow.

Table 2

Study 3: Goodness of fit indexes of confirmatory factor analysis (CFA) models for the 7-item WECS.

Model	χ^2	df	*p*	RMSEA	RMSEA 95% CI	RMSEA *p* for test of close fit	SRMR	CFI	NNFI
Model 1 Configural invariance	61.64	66	0.63	0.000	[0.00; 0.06]	0.90	0.084	0.99	0.99
Model 4 Configural invariance, longitudinally correlated item errors	59.08	59	0.47	0.004	[0.00; 0.07]	0.81	0.086	0.98	0.97
Model 5 Metric invariance	63.74	73	0.77	0.000	[0.00; 0.05]	0.96	0.088	1.00	1.01
Model 6 Scalar invariance	119.81	85	0.008**	0.073	[0.039; 0.10]	0.12	0.113	0.80	0.79

Note. $n = 77$. χ^2 = Chi-square; df = Degrees of freedom; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; CFI = Comparative Fit Index; NNFI = Non-Normed Fit Index. Light grey shadow indicates final model.
* $p < 0.05$ ** $p < 0.01$

Figure 1

Conceptual diagram of proposed Work Environment Complexity core content.

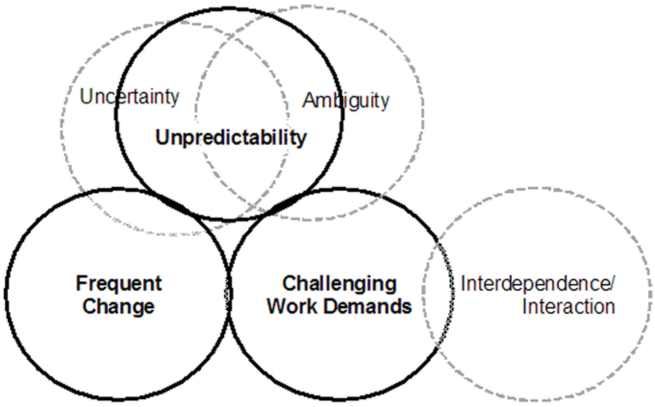
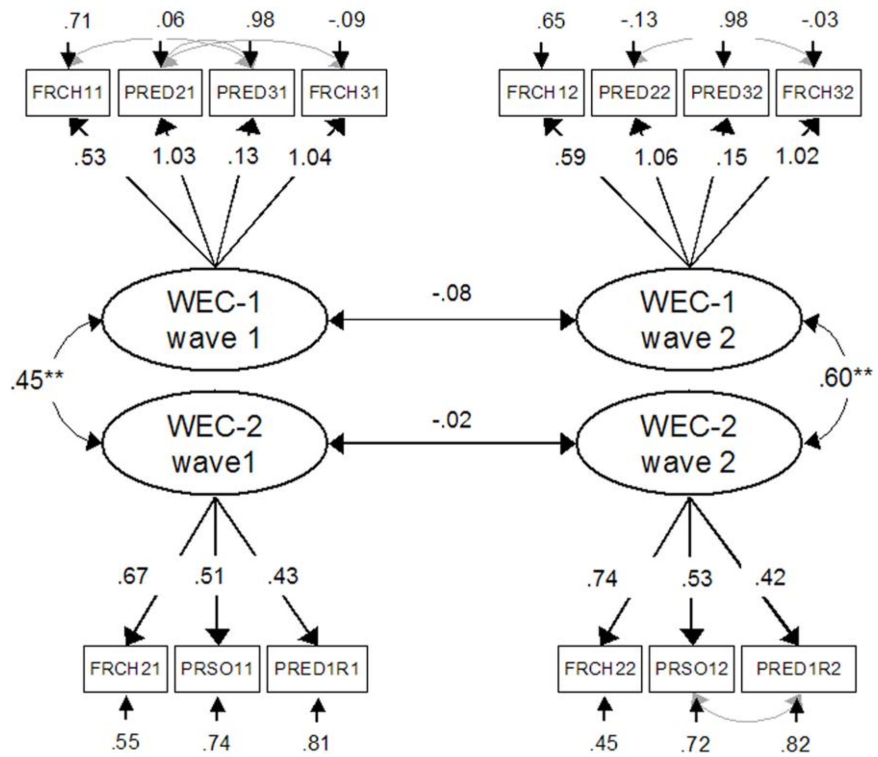


Figure 2

Study 3: Standardized factor loadings and measurement errors of the longitudinal WEC Model 5, stating metric invariance. Note. Factor labels: WEC-1 “Frequent Change and Events”, WEC-2 “Uncertain Work Demands”. Light grey arrows indicate modifications within factors as suggested by LISREL program.



* $p < 0.05$ ** $p < 0.01$