DOI: 10.20419/2013.22.372
CC = 3360
UDK = 159.9:331

Psihološka obzorja / Horizons of Psychology, 22, 66–79 (2013)

Znanstveni raziskovalnoempirični prispevek

Impact of error management culture on knowledge performance in professional service firms

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Abstract: Knowledge is the most crucial resource of the 21st century. For professional service firms (PSFs), knowledge represents the input as well as the output, and thus the fundamental base for performance. As every organization, PSFs have to deal with errors – and how they do that indicates their error culture. Considering the positive potential of errors (e.g., innovation), error management culture is positively related to organizational performance. This longitudinal quantitative study investigates the impact of error management culture on knowledge performance in four waves. The study was conducted in 131 PSFs, i.e. tax accounting offices. As a standard quality management system (QMS) was assumed to moderate the relationship between error management culture and knowledge performance, offices' ISO 9000 certification was assessed. Error management culture correlated positively with knowledge performance at a significant level and predicted knowledge performance one year later. While the ISO 9000 certification correlated positively with knowledge performance, its assumed moderation of the relationship between error management culture and knowledge performance was not consistent. The process-oriented QMS seems to function as facilitator for the more behavior-oriented error management culture. However, the benefit of ISO 9000 certification for tax accounting remains to be proven. Given the impact of error management culture on knowledge performance, PSFs should focus on actively promoting positive attitudes towards errors.

Keywords: error management culture; organizational effectiveness; professional service firms; quality control; longitudinal studies

Vpliv kulture upravljanja z napakami na učinkovitost v storitvenih podjetjih

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Povzetek: Znanje velja za najbolj ključen resurs 21. stoletja. Za storitvena podjetja (SP) znanje predstavlja tako vložek kot donos ter je tako osnova za delovno učinkovitost. SP morajo upravljati z napakami. Način, preko katerega to storijo, kaže na njihovo kulturo upravljanja z napakami. Če upoštevamo pozitivni potencial napak (npr. inovacije), je kultura upravljanja z napakami pozitivno povezana z učinkovitostjo. Pričujoča vzdolžna raziskava s štirimi meritvami je proučevala vpliv kulture upravljanja z napakami na delovno učinkovitost v smislu poznavanja in obvladovanja nekega področja. Raziskava je bila izvedena v 131 storitvenih podjetjih, natančneje v podjetjih za davčne in računovodske storitve. Ker smo dodatno proučevali tudi moderatorski učinek sistema vodenja kakovosti, smo prav tako preverili, ali ima podjetje certifikat kakovosti ISO 9000. Kultura upravljanja z napakami je bila statistično pomembno pozitivno povezana z učinkovitostjo in je napovedovala tudi delovno učinkovitost leto kasneje. Medtem ko je bil prejem certifikata ISO 9000 pozitivno povezan z delovno učinkovitostjo, predpostavljeni moderatorski učinek pri vplivu kulture upravljanja z napakami na učinkovitost ni bil konsistenten. Zdi se, da procesno orientiran sistem vodenja kakovosti še dodatno spodbuja bolj vedenjsko usmerjeno kulturo upravljanja z napakami. Vseeno je pozitivne učinke certifikata ISO 9000 potrebno preverjati v prihodnjih raziskavah. Glede na vpliv kulture upravljanja z napakami na delovno učinkovitost, bi storitvena podjetja morala aktivno spodbujati tudi pozitivna stališča do napak.

Ključne besede: kultura upravljanja z napakami, učinkovitost organizacije, storitvena podjetja, nadzor kakovosti, vzdolžne študije

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Knowledge intensity is rising in the work context of organizations, making knowledge the crucial production resource of the 21st century. In professional service firms (PSFs), knowledge represents input as well as output (von Nordenflycht, 2010), and thus the key of the whole business model. Given the association of organizational culture and performance indicators (e.g., Hartnell, Ou & Kinicki, 2011), knowledge performance as a main outcome of PSFs depends on the organizational culture of the firm. For instance, employees share knowledge more willingly if the culture is supportive rather than competitive (e.g., framing project shortcomings as areas for improvement; Wiewiora, Trigunarsyah, Murphy & Coffey, 2013).

Like other performance indicators, knowledge outcomes are jeopardized by errors. Errors produce human and economic costs (Zapf, Brodbeck, Frese, Peters & Prümper, 1992). As errors cannot be avoided completely, the specific error management culture determines the way an organization deals with errors and thereby impacts organizational performance (e.g., van Dyck, Frese, Baer & Sonnentag, 2005). In the knowledge intensive environments of PSFs, work practices are ill-defined, barely visible and their outputs are often ambiguous (Treem, 2012). Additionally, the majority of errors occur on the intellectual level, needing more time for detection. Furthermore, professionals work autonomously to a great extent, which hinders error detection and – subsequently – error communication. Thus, an error management culture promoting open communication about errors and error knowledge sharing is highly salient for PSFs. Knowledge sharing, for instance, not only depends on trust towards superiors, but also on the superiors' error attitudes (e.g., Leach, Wall & Jackson, 2003). Error management culture might be more effective if embedded in wide-ranging organizational quality management systems (QMSs), implying standards in terms of documentation and improvement of operational practices.

The aim of this study is (i) to demonstrate that error management culture correlates positively with knowledge performance and predicts knowledge performance in PSFs one year later, and – given that standard QMS like the ISO 9000s certification have become widely and globally accepted – (ii) to show a moderating role of ISO 9000 certifications. That is, error management culture is expected to show a stronger positive relation to knowledge performance if a firm undergoes the entire QMS certification process. This longitudinal study was carried out in four waves in tax accounting offices, which are prototypical PSFs.

The special contribution of our study is twofold. First, the relationship of error management culture with knowledge performance in PSFs is investigated by applying error management culture to PSFs and using an ecologically valid measure of knowledge performance. Second, the effects of an ISO 9000 certification on knowledge performance as well as the relationship between error management culture, an objective QMS and knowledge are explored. To date, neither the relationship of error management culture with knowledge performance in PSFs nor the effects of an ISO 9000 certification on knowledge performance and the relationship between error management culture, an objective QMS and knowledge have been explored respectively investigated, to our knowledge. Additionally, the longitudinal design with four waves is unique.

Thus, our study fills an important research gap by shedding light on the particularly difficult error management processes in knowledge intensive work environments, where errors occur on an intellectual level, hence, are less obvious and accordingly hard to manage. Additionally, the inclusion of certified versus non-certified PSFs complements QMS research, as respective empirical studies in knowledge intensive environments are scarce. Thereby, our study will contribute to the discussion of whether the implementation of QMS such as ISO 9000, which were originally introduced for production processes, is beneficial for PSFs. Overall, this study sets ground for evidence-based management (e.g., Rousseau & Barends, 2011) in knowledge intensive work environments with regard to error culture as well as a more detailed consideration of certification processes within QMS approaches.

In the following, the relationship of organizational (error) culture and organizational performance indicators (like knowledge) will be outlined with reference to knowledge-intensive work contexts. The linking mechanisms (e.g., employee empowerment, motivation, strain reduction) and relevant PSF features will be discussed, followed by a brief review of QMS standards and, finally, the hypotheses.

Organizational error management culture and firm performance

Organizational culture refers to shared norms, values and assumptions (Schein, 1996). Recent research also includes shared practices and procedures, as they are more visible (e.g., van Dyck et al., 2005), and thus includes organizational attitudes towards errors. Defined on the basis of action regulation theory, errors only occur in goal-oriented actions, imply the failed accomplishment of a goal and are potentially avoidable (Rasmussen, 1987; Reason, 1990; Zapf et al., 1992). Since errors are never completely avoidable, a positive error culture (Keith & Frese, 2005) should predominate. While the error prevention approach frames errors as negative events and attempts to avoid errors up-front, error management culture assumes that an error can never be completely prevented (e.g., Frese & Zapf, 1991). This approach distinguishes between errors and their consequences, focusing on the reduction of negative error consequences and increasing potentially positive long-term consequences of errors (e.g., appraising errors as opportunity for learning). According to van Dyck et al. (2005, p. 1229), "[…] error management culture encompasses organizational practices related to communicating about errors, to sharing error knowledge, to helping in error situations, and to quickly detecting and handling errors."

Organizational culture is strongly related to organizational effectiveness, with knowledge management being a full mediator of that relationship (Zheng, Yang & McLean, 2010). Furthermore, the *type* of culture is decisive for organizational outcomes. In a recent meta-analysis Hartnell and colleagues (2011) investigated culture types and organizational effectiveness within the Competing Values Framework (see Cameron, Quinn, DeGraff &Thakor, 2006): The 'clan' type, relating to an employee supportive culture including participation, employee involvement and open communication, showed strong associations with employee attitudes (e.g., job satisfaction, organizational commitment) as well as an association with quality of products and services. Accordingly, Wiewiora and colleagues (2013) found strong evidence for the willingness to share any kind of knowledge within organizations with the highest rating in 'clan' culture. In those organizations, teamwork und informal discussions are the way to solve project issues, and project shortcomings are seen as areas for improvement rather than failures (Wiewiora et al., 2013). This 'clan' type of organizational culture shares several features with error management culture, e.g. both promote open communication, suggesting that error management culture should foster knowledge sharing as well.

Communication about errors is perhaps the most important error management practice (e.g., van Dyck et al., 2005), implying actively rewarding communication of errors and inhibiting their punishment (Edmondson, 1999). Also, error communication is one of the main opportunities for organizations to learn from errors (Homsma, van Dyck, De Gilder, Koopman & Elfring, 2009), and an organizational error management approach is conceptually associated with a general goal of learning (van Dyck et al., 2005). Such highlevel organizational error management culture is pivotal to the reduction of negative and the promotion of positive error consequences like goal achievement and economic performance (van Dyck et al., 2005). Moreover, organizations with error management are more innovative and action-oriented (Rybowiak, Garst, Frese & Batinic, 1999).

Organizations need to establish an error management culture that ensures the detection of and communication about errors. This is especially relevant in knowledge-intensive environments. In highly complex work fields like PSFs, action regulation is mainly knowledge-based, with the majority of errors occurring on the intellectual level – i.e. thought, memory or appraisal errors. These errors need more time to be detected and more external support for error rectification. Organizations mainly learn from severe consequences of errors (Homsma et al., 2009), but the majority of errors – like near-misses (Reason, 1990) and latent errors (Ramanujam & Goodman, 2003) – does not lead to consequences, especially in PSFs. Time pressure – which is ever present in PSFs – prevents learning from apparently non-serious incidents (Homsma et al., 2009). Error communication is one opportunity to learn from errors that do not cause severe consequences.

While communication virtually represents the exclusive way to detect errors in PSFs, it is not automatically practiced: the personnel works very autonomously, errors are hardly visible and impact the output massively on the knowledge level only. While the high autonomy is needed for effective working (von Nordenflycht, 2010), its downside are problems to detect errors if professionals work inaccurately (Mintzberg, 1983). The non-crystalline nature of knowledge-work exacerbates judgment of outputs (Treem, 2012) and the output quality is subject to debate in respect to relevant criteria (Alvesson, 2001; Lowendahl, Revang & Fosstenlokken, 2001). Professionals encounter difficulties in explaining the processes by which they accomplish tasks (von Nordenflycht, 2010). Hence, error communication could be one way of accomplishing transparency and thereby enabling performance improvement. Thus, dealing with errors proactively is especially relevant for PSFs, due to their high knowledge complexity.

Effects of error management: strain reduction, empowerment, motivation

The error culture of an organization is determined by the error orientation of the employees, i.e., how they think about errors in the work context and how they handle them (Rybowiak et al., 1999). Thus, organizational level error culture has its analogy on the employee level. The interaction of affective and anticipated error perception (primary appraisal) as well as perceived coping resources (secondary appraisal) leads to individual error orientation. Rybowiak et al. (1999) conceptualize error orientation positively, with low affective (e.g., error strain, covering up error) and error anticipating components as well as high beneficial attitudes (e.g., error competency, learning from error, error risk taking, error communication). Error orientation shows a significantly positive relationship with personal initiative (Rybowiak et al., 1999). One of the ways in which knowledge performance could benefit from a supportive error management culture, is the potential for motivating and empowering employees, accompanied by a reduction of stress produced by errors.

Errors are exhausting as they interrupt goal-oriented behavior and lead to negative emotions (Zapf et al., 1992). Additionally, the expectation of error punishment leads to strain. By reducing the negative emotional impact of errors (Keith & Frese, 2005), error management boosts employees' motivation to communicate about and learn from errors. Also, a supportive error attitude reduces strain which results from fear of exposure or punishment. Accordingly, error orientation is associated with lower depression and strain in general (Rybowiak et al., 1999). Knowledge performance can benefit from both strain reduction as well as employee motivation and empowerment. By enhancing information sharing and learning from errors, the positive attitude towards errors facilitates employees' error competency.

Empowerment is an intrinsic task motivation reflecting a sense of control regarding one's work and active orientation to one's work role (Spreitzer, 1995). As psychological empowerment refers to employees' feelings of "competence or confidence in their ability to perform tasks well" (Leach et al., 2003, p. 28), this may include error handling as well. In particular, the cognitions of competence and self-determination should gain/increase from error management culture. Competence refers to the capability to perform activities with skill, which should be positively affected by increasing error (handling) knowledge. Self-determination reflects choice of initiation and continuation of work behaviors and processes (Spreitzer, 1995), which likewise applies to error-related actions.

Work contexts shape empowerment cognitions, which in turn motivate individual behavior (Spreitzer, 1995). As such, high-performance managerial practices are strongly related to psychological empowerment (meta-analysis, Seibert, Wang & Courtright, 2011), and error management being one such practice should likewise lead to empowered employees. Effective error management reduces strain, enhances communication of errors, furthers the appraisal of errors as learning opportunity and thus facilitates empowerment. For instance, the management practice of information sharing is significantly related to empowerment (Spreitzer, 1995).

According to the classification of empowerment by Wilkinson (1998), professionals are partly empowered as task autonomy and self-management are high by the nature of their work, whereas information sharing and upward problem solving may still be subject for empowering practices like error management. Thus, empowerment should lead to beneficial outcomes like knowledge performance. In fact, psychological empowerment has been found to be positively related to a range of employee outcomes (e.g., task and contextual performance), negatively related to employee strain, and team empowerment is significantly related to team performance (meta-analysis, Seibert et al., 2011). Also, empowerment decreases information pathologies (Scholl, Schermuly & Klocke, 2013), which are avoidable failures of distributed information processing (Scholl, 1999), and promotes job knowledge (Leach et al., 2003).

The supportive 'clan' culture may concur with high psychological empowerment of employees, and an employee empowering attitude towards errors should in turn e.g. strengthen employees' willingness to share knowledge (Wiewiora et al., 2013). While empowerment is motivationally relevant per se, the motivation to share knowledge is a crucial aspect for knowledge performance. If employees have to fear damage to their reputation by negative attributions due to error reporting (van Dyck et al., 2005), they will less likely be willing to share their knowledge. The type of motivation also impacts knowledge sharing (Hung, Durcikova, Lai & Lin, 2011): reputation feedback intrinsically motivates employees to share knowledge and is significantly associated with knowledge quantity and quality. Influencing the motivation of employees in PSFs represents a challenge (von Nordenflycht, 2010), as professionals work autonomously and dislike direct authoritarian orders (e.g., Maister, 2003). Motivating professionals intrinsically by error management culture might present a fruitful method for enhancing error knowledge sharing and thereby knowledge performance.

Beyond individual motives, the qualitative nature of relations impacts knowledge sharing behavior (Boer, Berends & van Baalen, 2011): being member of the same group (communal sharing) and striving for recognition as expert (expertise-based authority ranking) are motivations best applicable to groups of professionals. However, high error management culture with its empowering practices would be needed as breeding ground for intrinsic motivation of professionals.

Error management includes a notion of striving for development, which can also be inherent in organizations' motivation to set quality standards for procedures, as reflected in QMSs.

QMS and knowledge performance

Standards impact an estimated 80% of world commodity trade (International Organization for Standardization, 2012). Belonging to the process-oriented ISO 9000's standards, the ISO 9001 is the most accepted one. The total number of ISO 9001 certificates in 2011 amounted to 1.111.698 in 180 countries (International Organization for Standardization, 2011), with nearly half a million being allotted to Europe. A QMS that conforms to ISO 9000 entails documenting operating procedures, training, internal auditing, and corrective action procedures. ISO 9000 certification also requires implementing procedures for improvement of existing procedures. In general, quality management programs/standards such as ISO 9000 are said to improve both management practices and production processes, which subsequently translate into increased sales and employment (e.g., Levine & Toffel, 2010).

Companies' motivation for becoming certified may be internal or external (Sampaio, Saraiva, & Rodrigues, 2010): Internal motivations are related to genuine organizational improvement goals (e.g., internal communication), while external motivations are mainly related to promotional and marketing issues like market share. Thus, the kind of motivation is one of the moderators determining the effects of ISO 9001, being linked to corresponding internal and external benefits (Sampaio et al., 2010). The external motivation of firms employing professionals for establishing standards is to signal expertise (Lowendahl et al., 2001). Internal motivations should be predominantly linked to internal benefits like knowledge sharing.

In a meta-analysis including 23 studies, Nair (2006) reaffirms the role of QM practices in improving

performance. As total QM is a loosely defined, holistic set of principles and tools aimed at, e.g., encouraging continuous improvement and prevention of defects, outcomes may be diverse and are moderated by many factors (Nair, 2006), such as motivation (Sampaio et al., 2010). In contrast, the premise of ISO 9000 is that well defined and documented procedures improve the consistency of output.

Tzelepis, Tsekouras, Skuras and Dimara (2006) showed a positive impact of ISO 9001 on reducing productive inefficiency in a study with more than 1.500 firms of the Greek manufacturing industry. ISO 9000 improved financial performance (Corbett, Montes-Sancho & Kirsch, 2005). Among nearly 1.000 Californian companies, those adopting ISO 9001 were more likely to survive and had higher growth rates for sales, employment, payroll and average annual earnings (Levine & Toffel, 2010).

Drawing comparisons to the productive inefficiency (Tzelepis et al., 2006) and seeing knowledge performance as a product of PSFs, tax accounting offices' productive inefficiency regards information pathologies (Scholl et al., 2013) such as not communicating about and not sharing of errors. As such, the ISO 9000 certification process should have an impact in that it provides the ground for the relationship between error management culture and knowledge performance. In an office that underwent the certification process, error management culture should be related more strongly to knowledge performance as it provides a consistent frame of organizational standards and culture. Also, during the certification process an organization has to deal with its whole premises, practices and procedures, thus leading to more consciousness.

Aim of the study and hypotheses

This study is designed to demonstrate the importance of error management culture for expert performance in knowledge intensive work environments. Additionally, the interplay of error management culture and QMS certifications with regard to knowledge performance is considered. Specifically, the ISO 9000 certification of tax accounting offices is expected to enhance the positive impact of error management culture on knowledge performance.

Based on the discussion led in the prior sections, taking error management culture as antecedent of knowledge performance and ISO 9000 certification as a moderator of that relationship, we formulate our hypotheses as follows:

H1: Error management culture positively predicts knowledge performance one year later.

H2: The relationship between error management culture and knowledge performance is moderated by ISO 9000 certification: this relationship is stronger for certified offices as compared to non-certified offices.

Method

Setting and procedure

The study was conducted in tax accounting offices in Germany, as they resemble prototypical PSFs. The tax accounting offices participated voluntarily in a specialist competition, which is conducted by a magazine annually each autumn. While this magazine with a distribution of around 700.000 readers is not specialized on specific professions, around 10.000 tax accountants in Germany were approached via email. A letter of invitation from the project team as well as a sample of the questionnaires were distributed via email as well as via the magazins' website. This way, participation of all tax accountant offices located in Germany was enabled. As this competition is well known in the profession—it has been carried out for several years—participating and non-participating offices may differ due to their motivation to participate, but not due to lacks in regional information or reachability. The online competition questionnaire included several questions about the structure of the office, qualifications of the office's employees and attitudes (e.g., communicational aspects) as well as a series of questions about specialist knowledge. All German tax accounting offices were invited to take part in the competition. The results of the competition were published in a volume of this magazine. The best performing tax accounting offices were listed and mentioned in the text. Thus, participation was basically motivated by image and marketing considerations of the tax accounting offices.

Sample

At time-point 1 (T1) 336 offices participated in the competition. At time-point 2 (T2) 335, at time-point 3 (T3) 362, and finally at time-point 4 (T4) 418 offices participated. A sub-sample of $N = 131$ offices participated at all four points in time and was therefore included in our analyses. Generally, the owner of the tax accounting office was in charge of filling in the questionnaire. However, the knowledge questions could be answered jointly by all tax accountants of the office and the structural questions by other employees. Printed versions of the questionnaire were available together with the call for participation; thus, the collection of answers could be distributed in time and to several persons within one office.

Instruments

Independent variable. Error management culture was measured by items from a widely distributed manual for quality assurance and quality management in tax accounting (BStBK, DATEV & DStV, 2012) and originally consisted of seven items. Exploratory factor analysis with Varimax rotation was conducted. The

initial solution with the seven error management culture items produced three factors (respectively two, T4) with eigenvalues over 1. However, the Kaiser Eigenvalue criterion routinely retains too many factors (Lance, Butts & Michels, 2006). As the goal was to have one scale with the same items across all measurement points and due to breaks in the scree plot after the respective first factor, factor analyses were repeated with one forced factor. The rationale followed was item exclusion due to factor loadings below .50. However, exceptions were made with regard to reduction of the reliabilities of the final scales. Table 1 displays factor loadings, corrected item-total correlations, skewness and kurtosis. Factor analyses as well as reliability analyses lead to the exclusion of two items from the final scale, that is, item b as the only reverse coded item and item f. The final scale consisted of the same five items across the four points of measurement, e.g., "The employee will be informed about possible errors in a personal conversation." and "Critical incidents and errors will be systematically analyzed, evaluated and documented in an error report system.". The answering format was a five-point Likert scale, from 'applies not at all' to 'applies fully'. Scale reliability ranged from $\alpha = .56$ to $\alpha = .72$ (Table 2). With a mean ranging from $m = 4.67$ ($SD = 0.38$) at T1 to $m = 4.84$ ($SD = 0.31$) at T4 the scale is clearly skewed (see Table 1 for details). As (right-shifted) skewness and kurtosis were exceeding tolerable intervals, the scales were z-transformed for all analyses.

Moderator variable. The variable for quality management system was assessed dichotomously with '0' (no) and '1' (yes). Offices thus indicated whether they were certified with the standard ISO 9000. For proving validity, offices had to fax a copy of the certification. Of the 131 participating offices, 36 were certified at T1, respectively 40 (T2), 41 (T3), and 46 (T4).

Dependent variable. Knowledge performance was measured by questions on tax regulation, which were provided by independent tax accounting experts. One question at T4 was "Architects may assert parts of their input tax according to average rate. How high is the percentage?" with possible answers a) 1.2 percent, b) 1.6 percent, c) 1.9 percent, d) 2.4 percent. One or more answers had to be chosen, with the right answer in this case being c) 1.9 percent. The relative amount of valid answers was calculated. At T1, 27 multiple choice questions were included in the evaluation, respectively 20 (at T2 and T4) and 24 (at T3). Accordingly, the sums of valid answers ranged between $m = 23.62$ ($SD = 2.38$) at T1 and $m = 16.21$ ($SD = 1.64$) at T4 (Table 2). Due to the different possible ranges across years, the knowledge performance variables were z-transformed.

Control variable. The size of the offices was assessed by the total number of employees per office at all four measurement points. The average size ranged from $m = 87.4$ ($SD = 328.3$) to $m = 98.7$ employees ($SD = 314.1$; Table 2).

Analyses

Since our sample size is not sufficient for Structural Equation Modeling (e.g., Weston & Gore, 2006), we relied on stepwise regression analyses, conducted separately for knowledge performance at the four measurement points. In model 1, the control variable size of the office of the respective year is included in the equation, in model 2 the error management culture of the respective year is added. In the following model(s), error management culture of the year(s) prior to knowledge performance measurement is added consecutively. In the last model, the moderation by ISO 9000 certification is analyzed: size and ISO 9000 from the same year of the knowledge performance measurement as well as error management culture one year prior were included. The latter was also multiplied by ISO 9000, in order to model moderation, and this term was added into the equation.

Results

Descriptives and correlations are displayed in Table 2. The number of employees showed a significant positive relation cross-sectionally to knowledge performance at T1 and T2 ($r = .21$, $p < .01$, respectively $r = .19$, $p < .05$), but not T3 and T4. Error management culture was significantly positively associated cross-sectionally with knowledge performance at T3 and T4 (both $r = .26$, $p < .01$), only marginally at T1 ($r = .15$, $p < .10$) and not at T2. The percentages of the offices certified with ISO 9000 did rise from 27.5 % (T1) to 35.1 % (T4). Existence of an ISO 9000 certification correlated positively with knowledge performance at all times at a significant level (between $r = .19$, $p < .05$ and $r = .23$, $p < .01$) except at T2.

Regression analyses with the control variable (Table 3, models 1) showed cross-sectional patterns similar to that found in correlational analyses, that is significances of size of office with knowledge performance for T1 and T2 ($\beta = .21$, respectively $\beta = .19$; $p < .05$), but not for T3 and T4. The cross-sectional error management culture in model 2 was significantly positively related to knowledge performance at T1 ($\beta = .19$, $p < .05$), at T3 and T4 (both $\beta = .26$, $p < .01$) but not at T2 ($\beta = .06$, *ns*). Knowledge performance at T2 was significantly predicted by error management culture the year before (T1), as reflected in a positive coefficient (model 3, $\beta = .22$, $p < .05$). For knowledge performance at T3, the error management culture one (T2) or two years before (T1) was not a significant predictor (models 3 and 4), but the cross-sectional error management culture kept significance. Finally, knowledge performance at T4 was predicted by error management culture (T3) one year before (model 3, $\beta = .25$, $p < .05$), leading to a decline in significance of the cross-sectional T4 relationship between error management culture and knowledge performance. Error management culture two or three years earlier (T2 and T1) was not significantly related to knowledge performance at T4 (models 4 and 5).

Table 1. *Factor analysis of error management culture*

Item	Factor loading[1]	Corrected item total correlation[2]	Skewness[3]	Kurtosis[4]
T1				
a. The employee will be informed about possible errors in a personal conversation.	**.53**	.28	–3.59	13.36
b. Employees will be officially held accountable.	–.26	–	–	–
c. Critical incidents and errors will be systematically analyzed, evaluated and documented in an error report system.	**.66**	.42	–1.01	–.02
d. Together with the employee, error causes are analyzed and dealt with.	**.61**	.37	–2.30	4.66
e. Findings gained by error analysis (ways of error avoidance) will be announced in the office.	**.64**	.34	–2.20	5.23
f. The solution of clients' complains helps us to overcome our weaknesses.	.38	–	–	–
g. The office has access to pools of experts or specialist back office structures.	**.50**	.26	–4.30	20.65
Initial eigenvalues	1.96			
% of variance explained	28.0			
T2				
a.	**.50**	.24	–4.02	14.36
b.	–.15	–	–	–
c.	**.70**	.40	–1.74	3.03
d.	**.79**	.51	–2.86	6.30
e.	**.69**	.34	–3.82	19.24
f.	.15	–	–	–
g.	**.25**	.16	–6.21	42.97
Initial eigenvalues	1.93			
% of variance explained	27.56			
T3				
a.	**.56**	.23	–4.02	14.36
b.	–.00	–	–	–
c.	**.65**	.46	–1.90	3.60
d.	**.72**	.41	–3.83	15.43
e.	**.74**	.51	–3.34	14.13
f.	.50	–	–	–
g.	**.27**	.22	–4.25	18.84
Initial eigenvalues	2.13			
% of variance explained	30.38			
T4				
a.	**.77**	.55	–4.02	14.36
b.	–.28	–	–	–
c.	**.65**	.51	–1.67	1.75
d.	**.76**	.55	–3.25	10.48
e.	**.59**	.41	–3.66	17.13
f.	.71	–	–	–
g.	**.57**	.31	–6.11	41.67
Initial eigenvalues	2.85			
% of variance explained	40.74			

Note. Extraction Method: Principal Component Analysis. Items included in final scale in bold.

[1] Factor loadings below .50 are tolerated if exclusion from scale leads to reduction of alpha coefficient, see[2]

[2] Subsequently, corrected item-total correlation below .30 is tolerated if exclusion from scale leads to reduction of alpha coefficient (to .50/ item a, to .49/ item g, T1; to .50/ item a, to .51/ item g, T2; to .57/ item a, to .56/ item g, T3)

[3] Standard error for skewness = 0.21

[4] Standard error for curtosis = 0.42

Table 2. *Descriptive statistics and correlations among variables at T1, T2, T3, and T4*

		M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Size T1	98.66	314.09															
2	ISO T1	0.27	0.45	–.14														
3	[a]EMC T1	4.67	0.38	–.17*	.22*	**.58**												
4	Knowledge T1	23.62	2.38	.21*	.23**	.15†												
5	Size T2	90.87	302.58	.90**	–.13	–.13	.18*											
6	ISO T2	0.31	0.46	–.07	.89**	.24**	.21*	–.05										
7	EMC T2	4.81	0.29	–.03	.14	.50**	.16†	–.03	.15†	**.56**								
8	Knowledge T2	18.84	1.21	.21*	.10	.17†	.57**	.19*	.07	.05								
9	Size T3	90.63	301.22	.90**	–.13	–.13	.19*	1.00**	–.05	–.02	.20*							
10	ISO T3	0.31	0.47	–.07	.88**	.28**	.17†	–.05	.91**	.21*	.06	–.05						
11	EMC T3	4.81	0.31	–.06	.20*	.48**	.22*	–.06	.22*	.65**	.06	–.06	.26**	**.59**				
12	Knowledge T3	19.80	2.21	.09	.22*	.19*	.38**	.10	.24**	.19*	.35**	.11	.21*	.26**				
13	Size T4	87.43	328.29	.78**	–.12	–.09	.17*	.87**	–.02	–.03	.17†	.87**	–.02	.00	.10			
14	ISO T4	0.35	0.48	–.09	.77**	.23**	.19*	–.06	.80**	.25**	.06	–.06	.88**	.24**	.20*	–.03		
15	EMC T4	4.84	0.31	–.18*	.19*	.32**	.20*	–.18*	.20*	.41**	.09	–.17*	.22*	.66**	.17†	–.09	.22*	**.72**
16	Knowledge T4	16.21	1.64	.07	.21*	.27**	.30**	.04	.29**	.23**	.35**	.04	.26**	.31**	.34**	.04	.19*	.26**

Note. $N = 131$. $^{\dagger}p < .10$; $^{*}p \leq .05$; $^{**}p \leq .01$ (2-tailed). Diagonal in bold: alpha coefficients of scales. Knowledge performance for analyses z-transformed. [a]EMC: Error Management Culture.

Table 3. *Regression analyses of error management culture on knowledge performance*

	Knowledge T1			Knowledge T2				Knowledge T3					Knowledge T4					
Model	1	2	3	1	2	3	4	1	2	3	4	5	1	2	3	4	5	6
[a]Size	0.21*	0.24**	0.27**	0.19*	0.19*	0.22*	0.22*	0.11	0.12	0.12	0.13	0.11	0.04	0.07	0.05	0.05	0.06	0.05
[b]ISO			0.24**				0.08					0.05						0.13
[c]EMC T1		0.19*	0.15			0.22*	0.25**				0.10						0.15	
EMC T2					0.06	–0.05				0.04	0.01	0.14				0.06	0.10	
EMC T3									0.26**	0.24*	0.21†				0.25*	0.21	0.17	0.29***
EMC T4														0.26**	0.10	0.10	0.10	
EMCT1 X ISOT1			–0.02															
EMCT1 X ISOT2							–0.19*											
EMCT2 X ISOT3												0.24*						
EMCT3 X ISOT4																		–0.02
ΔR^2		0.03	0.05		0.00	0.04	(0.02)[1]		0.07	0.00	0.01	(0.07)[1]		0.07	0.04	0.00	0.02	(0.01)[1]
R^2	0.04	0.08	0.13	0.04	0.04	0.08	0.10	0.01	0.08	0.08	0.09	0.12	0.00	0.07	0.11	0.11	0.12	0.11
F	5.77*	5.31**	4.67**	5.00*	2.70†	3.53*	3.67**	1.44	5.60**	3.75*	3.07*	4.31**	0.23	4.86**	4.97**	3.77**	3.53**	4.04**

Note. Standardized regression coefficients β; $N = 131$; †$p < .10$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

[a]The respective size of the measurement time of knowledge performance is included (T1-T4); [b]The respective ISO certification of the measurement time of knowledge performance is included (T1-T4); [c]EMC: Error Management Culture.

[1] The delta *R* squared is calculated by subtracting the *R* squared from the same model without the iso/ and iso moderation term (knowledge performance - T2: $R^2 = .08$; T3: $R^2 = .05$; T4: $R^2 = .10$).

Thus, hypothesis 1, stating a significantly positive influence of error management culture on knowledge performance one year later, is supported for knowledge performance at T2 and T4, but not for T3.

Regarding the moderation by ISO 9000 certification, significant coefficients with knowledge performance emerged only at T1. Knowledge performance was cross-sectionally higher for certified offices at T1 only. The moderation term of ISO 9000 certification with (prior) error management culture was significant only at two waves. There was negative significance of the moderation term ($\beta = -0.19$, $p < .05$) for knowledge performance at T2 (model 4), and positive significance of the moderation term ($\beta = 0.24$, $p < .05$) for knowledge performance at T3 (model 5). While the latter moderation confirms our hypothesis, indicating a stronger positive relationship between error management culture T2 and knowledge performance T3, if an office is certified as compared to non-certified offices, the moderation for T2 knowledge indicates the opposite. Thus, certified offices at T2 show lower knowledge performance with higher error management culture at T1.

While the cross-sectional correlation generally speaks for a direct positive relationship between ISO 9000 and knowledge performance, the hypothesis of a moderation (H2) is only partially supported. Furthermore, the two significant moderations show contradicting relationships. The relationship between error management culture and knowledge performance seems either not to be moderated by ISO 9000 (T1, T4) or moderated in an unclear direction (negative for T2, positive for T3).

Discussion

Our results indicate a significant and positive relationship between error management culture and knowledge performance, which confirms our first hypothesis. While the certification by ISO 9000 generally showed a significant positive correlation with knowledge performance, it did not seem to moderate the relationship between error management culture and knowledge performance consistently. Thus, our second hypothesis is only partially supported.

Summarized, we demonstrated that error management culture positively predicts knowledge performance in PSFs one year later, and did not find a consistent positive moderating role of ISO 9000 certifications. Rather, error management culture and ISO 9000 certification are directly related to knowledge performance, and ISO 9000 has a positive association with error management culture. Overall, our results support a higher error management approach as being superior over a lower error management attitude and as being beneficial for organizational outcomes.

Error management culture and knowledge performance

As organizational culture impacts performance, error culture impacts knowledge performance. Conceiving error management as organizational practices like error communication, sharing error knowledge, and quick detection and handling of errors (van Dyck et al., 2005), translates into enhanced knowledge performance. These error-related practices share features with the 'clan' type of organizational culture (e.g., Hartnell et al., 2011; Wiewiora et al., 2013), hence this type might be viewed as beneficial for knowledge performance. Dealing proactively with errors seems especially relevant for PSFs with their great knowledge complexity, making a 'clan' culture a potentially preferable organizational culture for PSFs.

Though we did not assess the concrete mechanisms linking error management practices to knowledge performance, our results make empowerment, motivation and strain reduction feasible as possible relevant processes. Error management might enhance knowledge performance by reducing negative emotional impact of errors (e.g., Keith & Frese, 2005) and by improving error orientation of employees (e.g., Rybowiak et al., 1999). According to Spreitzer (1995), a key set of management practices are antecedents of empowerment. Error management seems to be one of those practices, implicating control regarding one's work (Spreitzer, 1995) and the ability to perform tasks well (Leach et al., 2003). Thus, error management might in particular affect the competence and self-determination cognitions of employees. Also, empowerment entails intrinsic motivation (e.g., Spreitzer, 1995), which is particularly valuable in PSFs. Despite being partly empowered by the nature of their work (Wilkinson, 1998), professionals may still be intrinsically motivated by error management. Empowerment devices like information sharing are underused in PSFs, making error management practices one of the few ways to enhance knowledge sharing among professionals and thus their knowledge performance.

The assumption underlying 'clan' cultures is that "[…] human affiliation produces positive affective employee attitudes directed toward the organization." (Hartnell et al., 2011, p. 679), which implies a supportive culture like error management. The approach of developing the human resource base seems to be beneficial for organizational knowledge performance.

QMS and knowledge performance

Given that ISO 9000 is a globally distributed and accepted QMS standard, the results are disillusioning with respect to knowledge performance. Offices successfully certified with ISO 9000 perform better at knowledge performance compared to their non-certified counterparts,

but once error management culture is accounted for, certification effects are less clear or diminish. Is error management culture more important for knowledge measures than standard QMS?

The ISO 9000 certification is found to translate into increased sales (e.g., Levine & Toffel, 2010), and financial performance (Corbett et al., 2005). As studies focus on industries (e.g., Tzelepis et al., 2006), the question whether ISO 9000 certification is as useful for PSFs remains unanswered. Specifically knowledge performance might be less enhanced by standardization, thus the question remains whether ISO 9000 certification processes are a sensible undertaking in knowledge-intensive environments. Certification processes bind enormous resources (e.g., employees work time in collecting existing checklists), making them costly and time-consuming. If costs outweigh the potentially beneficial effects, resources might be better allocated to high managerial practices like error management. If standard certification is understood as a mere technical adjustment of procedures and not accompanied by parallel development of human resources (e.g., leadership training), it might forfeit its benefits.

The question of the value of ISO 9000 certifications leads to highlighting the possibly moderating role of motivation for such an implementation. If offices are driven by external motivations to acquire ISO 9000 certification, benefits might also be more external (Sampaio et al., 2010). On the one hand, certification might have shown only moderate effects in our study because knowledge performance involves internal knowledge sharing, error communication and the like. On the other hand, knowledge is the crucial resource in PSFs, and if certification is less beneficial or even detrimental due to the mainly external motivation, the relevance of the ISO 9000 certification for PSFs is up for debate. There are several external reasons for tax accounting offices to implement a standard, e.g., like signaling expertise (Lowendahl et al., 2001), image gain and marketing in general. Also, certified clients of PSFs may demand certification of their service providers, as the certification of client companies and small and medium-sized enterprises may depend on it, e.g., the certification of their tax accountants. A direct economic reason for certification is the reduction of insurance rates. Certification out of solely external motivations would be a mere standardization process without changing the culture – thus, error management culture might be largely unaffected by the process. Hence certification motivation could be one moderator explaining the only moderate correlation between ISO 9000 and error management culture, and also between ISO 9000 and knowledge, with internal motivation being the pivot for knowledge-related performance. This could also explain why error management culture is the stronger predictor for knowledge performance than ISO 9000.

Two alternative explanations for the only moderate correlation between ISO 9000 and error management culture are possible: First, our sample size is very small, possibly too small for the ISO 9000 moderation to emerge. However, error management culture, despite its low variance due to an upward bias, is still more powerful for the explanation of knowledge performance. This, in turn, could imply a second alternative: ISO 9000 affects knowledge performance via mediation by error management culture. Thus, error management culture could be an expression of QMS, being closer to visible behavior as it reflects the organizational management style. ISO 9000 might be the broader organizational process behind error management culture. However, though ISO 9000 and error management are moderately correlated, the latter is still more powerful in explaining knowledge performance.

Strengths and limitations

One strength of our study is the rare longitudinal design. Providing a dataset of four waves that includes time lags of one year legitimizes directional interpretations across a time span of three years. This time frame allows for processes, e.g. related to error communication, to unfold within the offices and gain impact on the dependent variable, that is, expert knowledge.

Also, the high ecological validity of our study is unique. In particular, our knowledge measure is representative, as tax accountants may take time, use literature and consult with colleagues in solving their work tasks. Additionally, the content of the knowledge questions mirrors the everyday tasks of tax accountants saliently.

In contrast to the common distribution of questionnaires in work and organizational research, the competitive design ensured that participants were motivated to perform well, which is a further strength of our study.

Though we have self-report data, ISO 9000 certification had to be validated by fax and the knowledge performance measure required skills which could not be influenced/affected by social desirability. Error management culture may mainly mirror the attitude of the office owner and clearly has an upward bias regarding the mean due to social desirability and the competitive setting. But the relationship between error management culture and knowledge performance or ISO 9000 is less likely to be biased, as not the absolute data of error management but the patterns of interaction with the other variables are of interest. In fact, common method bias due to self-report data often falls in the category of statistical legends (Spector, 2006). Also, the merely moderate correlation (r = .15 - .26) between error management culture and ISO 9000 speaks against self-report bias, given that ISO 9000 includes standards for error management. The moderate correlation between error management culture and professional knowledge (maximum r = .26) hints at further moderators of that relationship.

The reliability of the error management culture scale was barely satisfying. Due to the nature of the setting (i.e., a competition forwarded by a practitioner journal), we had little influence on this measure. Still, this measure is of high ecological validity as it is provided for practice and

recommended for use in tax accounting offices (BStBK et al., 2012). The content may reflect a variety of facets of error management instead of a real scale. Thus, treating it as the sum of several error management practice indicators would be an alternative. However, with a five-point Likert answering format, calculating a mean seemed suitable. Additionally, the reliability varied across years, with an acceptable Cronbach α for T4.

The measurement at T2 deviated from the other measurement times. Correlations that are significant at all other times are not significant at T2. That applies to the relationship of error management with both, knowledge performance as well as ISO 9000, and to the correlation between the latter two variables. Why the measure is biased for that year is unclear, as no specific influencing events are known in the context of 2010. Error management and ISO 9000 were measured exactly the same across the years; only the knowledge measure varied. However, the correlation between error management and ISO 9000 for T2 also deviates, making an invalid knowledge measure at T4 unlikely. More importantly, error management culture at T2 was involved in the only significant moderation with ISO 9000 certification that supported our hypothesis. Thus, if the only hint to a favorable interaction of certification with error management is jeopardized by the measure of the latter, the evidence for beneficial impacts of ISO 9000 in this regard does not seem valid.

Despite shortcomings of some scales, the results should be reliable as the patterns between variables and not their absolute values are of interest.

Error management culture may be important for knowledge performance of prototypical PSFs as well as in other knowledge-intensive work environments. Also, ISO 9000 certification should generally be positively associated with knowledge performance. Our results may be generalizable to all organizations that have knowledge as a resource and/or a product. In fact, we expect that without the competitive setting as applied in our study, error management culture would show an even stronger association with knowledge performance.

Implications

Following the last argument, our hypotheses should be tested in a noncompetitive setting. However, finding a sufficient knowledge performance measure that employees are motivated to execute solely for research purposes presents a challenge. Future research should replicate our study with an established measure for error management culture, e.g., by van Dyck et al. (2005) on organizational level or by Rybowiak et al.'s (1999) error orientation measure on employee level. Modeling the mechanisms that mediate error management culture and knowledge performance (e.g., strain reduction, empowerment, error communication, knowledge sharing) would be of interest.

Whether our results are applicable to all sectors like heavy industry or manufacturing should be subject to further research as well. More importantly, the question whether external or internal motivations for ISO 9000 certification lead to different outcomes like knowledge performance, but also financial performance, should be investigated.

For practice, sensitivity regarding error attitude is recommended. Implementing an error management culture should be accompanied by leadership trainings and trust-building actions. Specifically, permanent leadership communication is needed in order to give accurate information on tasks and work to be done as well as to provide direct feedback and pay attention to communication needs of the employees. Conflicts or problems should be openly addressed by executives. Thus, managers should critically reflect their communication and leadership competencies and further develop those regularly, e.g., in trainings, workshops or coaching. Employee feedback – face to face or in writing and anonymously – should be obtained regularly.

QMSs like ISO 9000 might improve overall organizational performance, but given the resource-binding processes the motivation for such a certification procedure should be carefully balanced. Also, their applicability in knowledge intensive environments remains to be questioned. Highly formal standards and regulations for nearly "invisible" processes of knowledge work could jeopardize flexibility and therefore the overall performance. The disappointing results of ISO 9000 certification with regard to knowledge performance imply that a search for more appropriate quality management certifications, which are adopted for PSF settings and high knowledge intensity, would be fruitful. Mintzberg (1983) differentiated between standardization of procedures, of goals and of skills. While ISO 9000 focuses on the first two aspects, Mintzberg (1983) stressed standardization of skills as the only effective quality management for knowledge work. Qualification and professional education are the coordination mechanisms for knowledge intensive organizations, as they guarantee that work is done correctly and according to professional standards (Mintzberg, 1983). While this implicates high autonomy of employees, it can lead to deficient coordination. Mission statements as well as providing time and resource budgets for goal and task fulfillment to the highly qualified personnel may ensure the necessary coordination (Bürger, 2005; Mintzberg, 1983).

For now, error management culture seems to be more effective for enhancing knowledge performance within PSFs than ISO 9000 certification – whether it is also the better method for empowerment remains to be studied.

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Prispelo/Received: 10.4.2013
Sprejeto/Accepted: 24.9.2013