Measuring Culture of Innovation: A Validation Study of the Innovation Quotient Instrument (Part One)

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The ability for an organization to innovate has become one of the most important capabilities needed in the new knowledge economy. An organization's culture of innovation, in particular, predicts organizational innovativeness across multiple industries. While researchers have developed instruments to measure culture of innovation to inform organizational opportunities for improvement, few of these instruments have been validated or replicated beyond their initial use. The current article, which is part one of a two-part investigation, employs confirmatory factor analytic methods to validate the factor structure of the six models defined in the Innovation Quotient instrument developed by Rao and Weintraub (2013) and assess the extent to which the models are reliable across organizational groups. While each model demonstrated adequate model fit, a lack of discriminant validity was identified for each model, as well as a lack of reliability across some organizational groups. Recommendations for model respecification are presented.

Referred to as the "innovation imperative," the ability for an organization to innovate has become one of the most important capabilities needed in the new knowledge economy (Lawson & Samson, 2001). What must organizations be able to do to innovate their products and services or to transform to operate in new markets or lines of business? What capabilities or practices are necessary to facilitate an organization's ability to manage the competitive market terrain? Theorists argue that organizations require certain tangibles, such as specific innovation processes, as well as intangibles, such as innovative intelligence or innovation culture, to produce other critical business outcomes, specifically market and financial outcomes (e.g., Dyer, Gregersen & Christensen, 2011; O'Sullivan & Dooley, 2009; Weiss & Legrand, 2011). Within the last thirty years, the academic literature has also produced a substantial body of evidence that the ability to innovate, or lack thereof, has indeed contributed to the success or failure of organizations from all sectors or industries (e.g., Brettel & Cleven, 2011; Hurley & Hult, 1998; Zairi & Al-Mashari, 2005). Perel (2005) has argued that that most successful way to manage difficulties associated with an uncertain future and economic turbulence is to "make innovation an integral part of a firm's organization and management DNA" (p. 15).

To make such a focus a priority, Rao and Weintraub (2013) recommend organizational leaders intentionally create a culture of innovation within their organizations, as well as measure or assess the presence of

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that culture—a recommendation corroborated by Kuczmarski (2003) in his assertion that a "measurement system for assessing innovation" (p. 538) is a key ingredient for an organization's success. Rao and Weintraub (2013) also describe how organizations can use the results from such assessments to identify perceived differences across the multiple factors, particularly between senior leaders and employees, among geographical locations, or among sectors.

To accommodate organizations in such efforts to understand and improve a culture of innovation, researchers have developed measures to assess the construct, as well as other closely related ideas of innovation climate, innovativeness, and innovation capability (e.g., Aiman-Smith, Goodrich, Roberts, & Scinta, 2005; Anderson & West, 1998; Dobni, 2008; Hoe, 2011; Kuščer, 2013; Rao & Weintraub, 2013; Remneland-Wikhamn & Wikhamn, 2011; Sušanj, 2000; and Tohidi, Seyedaliakbar & Mandegari, 2012). Of these instruments, the most frequently cited from the literature was the instrument developed by Dobni (2008), which assesses innovation culture as a multidimensional construct along the domains of innovation propensity, organizational constituency, organizational learning, creativity and empowerment, market orientation, value orientation, and implementation context. A similar instrument that has become highly visible in the practitioner market for the assessment of innovation culture is the Innovation Quotient instrument developed by Rao and Weintraub (2013), which asks respondents to report their perceptions of their organization's performance in what Rao and Weintraub define as the six building blocks of a culture of innovation: values, resources, behaviors, processes, climate, and success.

While initial efforts have been made to validate some of the existing instruments as predictive of innovation outcomes, ensure internal reliability (e.g., Brettel & Cleven, 2011; Chen, 2011; Sharifirad & Ataei, 2012), and even compare performance with different groups (e.g., Sušanj, 2000; Velasco, Zamanillo, & Del Valle, 2013), few of these instruments—including Rao and Weintraub's (2013) Innovation Quotient instrument—have been replicated and reported in the empirical literature. Estimates of model fit, inter-item relationships, and reliability for the Innovation Quotient instrument, in particular, have yet to be cited in the literature. Therefore, there is a need to replicate investigations of innovation culture to assess and improve the validity and reliability of current instrumentation. Through the analysis and validation of such an instrument, organizational leaders and researchers may better assess its current state for its determinants of innovation (Aiman-Smith et al., 2005; Sušanj, 2000), leading to better organizational outcomes.

The purpose of this investigation is to assess the construct validity and reliability of the Innovation Quotient instrument (Rao & Weintraub, 2013). This first part of the study employs confirmatory factor analytic strategies to examine the hypothesized factor structure of each of the six measurement models within the instrument by estimating model fit and reliability across multiple organizational groups, including countries, industries, employee levels, functional roles, and the languages of instrument administration. The second part of this investigation—published at a later date—will evaluate alternative plausible factor structure, as the need is identified.

Review of the Literature

Schneider, Ehrhart, and Macey (2013) posited that it is helpful for the research and practice of organizational culture to study its variety of values and behaviors within the context of "a culture for-something, such as for a *culture of well-being* or a *culture of innovation*" (p. 377). The study of a culture of innovation, therefore, supports this aim and may involve integrating the definitions of innovation and organizational culture. While it has not been the practice of most researchers to define culture of innovation in a systematic fashion through the integration of a formal definition of innovation with cultural domains, such as structure, support, risk, cohesiveness, and outcome orientation (Denison, 1996), authors have certainly canvassed these key domains indirectly, as well as those related to the strikingly similar topics of innovative culture, innovation capability, innovative capacity, innovation competence, innovation climate, and global innovation culture (e.g., Crossan & Apaydin, 2010; Hurley & Hult, 1998; Kleinschmidt, De Brentani, & Salomo, 2007; Panayides, 2006; Sarros, Cooper, & Santora, 2008; Shahin & Zeinali, 2010; Sun, Wong, Zhao, & Yam, 2012).

Most theorists and investigators have not defined innovation culture as an integrated construct, but have instead focused on describing the key dimensions or factors that contribute to an innovation culture. An example of this is Dobni (2008), who defined innovation culture as "a multi-dimensional context which includes the *intention* to be innovative, the *infrastructure* to support innovation, operational level *behaviors* necessary to influence a market and value orientation, and the *environment* to implement innovation" (p. 540), a definition which has influenced and shaped the work of many other investigations (e.g., Humphreys, McAdam, & Leckey, 2005; Sharifirad & Ataei, 2012), as well as the four conceptual models of innovation described in the previous section (Crossan & Apaydin, 2010; Hurley & Hult, 1998; Rao & Weintraub, 2013; Sun et al., 2012). As interest in the culture of innovation in organizations has climbed, dozens of other voices have emerged to support or slightly modify existing notions of this multidimensional construct. Anderson and West (1998) proposed a four-factor model of work group innovation climate: vision, participative safety, task orientation, and support for innovation. Humphreys et al. (2005) applied Francis's (2000) dimensions of innovativeness, which include direction, capability, culture, learning, structure and process, and decision making, to evaluate the progression of innovativeness of a small-to-medium enterprise over time. Finally, operating with the theory that the climate research better aids in the understanding of the surface structures of culture and that climate can more easily be assessed and measured, Remneland-Wikhamn, and Wikhamn (2011) integrated the research performed by Patterson et al. (2005) on the climate for innovation, proposing four dimensions of flexibility, innovation support and approaches, outward focus, and reflexivity.

While previous investigators have attempted to relate culture of innovation to other critical organizational outcomes, the work of Rao and Weintraub (2013) focused on the construct of culture of innovation itself, culminating in a comprehensive and multifactorial theory of innovation culture that can be observed and measured in organizations. Rao and Weintraub's six building blocks of an innovative culture were built upon the existing literature on organizational culture (Denison, 1996; Hofstede, 1998; Schein, 1984), the practitioner literature on innovation theory (Christensen, Anthony, & Roth, 2004), case studies of hundreds of companies across multiple industries, and other empirical works on innovation (Tellis, Prabhu, & Chandy, 2009). The authors proposed the six building blocks of resources, processes, success, values, behaviors, and climate, each of which consists of three first order factors composed of three elements, or indicators. Figure 1 illustrates each of the six building blocks, their factors, and their elements (indicators) (Rao & Weintraub, 2013).

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Rao and Weintraub (2013) proposed that the three building blocks in a culture of innovation that are easiest to understand and observe are an organization's resources, processes, and successes. The extent to which an organization resources its innovation efforts, particularly through the identification of its innovation champions and experts, affects innovativeness. Organizations that deploy specific innovation processes, such as steps to generate and filter new ideas, develop and test prototypes, and flexibly determine which ideas or products go to scale, are better able to innovate in new markets than organizations that do not employ such methods. Also, organizations that recognize their successes at the external or market, enterprise, and individual levels can better engage their customers and maintain market advantage. However, the three building blocks that are more often neglected and much less frequently measured in organizations are the critical areas of values, behaviors, and climate. Rao and Weintraub identified that the values of an entrepreneurial focus, creativity, and a willingness to learn affect organizational priorities, and will therefore shape the use of its resources and other innovative efforts and processes. Other specific behaviors were also found to be conducive to the ability to innovate new products, including a willingness to adapt to new markets, abandon ineffective approaches, energize employees,

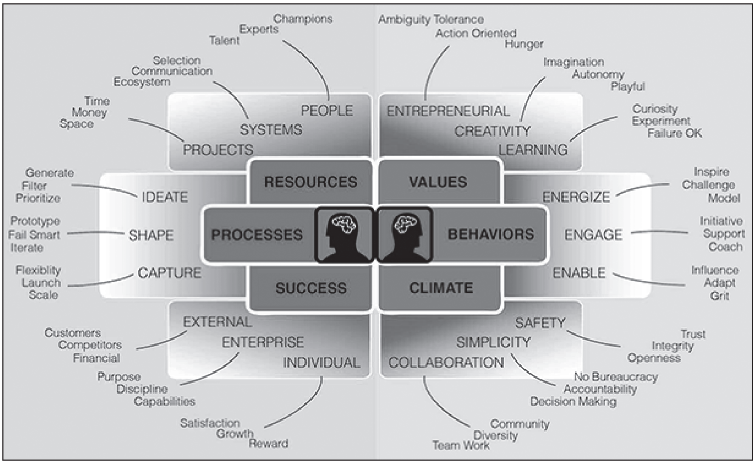

FIGURE 1. BUILDING BLOCKS TO A CULTURE OF INNOVATION

and exhibit grit when external forces apply pressure. Rao and Weintraub also demonstrated that a climate of safety, trust, willingness to take risks, and limited bureaucracy "fostered learning and encourages independent thinking" (p. 30).

Measuring Culture of Innovation

To identify existing instruments that define and measure a culture of innovation, we conducted an extensive literature search to identify a menu of possible instruments from which a final instrument could be selected. A total of nearly 60 empirical articles, theoretical articles, and meta-analytic articles were identified based on a keyword selection using "innovation culture" AND "measurement" from among the Serials Solutions databases and packages and a broad Google search. To critically appraise each article for key abstractions that relate to this present study, Garrard's (2011) matrix method was used. The majority of the reviewed works could be classified into one of four types of studies: (1) the testing of relationship between culture of innovation and other outcomes; (2) the testing of relationship between a culture of innovation and other outcomes, which included the adaptation of previously used measures of innovation culture; (3) the development and validation of a new measure of a multifactorial construct of innovation culture; and (4) a literature review or conceptual article summarizing the importance of the measurement of multidimensional model of innovation culture or prescribing the improvement of innovation culture within organizations. Of these articles, it was found that 10 articles presented a unique, nonadapted instrument measuring innovation culture, innovation capability, innovation climate, innovativeness, or a related construct (Table 1).

Each of the instruments shown in Table 1 was evaluated against the criteria of validity, reliability, parsimony, and interpretation or

TABLE 1 SAMPLING OF INSTRUMENTS: CULTURE OF INNOVATION OR A RELATED CONSTRUCT

REFERENCE	PURPOSE	INSTRUMENT	SUBSCALES	VALIDITY/RELIABILITY
Aiman-Smith et al., 2005*	Summarize the development of a tool to measure value innovation potential	Value Innovation Potential Assessment Tool (VIPAT)	Meaningful work, risk-taking culture, customer orientation, agile decision making, business intelligence, open communication, empowerment, business planning, learning	Reliabilities, as measured by Cronbach alpha, were greater than 0.70; content/convergent validity was checked.
Anderson & West, 1998	Measure and relate facets of climate for innovation and innovativeness	Team Climate Inventory	Vision, participative safety, task orientation, support for innovation	Reliabilities, as measured by Cronbach alpha, ranged from 0.67 to 0.98; discriminant consensual validity.
Dobni, 2008*	Develop a comprehensive instrument for measuring innovation culture	Dobni (2008)	Innovation propensity, organizational constituency, organizational learning, creativity and empowerment, market orientation, value orientation, and implementation context	Reliabilities, as measured by Cronbach alpha, ranged from 0.74 to 0.82; content/construct validity was checked.
Hoe, 2011*	Develop an instrument	Hoe (2011)	Shared vision, management support, community and individual creativity, implementation, and motivators	No summary results were reported; Not reported
Humphreys et al., 2005*	Apply the innovation audit instrument organization over time	Francis' (2000) Centrim G2 Innovation Audit	Direction, capability, culture, learning, structure and process, and decision making	Only average ratings over time are presented; not reported.

REFERENCE	PURPOSE	INSTRUMENT	SUBSCALES	VALIDITY/RELIABILITY
Kuščer, 2013	Test elements of mountain destination innovativeness; develop measure	Kuščer (2013)	Sociocultural sustainability and stakeholder participation, environmental sustainability (natural environment), and proactiveness	Reliabilities, as measured by Cronbach alpha, ranged from 0.899 to 0.92; content validity checked.
Rao & Weintraub, 2013*	Propose and advocate for use of instrument	Innovation Quotient Survey	Values, behaviors, climate, resources, processes, and success	"Field tested over two years for statistical validity" (2013, p. 31).
Remneland-Wikhamn & Wikhamn, 2011	Propose and validate instrument	Open Innovation Climate Measure	Innovation and flexibility, outward focus, and reflexivity	Reliabilities, as measured by Cronbach alpha, ranged from 0.66 to 0.83; discriminant/convergent validity.
Sušanj, 2000	Examine differences in innovation culture and climate in different countries	FOCUS Questionnaire	Risk-taking, open to criticism, forefront of technology, flexibility, challenging old ideas, searching for new markets, pioneering	Discriminant/convergent validity.
Tohidi et al., 2012	Propose and validate a measurement scale to capture learning capabilities	Organizational Learning Capabilities	Managerial commitment/empowerment, experimentation, risk taking, interaction with the external environment and openness, and knowledge transfer and integration	Reliabilities, as measured by Cronbach alpha, ranged from 0.73 to 0.89; Discriminant/convergent validity.

Note: *Denotes a more comprehensive alignment to previous research models of determinants of innovation.

user-friendliness (Kimberlin & Winterstein, 2008; Switzer, Wisniewski, Belle, Dew, & Schultz, 1999). Only five instruments (denoted by an asterisk in the table) incorporated the factors that were articulated by the more complex models of determinants of innovation according to Crossan and Apaydin (2010), Hurley and Hult (1998), and Sun et al. (2012); and of these five, only three instruments presented a description of their efforts to affirm the validity or reliability of their instruments, as well as the subsequent results from these analyses. These three included the Value Innovation Potential Assessment Tool (VIPAT) (Aiman-Smith et al., 2005), Dobni's instrument of innovation culture (Dobni, 2008), and the Innovation Quotient survey (Rao & Weintraub, 2013). The Rao and Weintraub (2013) instrument identifies the sum of ideas presented by both of the other two instruments, but with 54 items, it more parsimoniously captures what each of the key factors identified in Dobni's (2008) instrument assesses with 70 items. While the instrument developed by Aiman-Smith et al. (2005) contains only 33 items, the instrument does not address the key construct of resources while more rigorously addressing the external domains of customer orientation (five items), business intelligence (three items), and business planning (four items), which Rao and Weintraub (2013) captured with a total of nine items. The Rao and Weintraub (2013) Innovation Quotient instrument best met the criterion of interpretation and user-friendliness, and was therefore selected for this present investigation.

The Innovation Quotient instrument assesses an individual's perception of the culture of innovation in the organization where the participant is employed. The aggregate results of the instrument measure the performance of an organization along each of the six building blocks that contribute to a culture of innovation—values, resources, behaviors, processes, climate, and success—each of which is represented by three first order factors. Rao and Weintraub (2013) advocate the use of the instrument to compare performance across different groups to inform opportunities for improvement. Some of these comparisons may include the country of residence, industry or sector, work unit (e.g., between departments and entities), employee level (e.g., executive leadership, middle leader or manager, or frontline staff), or the functional role of the employee (e.g., commercial or customer-facing, research and development (R&D) or innovation, operations, support, or other). Comparative results can be used to identify blind spots, and improve the culture of innovation. However, investigators have presented little evidence of validating the hypothesized factor structure of these models to ensure meaningful interpretation of results.

Methodology

The key objective of this study was to assess the validity and reliability of the Innovation Quotient instrument. The key research questions for this study (part one) were as follows: To what extent do each of the six measurement models within the Innovation Quotient instrument demonstrate evidence for convergent and discriminant validity? And to what extent are each of the six measurement models and their hypothesized factors reliable across multiple organizational groups, including countries, industries, employee levels, functional roles, and the languages of instrument administration?

Sample

A sufficiently large sample size was needed for the number of variables ($p = 54$) for this study. Kline (2011) indicated that a sample size of 540, or at least $N > 10p$, would be necessary to produce confidence in the variable scores and factors. The lead author of the Innovation Quotient instrument was contacted to seek permission for its use, as well as to obtain additional evidence for its validity and reliability in current administrations. This investigator identified at this time that the instrument's lead author had already executed a detailed, multifaceted administration of the instrument, in partnership with the Spanish Society for Quality (2015), to just under 20,000 participants from 138 companies across 24 industries in 13 countries. Therefore, this existing, secondary dataset was obtained for use in this study.

The final dataset used for this present study consisted of a total sample size of 9,860 participants. Across the entire sample, 27% of the participants were male, 18% were female, and 55% did not report their gender. The age ranges of the participants were as follows: younger than 26 years old (4%), from 26 to 35 years old (28%), from 36 to 45 years old (34%), older than 45 years old (26%), those that did not report their age (8%), and other (11%). The education level of the participants included professional studies or vocational training (17%), bachelor or grade school (39%), postgraduate or master's degree (21%), doctorate (2%), and those that did not report their educational attainment (10%). Company seniority was also evenly dispersed as follows: less than one year (7%), from one to three years (15%), from four to eight years (23%), from nine to 15 years (20%), more than 15 years (27%), and those that did not report their company seniority (8%). Total representation of participants for the entire dataset is presented in Tables 2 through 4.

Instrumentation

Rao and Weintraub (2013) developed their Innovation Quotient instrument based on studies conducted by Tellis et al. (2009), who investigated innovation among 759 companies across 17 markets, and the work of Christensen et al. (2004), Schein (1999), O'Reilly (1989), and Denison (1996). While specific results of tests for reliability and validity were not reported, the authors stated that the elements and factors were "field-tested for over two years for statistical validity and executive acceptance as both a diagnostic and actionable tool. Data [were] gathered from 1,026 executives and managers in 15 companies headquartered in

TABLE 2	PARTICIPATING COUNTRIES		
COUNTRY	***N***	**COUNTRY**	***N***
Spain	5,237	Mexico	70
Chile	2,346	Germany	69
Colombia	797	Scotland	21
United States	447	United Kingdom	25
Panamá	385	Saudi Arabia	12
El Salvador	356	Belgium	9
Portugal	86		

TABLE 3	PARTICIPATING INDUSTRIES		
INDUSTRY	***N***	**INDUSTRY**	***N***
Financial and Insurance	2,404	IT—Software and Electronics	238
Telecommunications	1,053	Retail	239
Professional Services	841	Education	221
Industrial Machinery and Equipment	802	Public and State Administration	203
Health Care and Social Services	665	Transport and Logistics	206
Aerospace and Defense	647	Pharmaceuticals	161
Food and Beverages	435	Biotechnology and Research	42
Construction and Building Materials	396	Media and Publication	40
Industrial Metals and Mining	384	Agriculture and Fisheries	20
Automobile and Parts	315	NGOs	14
Oil and Chemicals	283	Distributors	7
Energy—Electricity and Gas	241	Hotels, Restaurants, Lodging	3

TABLE 4	PARTICIPATING FUNCTIONAL ROLES, ORGANIZATIONAL LEVELS, AND LANGUAGES				
ROLE	***N***	**LEVEL**	***N***	**LANGUAGE**	***N***
Operations	4,164	Staff, without direct reports	5,991	Spanish	9,027
Commercial	1,942	Manager, with direct reports	2,793	English	833
Support	1,878	Director or executive	1,076		
R&D/Innovation	920				
Others	956				

the United States, Europe, Latin America, and Asia" (Rao & Weintraub, 2013, p. 31). As no additional evidence for the validity or reliability of the instrument was originally presented, the need to apply approaches to examine the validity and reliability of the instrument, as previously described, was evident. While other authors have cited this new instrument and the theoretical framework from which it was derived (e.g. Silva, 2014), no additional use of the instrument in subsequent investigations within the last two years is evident in the published literature.

Rao and Weintraub's (2013) Innovation Quotient instrument consisted of six building blocks (see Figure 1), each of which was represented by three first order factors. Each first order factor was indicated by three elements, or indicators, represented by one survey question or item. There was a total of 54 indicators on the instrument, which were assessed using an ordinal, Likert-style scale where 1 = *not at all*, 2 = *to a small extent*, 3 = *to a moderate extent*, 4 = *to a great extent*, and 5 = *to a very great extent*. In addition to the instrument, grouping variables of countries, industries, employee levels, functional roles, and languages of instrument administration were solicited. While it is typically not common practice among the academic community to pool data administered in more than one language, this present study maintained the pooled dataset administered in two languages. Practitioners who seek to compare their performance across multiple countries, industries, organizational levels, functional roles, etc. often analyze results regardless of the language of administration, and it has been the practice of the instrument's author to facilitate such analyses. Therefore it was necessary to consider the dataset in aggregate.

Data Analysis and Procedures

As this investigation employed the use of a secondary dataset, no additional procedures were required to manage missing data (Kline, 2011). For each of the six models, data screening procedures were utilized to ensure the integrity, normality, and reliability of the first dataset. Univariate statistics of mean, standard deviation, skewness, and kurtosis, as well as Pearson interitem correlations, were computed and examined for each of the 54 items using the Statistical Package for the Social Sciences (SPSS version 22; IBM Corp., 2013). Individual items that exceeded the recommended standardized values for skewness or kurtosis (+/- 3.0) were considered non-normal (Kline, 2011), but were considered in the analysis regardless of skewness or kurtosis, as Field (2009) indicated that extremely large sample sizes are likely to reduce standard errors, yielding standard z-scores for skewness and kurtosis that are more likely to yield extreme values. Each of the item distributions was also visually assessed to ensure that each of the categories within the ordinal scales was populated. Tests for multivariate normality within each of the six measurement models were conducted in LISREL 9.2 (Scientific Software International [SSI], 2015) based upon Mardia's (1985) recommendations. Models that failed to pass the test were managed by extracting and applying the asymptotic covariance matrix for issues with multivariate non-normality (Curran, West, & Finch, 1996; Kline, 2011) during model fit analyses.

Confirmatory factor analyses (CFAs) were performed in LISREL 9.2 (Kline, 2011; SSI, 2015) for each of the six models shown in Figure 2 to determine model fit. Hair, Black, Babin, and Anderson (2010) asserted that the use of a CFA approach is appropriate if the investigator seeks to affirm a factor pattern that has previously been theorized. As Rao and Weintraub (2013) provided the initial yet limited evidence for the validity of the factor structures of the Innovation Quotient instrument, a CFA was used to assess model fit for this present study. As each of the items in every model was ordinal in scale, a polychoric matrix was used (Tello, Moscoso, García, & Abad, 2010; Tello, Moscoso, García, & Chaves, 2006). The unweighted least squares (ULS) estimation method (Kline, 2011) was employed for each CFA, in which the presence of multivariate non-normality for each of the six measurement models was identified and where a fewer number of indicators per factor were present (Forero, Maydeu-Olivares, & Gallardo-Pujol, 2009). Multiple indices were utilized to interpret adequacy of model fit in addition to the chi-square tests (χ^2)—values approximately greater than 0.90 on the comparative fit index (CFI), greater than 0.95 the adjusted goodness of fit index (AGFI), and lower than 0.10 on the standardized root mean square residual (SRMR) (Brown, 2006; Hair et al., 2010). While it has been stated that current research advises against drawing conclusions based on strict root mean square error of approximation (RMSEA) cutoffs, results that sat within the confidence interval at 1.0 or less were interpreted as having a desirable fit (Hair et al., 2010).

To specify each of the models, the first indicator for each first order factor was set to one for the first test of model fit. In cases where the model with only first order factors failed to produce appropriate model fit or too much error, additional considerations were made, including the decision

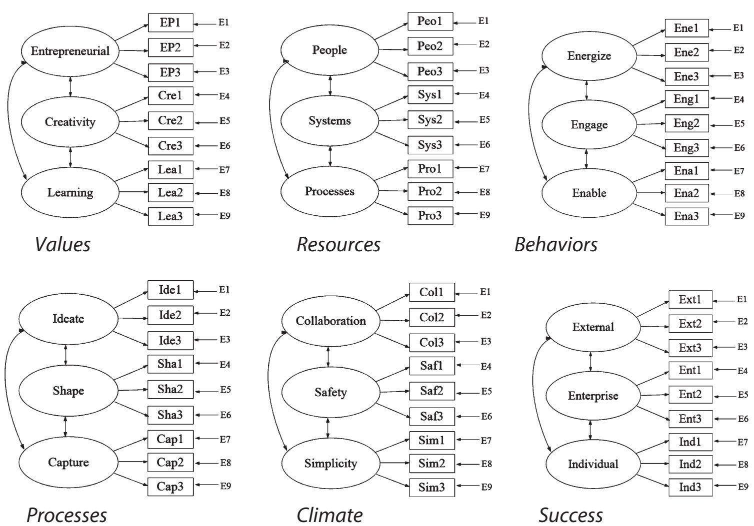

FIGURE 2. HYPOTHESIZED FACTOR STRUCTURE FOR EACH OF THE SIX BLOCKS OF INNOVATION CULTURE

to specify a higher order factor for that model—based on the theory that the factors of each measurement model relate to the higher order construct (Rao & Weintraub, 2013)—or the option to collapse factors to produce a two-factor solution if multicollinearity was present (Kline, 2011). Also, in cases where common method variance exceeded 50% of the total variance explained by all of the indicators within a model, the inclusion of a common, social desirability latent factor was considered to establish a better fit (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). If model fit still could not be produced, evaluation of factor loading estimates and modification indices were used to correlate errors, or make other appropriate revisions. Finally, while multiple approaches were used to identify the model with best fit, it was noted that "specification searches based on purely empirical grounds are discouraged because they are inconsistent with the theoretical basis of CFA" (Hair et al., 2010), so the simplest model demonstrating acceptable goodness of fit was selected.

Results from each of the six CFAs were used to either corroborate the hypothesized models or to propose the models demonstrating the best solutions and model fits. Using the proposed models, assessments of the average variance extracted (AVE) and composite reliability (CR) were conducted to provide additional evidence for convergent validity for each construct, and the squared interconstruct correlations (SIC) were used to compare to AVE to assess divergent validity. To evaluate score reliability (Thompson, 2003), initial estimates of item relatedness, as measured by the proxy of Cronbach's alpha coefficients, were computed for the overall measurement models, for each factor, and for each of the group samples for which analysis is typically reported in organizations: by countries, industries, employee levels, functional roles, and languages. Alpha coefficients were loosely and contextually interpreted, as it is known that alpha values can inflate as the number of items increases (Field, 2009).

Results

Tests for normality, multivariate normality, and the presence of common method variance and multicollinearity were conducted to ensure accuracy and reliability of the results. While the large sample size ($n = 9{,}860$) drove standard errors low, leading to highly inflated z-scores for skewness, this was not determined as problematic (Field, 2009). However, each of the six measurement models failed Mardia's (1985) test for multivariate normality, leading to the application of the ULS method of estimation within the confirmatory factor analyses, which has been shown to outperform the weighted least squares estimation in accuracy when there are few indicators per factor or high levels of skewness in the univariate distributions (Forero et al., 2009). While estimated variance inflation factors did not produce evidence for multicollinearity, each measurement model failed Harman's single common factor test (Podsakoff et al., 2003), suggesting that common method variance could potentially obfuscate the true nature of any interfactorial correlations.

To evaluate the extent to which the hypothesized factor structure of each of the six measurement models of the Innovation Quotient instrument was consistent with the administration of this present study, a CFA for each of the hypothesized measurement models (Figure 2) was conducted using LISREL 9.2 (SSI, 2015). Results for each of the hypothesized measurement models (Table 5) demonstrated adequate model fit, but also presented error that approached undesirable suggested thresholds for the RMSEA upper bound. Additional specifications were also considered due to common variance, such as the inclusion of a common latent factor, inclusion of a higher order factor, and specifications with correlated errors within a factor. However, for each of the six models, none of these additional specifications improved fit or reduced error, but in many cases returned a nonpositive definite result. The original three-factor models best fit the data and reduced error.

For each of these original models, standardized coefficients, structure coefficients, and R^2 values were reviewed to avoid misinterpretation of the relationships among the items and their corresponding factors (Graham, Guthrie, & Thompson, 2003) (Table 6). Standardized path coefficients indicated strong loadings on each of the indicators' respective factors, but also suggested possible similarity, as the coefficients were close in range across factors. Structure coefficients for each of the three latent factors were also high, suggesting a possible lack of discriminant validity across the factors within the model. Such high values for *Entrepreneurial 1* illustrate (Table 6), for example, that for every one-unit increase of both creativity and learning, performance on entrepreneurial's EP1 increased 0.767 and 0.717, respectively. The relationships between the latent variables indirectly increased the relationship between a discriminant factor and an individual item. For each of the measured variables in the models, the amount of variance explained ranged from $R^2 = 0.276$ to 0.764. Finally, for each of the models, it was identified that three factors within the models—such as entrepreneurship, creativity, and learning, for example—were highly correlated, explaining the higher structure coefficients between the three factors. Finally, to evaluate convergent and discriminant validity, AVE and CR, as well as SIC values, were computed. While each of the three factors' AVE and CR values exceeded desirable thresholds of 0.5 and 0.7 for each (Table 7), the SIC values exceeded the corresponding AVE values, illustrating that the factors did not discriminate well between each other within each model.

Estimates of score reliability, as measured by coefficient alpha (Thompson, 2003), were computed to ensure consistency across each of the groups for which comparisons are frequently conducted in organizations: by countries, industries, employee levels, functional roles, and the languages of administration. Estimates were only computed for groups that had a minimum sample size of 30. Most of these first-order factor estimates exceeded Nunnally's (1978) recommended threshold of 0.70,

TABLE 5 CFA RESULTS BY MODEL

BLOCK AND MODEL	χ^2	DF	CFI	AGFI	RMSEA	RMSEA CI_{90}	SRMR
Values							
3 factor	**1117.818***	**24**	**0.960**	**0.996**	**0.097**	**(0.094; 0.100)**	**0.029**
3 factor with common factor	767.737*†	12	0.989	0.998	0.072	(0.067; 0.077)	0.014
3 factor with higher order	1117.818*†	24	0.960	0.996	0.097	(0.094; 0.100)	0.029
2 factors, EP and Cre-Lea	1280.804*	26	0.954	0.995	0.100	(0.097; 0.103)	0.031
Resources							
3 factor	**883.691***	**24**	**0.980**	**0.997**	**0.060**	**(0.057; 0.064)**	**0.021**
3 factor with common	1503.830*‡	12	0.993	0.998	0.051	(0.046; 0.055)	0.014
3 factor with higher order	883.691*	24	0.980	0.997	0.060	(0.057; 0.064)	0.021
3 factor, Pro2-Pro3 errors	612.883*	23	0.986	0.998	0.051	(0.048; 0.055)	0.018
Behaviors							
3 factor	**1903.178***	**24**	**0.975**	**0.998**	**0.090**	**(0.087; 0.094)**	**0.022**
3 factor with common	656.065*‡	12	0.996	1.000	0.048	(0.043; 0.053)	0.007
3 factor with higher order	1903.179*	24	0.975	0.998	0.090	(0.087; 0.094)	0.022
3 factor, Eng1-Eng2	1670.012*	23	0.978	0.998	0.086	(0.083; 0.090)	0.021
Processes							
3 factor	**924.771***	**24**	**0.983**	**0.998**	**0.062**	**(0.058; 0.065)**	**0.019**
3 factor with common	1806.877*†	12	0.996	1.000	0.045	(0.040; 0.050)	0.010
3 factor with higher order	924.771*†	24	0.983	0.998	0.062	(0.058; 0.065)	0.019
3 factor, Ide1-Ide3	580.986*	23	0.990	0.999	0.050	(0.046; 0.053)	0.016
Climate							
3 factor	**1755.376***	**24**	**0.962**	**0.995**	**0.086**	**(0.082; 0.089)**	**0.030**
3 factor with common	215.070*†	12	0.984	0.996	0.079	(0.074; 0.084)	0.019
3 factor with higher order	1755.376*	24	0.962	0.995	0.086	(0.082; 0.089)	0.030
3 factor, Saf2-Saf3	1381.982*	23	0.970	0.996	0.078	(0.074; 0.081)	0.026
Success							
3 factor	**982.654***	**24**	**0.983**	**0.998**	**0.064**	**(0.060; 0.067)**	**0.019**
3 factor with common	9.399†	12	0.997	0.999	0.040	(0.035; 0.045)	0.008
3 factor with higher order	982.654*	24	0.983	0.998	0.064	(0.060; 0.067)	0.019
3 factor, Ent1-Ent2	666.111*	23	0.989	0.999	0.053	(0.050; 0.057)	0.016

Note: *$p < .001$. χ^2 = Satorra-Bentler (1988) scaled chi-square; † = solution is not positive definite; ‡ = errors could not be identified; CFI = comparative fit index; AGFI = adjusted goodness of fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square.

with many of them higher than 0.90 (Tables 8 through 10). Many of these estimates also met or exceeded reliability findings identified in previous literature (e.g., Aiman-Smith et al., 2005; Anderson & West, 1998; Dobni, 2008; Kuščer, 2013; Remneland-Wikhamn & Wikhamn, 2011; and Tohidi et al., 2012) but for some groupings, the estimates did not meet the desired threshold.

TABLE 6 PATTERN AND STRUCTURE COEFFICIENTS BY MODEL

ITEM	UNSTANDARDIZED COEFFICIENTS	ERROR VARIANCE	PATTERN COEFFICIENTS	STRUCTURE COEFFICIENTS			R2
				FACTOR 1	FACTOR 2	FACTOR 3	
Values							
EP1	1.000	0.287 (0.015)	0.845	.	0.767	0.717	0.713
EP2	0.976 (0.010)	0.320 (0.014)	0.825	.	0.749	0.700	0.680
EP3	0.819 (0.011)	0.522 (0.015)	0.692	.	0.628	0.587	0.478
Cre1	1.000	0.294 (0.013)	0.840	0.763	.	0.811	0.706
Cre2	0.786 (0.010)	0.564 (0.014)	0.660	0.599	.	0.638	0.436
Cre3	0.906 (0.008)	0.421 (0.014)	0.761	0.691	.	0.735	0.579
Lea1	1.000	0.363 (0.014)	0.798	0.677	0.771	.	0.637
Lea2	1.072 (0.009)	0.268 (0.013)	0.856	0.726	0.827	.	0.732
Lea3	0.999 (0.010)	0.364 (0.014)	0.797	0.676	0.770	.	0.636
Resources							
Peo1	1.000	0.454 (0.013)	0.739	.	0.704	0.651	0.546
Peo2	1.029 (0.010)	0.422 (0.013)	0.760	.	0.724	0.670	0.578
Peo3	0.710 (0.012)	0.724 (0.013)	0.525	.	0.500	0.463	0.276
Sys1	1.000	0.420 (0.013)	0.761	0.725	.	0.679	0.580
Sys2	1.080 (0.008)	0.323 (0.012)	0.823	0.784	.	0.734	0.677
Sys3	0.948 (0.009)	0.479 (0.013)	0.722	0.689	.	0.644	0.521
Pro1	1.000	0.374 (0.013)	0.791	0.697	0.706	.	0.626
Pro2	0.947 (0.009)	0.439 (0.013)	0.749	0.660	0.668	.	0.561
Pro3	0.993 (0.008)	0.383 (0.013)	0.785	0.692	0.700	.	0.617
Behaviors							
Ene1	1.000	0.207 (0.011)	0.891	.	0.822	0.801	0.793
Ene2	0.972 (0.004)	0.250 (0.011)	0.866	.	0.799	0.779	0.750

ITEM	UNSTANDARDIZED COEFFICIENTS	ERROR VARIANCE	PATTERN COEFFICIENTS	STRUCTURE COEFFICIENTS			R2
				FACTOR 1	FACTOR 2	FACTOR 3	
Ene3	1.028 (0.004)	0.161 (0.011)	0.916	.	0.845	0.823	0.839
Eng1	1.000	0.279 (0.012)	0.849	0.784	.	0.792	0.721
Eng2	0.819 (0.007)	0.517 (0.013)	0.695	0.641	.	0.648	0.483
Eng3	0.986 (0.005)	0.300 (0.012)	0.837	0.773	.	0.781	0.700
Ena1	1.000	0.236 (0.012)	0.874	0.786	0.815	.	0.764
Ena2	0.966 (0.005)	0.286 (0.012)	0.845	0.760	0.788	.	0.714
Ena3	0.956 (0.005)	0.302 (0.012)	0.836	0.752	0.780	.	0.698
Processes							
Ide1	1.000	0.342 (0.013)	0.811	.	0.737	0.636	0.658
Ide2	1.044 (0.007)	0.282 (0.012)	0.848	.	0.771	0.665	0.718
Ide3	0.986 (0.008)	0.360 (0.013)	0.800	.	0.727	0.627	0.640
Sha1	1.000	0.349 (0.012)	0.807	0.734	.	0.734	0.651
Sha2	0.905 (0.007)	0.468 (0.013)	0.730	0.664	.	0.664	0.532
Sha3	0.851 (0.008)	0.529 (0.013)	0.686	0.624	.	0.624	0.471
Cap1	1.000	0.411 (0.013)	0.768	0.602	0.699	.	0.589
Cap2	1.103 (0.009)	0.283 (0.012)	0.847	0.664	0.771	.	0.717
Cap3	1.099 (0.009)	0.288 (0.012)	0.844	0.662	0.768	.	0.712
Climate							
Col1	1.000	0.457 (0.013)	0.737	.	0.686	0.661	0.543
Col2	1.094 (0.009)	0.350 (0.012)	0.806	.	0.750	0.723	0.650
Col3	1.102 (0.009)	0.340 (0.012)	0.812	.	0.756	0.728	0.660
Saf1	1.000	0.290 (0.013)	0.843	0.785	.	0.728	0.710
Saf2	0.787 (0.008)	0.560 (0.013)	0.664	0.618	.	0.573	0.440

TABLE 6 (CONTINUED)

ITEM	UNSTANDARDIZED COEFFICIENTS	ERROR VARIANCE	PATTERN COEFFICIENTS	STRUCTURE COEFFICIENTS			R2
				FACTOR 1	FACTOR 2	FACTOR 3	
Saf3	0.842 (0.008)	0.497 (0.013)	0.710	0.661	.	0.612	0.503
Sim1	1.000	0.559 (0.013)	0.664	0.596	0.573	.	0.441
Sim2	1.097 (0.013)	0.470 (0.013)	0.728	0.653	0.628	.	0.530
Sim3	1.190 (0.014)	0.376 (0.013)	0.790	0.709	0.682	.	0.624
Success							
Ext1	1.000	0.357 (0.012)	0.802	.	0.715	0.601	0.643
Ext2	1.065 (0.007)	0.271 (0.012)	0.854	.	0.761	0.640	0.729
Ext3	1.075 (0.008)	0.257 (0.012)	0.862	.	0.768	0.646	0.743
Ent1	1.000	0.428 (0.013)	0.756	0.674	.	0.630	0.572
Ent2	1.122 (0.008)	0.280 (0.012)	0.848	0.756	.	0.706	0.720
Ent3	1.050 (0.008)	0.369 (0.012)	0.794	0.707	.	0.661	0.631
Ind1	1.000	0.378 (0.013)	0.789	0.591	0.657	.	0.622
Ind2	1.088 (0.009)	0.264 (0.012)	0.858	0.643	0.715	.	0.736
Ind3	0.947 (0.010)	0.442 (0.013)	0.747	0.560	0.622	.	0.558

TABLE 7	INTERCONSTRUCT CORRELATIONS, SIC, AVE, AND CR BY MODEL				
Values					
	Entrepreneurship	Creativity	Learning	**AVE**	**CR**
Entrepreneurship	1.000	0.824	0.719	**0.625**	**0.832**
Creativity	0.908	1.000	0.933	**0.573**	**0.800**
Learning	0.848	0.966	1.000	**0.668**	**0.858**
Resources					
	People	Systems	Projects	**AVE**	**CR**
People	1.000	0.908	0.776	**0.466**	**0.719**
Systems	0.953	1.000	0.796	**0.593**	**0.813**
Projects	0.881	0.892	1.000	**0.601**	**0.819**
Behaviors					
	Energize	Engage	Enable	**AVE**	**CR**
Energize	1.000	0.852	0.808	**0.794**	**0.920**
Engage	0.923	1.000	0.870	**0.635**	**0.838**
Enable	0.899	0.933	1.000	**0.726**	**0.888**
Processes					
	Ideate	Shape	Capture	**AVE**	**CR**
Ideate	1.000	0.826	0.615	**0.672**	**0.860**
Shape	0.909	1.000	0.828	**0.552**	**0.786**
Capture	0.784	0.910	1.000	**0.673**	**0.860**
Climate					
	Collaboration	Safety	Simplicity	**AVE**	**CR**
Collaboration	1.000	0.867	0.805	**0.617**	**0.829**
Safety	0.931	1.000	0.745	**0.552**	**0.785**
Simplicity	0.897	0.863	1.000	**0.532**	**0.772**
Success					
	External	Enterprise	Individual	**AVE**	**CR**
External	1.000	0.794	0.561	**0.705**	**0.878**
Enterprise	0.891	1.000	0.694	**0.640**	**0.842**
Individual	0.749	0.833	1.000	**0.639**	**0.841**

Note: Values below the diagonal are estimates of interconstruct correlations, and values above the diagonal are squared interconstruct correlations (SIC).

Discussion and Implications for Future Research and Practice

This study employed confirmatory factor analyses and score reliability estimates to examine the construct validity and reliability of each of the six measurement models within the Innovation Quotient (Rao & Weintraub, 2013) instrument, where multiple findings presented oppor-

TABLE 8 INITIAL FACTOR SCORE REALIABILITY ESTIMATES BY COUNTRY

MODEL	α	FACTOR	α	1	2	3	4	5	6	7	8	9
Values	.904	Entrepreneurial	.781	.792	.753	.713	.736	.733	.704	.700	**.664**	.745
		Creativity	.755	.728	.731	.717	.789	.732	.709	.820	.709	.810
		Learning	.820	.804	.798	.837	.750	.826	.824	.841	.820	.796
Resources	.904	People	.712	**.689**	.720	.727	**.693**	.730	.721	.753	.744	**.688**
		Systems	.811	.788	.811	.809	.749	.835	.837	.807	.863	.733
		Projects	.819	.796	.774	.836	.863	.851	.891	.859	.742	.850
Behaviors	.948	Energize	.920	.917	.914	.903	.889	.923	.922	.913	.925	.854
		Engage	.837	.817	.845	.829	.801	.846	.832	.854	.854	.723
		Enable	.888	.880	.885	.883	.814	.913	.897	.859	.887	.772
Processes	.921	Ideate	.859	.846	.862	.842	.792	.898	.875	.871	.833	.823
		Shape	.785	.746	.830	.782	.670	.822	.780	.818	.840	.707
		Capture	.857	.844	.838	.880	.781	.877	.878	.848	.854	.810
Climate	.906	Collaboration	.827	.820	.802	.796	.803	.813	.831	.836	.809	.822
		Safety	.784	.765	.779	.719	.803	.824	.758	.798	**.637**	.782
		Simplicity	.768	.747	.751	.724	.744	.789	.740	.806	.734	**.589**
Success	.923	External	.877	.858	.854	.905	.850	.920	.917	.830	.899	.869
		Enterprise	.842	.841	.789	.839	.848	.844	.847	.825	.763	.742
		Individual	.837	.833	.821	.816	.792	.861	.820	.844	.853	.758

Note: α = alpha coefficient, 1 = Spain, 2 = Chile, 3 = Colombia, 4 = United States, 5 = Panama, 6 = El Salvador, 7 = Portugal, 8 = Mexico, 9 = Germany.

TABLE 9 INITIAL FACTOR SCORE RELIABILITY ESTIMATES BY INDUSTRY

FACTOR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Entrepreneurial	.762	.806	.821	.757	.821	.790	.749	.694	.656	.749	.803	**.681**	.749	.826	.665	.808	.772	.710	**.669**	.786
Creativity	.764	.760	.799	.766	.712	.737	.727	**.693**	**.638**	**.681**	.731	.708	.748	.795	**.650**	**.673**	**.660**	**.683**	.727	.776
Learning	.848	.836	.820	.800	.793	.807	.781	.731	.778	.739	.801	.756	.776	.835	.752	.798	.794	.751	.741	.798
People	.754	.747	.705	**.693**	**.670**	**.699**	**.673**	**.643**	**.639**	.702	.700	.716	**.682**	.731	**.555**	**.562**	.701	**.638**	**.630**	.811
Systems	.846	.829	.827	.807	.775	.766	.784	.748	.733	.716	.740	.744	.800	.805	.745	.722	.764	**.687**	.703	.816
Projects	.853	.842	.812	.830	.781	.762	.790	.752	.729	.703	.790	.827	.811	.852	.743	**.680**	.773	.816	.747	.791
Energize	.925	.928	.933	.918	.910	.915	.879	.884	.883	.890	.910	.906	.908	.873	.878	.915	.907	.893	.910	.905
Engage	.855	.860	.835	.840	.810	.807	.805	.765	.783	.779	.829	.824	.778	.846	.767	.798	.750	.798	.707	.719
Enable	.908	.900	.893	.870	.870	.886	.819	.825	.849	.859	.897	.884	.805	.831	.851	.902	.844	.838	.782	.827
Ideate	.879	.882	.854	.853	.871	.836	.851	.792	.807	.793	.833	.838	.836	.833	.870	.816	.821	.794	.773	.866
Shape	.823	.857	.760	.805	.763	**.697**	.746	.704	.704	**.663**	.725	**.672**	.747	.754	.708	.722	.727	.719	**.589**	**.595**
Capture	.895	.880	.851	.843	.812	.840	.804	.773	.745	.820	.828	.799	.778	.829	.760	.824	.849	.778	.723	.837
Collaboration	.841	.834	.844	.829	.787	.834	.774	.732	.763	.800	.827	.817	.759	.823	.808	.772	.839	.792	**.557**	.773
Safety	.800	.806	.785	.780	.757	.793	.771	**.648**	.759	**.662**	.787	.789	.701	.711	.752	.740	.770	.788	**.652**	.850
Simplicity	.794	.806	.757	.793	.733	.734	.722	**.650**	**.689**	**.639**	.763	.706	**.695**	.763	.724	**.683**	.706	.651	**.487**	.745
External	.925	.871	.870	.877	.846	.857	.776	.851	.843	.749	.861	.828	.820	.838	.829	.826	.868	.828	.804	.811
Enterprise	.861	.841	.856	.850	.825	.835	.772	.794	.794	.777	.829	.834	.769	.754	.827	.811	.824	.772	.801	.851
Individual	.854	.869	.852	.826	.815	.827	.772	.728	.760	.782	.834	.852	.805	.842	.819	.833	.804	.790	.733	**.699**

Note: 1 = Financial and insurance, 2 = Telecommunications, 3 = Professional services, 4 = Industrial machinery and equipment, 5 = Health care and social services, 6 = Aerospace and defense, 7 = Food and beverages, 8 = Construction and building materials, 9 = Industrial metals and mining; 10 = Automobile and parts, 11 = Oil and chemicals, 12 = Energy – electricity and gas, 13 = IT – software and electronics, 14 = Retail, 15 = Education, 16 = Public and state administration; 17 = Transport and logistics, 18 = Pharmaceuticals, 19 = Biotechnology and research, 20 = Media and publication.

TABLE 10	RELIABILITY ESTIMATES BY ORGANIZATIONAL LEVEL, FUNCTIONAL ROLE, AND LANGUAGE									
FACTOR	**STAFF**	**MAN**	**EXEC/DIR**	**OPS**	**COM**	**SUP**	**OTH**	**R&D**	**SPAN**	**ENG**
Entrepreneurial	.785	.776	.771	.781	.772	.789	.761	.775	.782	.740
Creativity	.755	.745	.798	.754	.750	.740	.792	.733	.753	.773
Learning	.818	.812	.848	.817	.838	.828	.772	.819	.825	.768
People	.724	**.681**	.712	.722	.718	.705	.712	**.679**	.716	**.682**
Systems	.817	.791	.825	.813	.829	.799	.785	.764	.814	.761
Projects	.830	.790	.820	.809	.828	.807	.858	.758	.814	.854
Energize	.920	.920	.916	.918	.924	.924	.884	.919	.923	.882
Engage	.848	.819	.816	.842	.855	.820	.812	.791	.840	.790
Enable	.894	.882	.862	.893	.891	.888	.833	.874	.893	.821
Ideate	.866	.846	.854	.867	.861	.868	.831	.805	.864	.799
Shape	.796	.771	.757	.796	.814	.770	.739	.708	.792	**.687**
Capture	.861	.851	.845	.861	.871	.857	.816	.820	.862	.791
Collaboration	.833	.813	.829	.836	.810	.822	.821	.807	.829	.801
Safety	.791	.775	.762	.778	.786	.786	.787	.772	.784	.777
Simplicity	.768	.754	.803	.764	.785	.755	.766	.743	.771	.730
External	.881	.864	.882	.876	.882	.880	.870	.860	.878	.864
Enterprise	.844	.835	.843	.842	.843	.847	.828	.820	.844	.826
Individual	.843	.820	.842	.843	.841	.833	.792	.831	.841	.781

Note: Man = Manager, Exec/Dir = Executive or director, Ops = Operations, Com = Commercial, Sup = Support, Oth = Other, R&D = Research and development, Span = Spanish, Eng = English.

While it was identified that each of the models showed acceptable model fit with strong item loadings, the structure coefficients for each of the models' three latent factors were also high, suggesting a possible lack of discriminant validity.

tunities for future research. A summary of the best fitting models for each of the six measurement models is presented in Table 11. While it was identified that each of the models showed acceptable model fit with strong item loadings, the structure coefficients for each of the models' three latent factors were also high, suggesting a possible lack of discriminant validity. This issue was checked through evaluation of the squared interconstruct correlations—each of which exceeded the average variance extracted for their individual factors. Such results are expected when those factors are hypothesized to be highly related, but also indicate that future investigation into the nature of these relationships may be warranted. Multicollinearity was excluded as a possible contributor to this issue via review of squared multiple correlations and variance inflation factors, but future researchers may wish to propose and test the specification of a global, six-factor construct of innovation culture, in which each of the six building blocks relates to one another.

Future researchers may wish to explore possible explanations for inconsistencies in score reliability estimates across groups, particularly for the

TABLE 11	CFA RESULTS SUMMARY							
MODEL	**SPEC**	χ^2	***DF***	***CFI***	***AGFI***	***RMSEA***	***RMSEA*** CI_{90}	***SRMR***
Values	3 factor	1117.818*	24	0.960	0.996	0.097	(0.094; 0.100)	0.029
Resources	3 factor	883.691*	24	0.980	0.997	0.060	(0.057; 0.064)	0.021
Behaviors	3 factor	1903.178*	24	0.975	0.998	0.090	(0.087; 0.094)	0.022
Processes	3 factor	924.771*	24	0.983	0.998	0.062	(0.058; 0.065)	0.019
Climate	3 factor	1755.376*	24	0.962	0.995	0.086	(0.082; 0.089)	0.030
Success	3 factor	982.654*	24	0.983	0.998	0.064	(0.060; 0.067)	0.019

Note. *$p < .001$. χ2 = Satorra-Bentler (1988) scaled chi-square; CFI = comparative fit index; AGFI = adjusted goodness of fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square.

values, resources, processes, and climate blocks. While many of the reliability estimates exceeded and approximated the threshold, which is a desirable result considering the inclusion of only three items, multiple thresholds were not met. For example, while the reliability estimate for the factor of People within the resources model was sufficient for the entire sample ($\alpha = 0.712$), the thresholds were not consistent for all countries (Spain, the United States, and Germany), industries (industrial machinery and equipment, health care and social services, aerospace and defense, food and beverages, construction and building materials, industrial metals and mining, IT software and electronics, education, public and state administration, pharmaceuticals, and biotechnology and research), for the organizational level of managers, for the functional role of R&D, or for the English language. Another finding emerged for the creativity factor within the values model. While the overall estimate for the whole sample was $\alpha = 0.755$, a lack of evidence for reliability was identified for multiple industries (construction and building materials, industrial metals and mining, automobile and parts, education, public and state administration, transport and logistics, and pharmaceuticals). The simplicity factor in the climate model produced questionable reliability for one country (Germany), but among multiple industries (construction and building materials, industrial metals and mining, automobile and parts, IT—software and electronics, public and state administration, and biotechnology and research). Finally, for some particular industries (construction and building materials, automobile and parts, public and state administration, and biotechnology and research), reliability results, overall, were insufficient for four or more factors. An opportunity exists for research to identify those items that contributed to decreased reliability estimates to improve the measurement of the instrument.

Due to a lack of discriminant validity and reliability across organizational groups, additional investigation of alternative models is needed. In part two of the current investigation, which will be published in a future article, additional models are explored. One such model that is considered is the specification of a single, global six-factor model of culture of innovation, in which each factor is measured by nine items. Also, as it was identified that some individual items could relate with and load onto other factors, exploratory factor analytic methods are also employed to identify possible common factors or other plausible model specifications. Such investigations at the item level across the entire instrument's 54 items may yield additional examples where theory might be guided, enabling practitioners who use the instrument to better measure and understand culture of innovation in their organizations.

Finally, researchers who have studied common method variance have articulated its effects on interitem relationships and have made recommendations for how to reduce those effects on the validity of findings, which include both instrument design methods and statistical controls (i.e., Lindell & Whitney, 2001; Podsakoff et al., 2003). The current study attempted to control for the presence of common method variance through the inclusion of a common variable in the model specification, but other recommendations could be applied, such as the reduction of items with similar wording or stems, or the inclusion of a marker variable to detect relationships to theoretically irrelevant behaviors. In part two of this investigation, these recommendations in factor specification will be implemented, analyzed, and discussed for their implications to practitioners who seek to apply the Innovation Quotient instrument in their organizations.

References

Aiman-Smith, L., Goodrich, N., Roberts, D., & Scinta, J. (2005). Assessing your organization's potential for value innovation. *Research-Technology Management*, *48*(2), 37–42.

Anderson, N. R., & West, M. A. (1998). Measuring climate for work group innovation: Development and validation of the team climate inventory. *Journal of Organizational Behavior*, *19*(3), 235–258. doi:10.1002/(SICI)1099-1379(199805)19:3%3C235::AID-JOB837%3E3.0.CO;2-C

Brettel, M., & Cleven, N. J. (2011). Innovation culture, collaboration with external partners and NPD performance. *Creativity and Innovation Management*, *20*(4), 253–272. doi:10.1111/j.1467-8691.2011.00617.x

Brown, T.A. (2006). *Confirmatory factor analysis for applied research.* New York, NY: The Guilford Press.

Chen, W. J. (2011). Innovation in hotel services: Culture and personality. *International Journal of Hospitality Management*, *30*(1), 64–72. doi:10.1016/j.ijhm.2010.07.006

Christensen, C. M., Anthony, S. D., & Roth, E. A. (2004). *Seeing what's next: Using the theories of innovation to predict industry change.* Boston, MA: Harvard Business Press.

Crossan, M. M., & Apaydin, M. (2010). A multi-dimensional framework of organizational innovation: A systematic review of the literature. *Journal of Management Studies*, *47*(6), 1154–1191. doi:10.1111/j.1467-6486.2009.00880.x

Curran, P. J., West, S. G., & Finch, J. F. (1996). The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological Methods*, *1*(1), 16–29. doi:10.1037/1082-989X.1.1.16

Denison, D. R. (1996). What is the difference between organizational culture and organizational climate? A native's point of view on a decade of paradigm wars. *Academy of Management Review*, *21*(3), 619–654. doi:10.5465/AMR.1996.9702100310

Dobni, C. B. (2008). Measuring innovation culture in organizations: The development of a generalized innovation culture construct using exploratory factor analysis. *European Journal of Innovation Management*, *11*(4), 539–559. doi:10.1108/14601060810911156

Dyer, J., Gregersen, H., & Christensen, C.M. (2011). *The innovator's DNA: Mastering the five skills of disruptive innovators.* Boston, MA: Harvard Business Review Press.

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). London, United Kingdom: Sage Publications.

Forero, C. G., Maydeu-Olivares, A., & Gallardo-Pujol, D. (2009). Factor analysis with ordinal indicators: A Monte Carlo study comparing DWLS and ULS estimation. *Structural Equation Modeling, 16*(4), 625–641. doi:10.1080/10705510903203573

Francis, D. L. (2000). *Assessing and improving innovation capabilities in organizations*. (Doctoral thesis). Center for Research in Innovation Management. Brighton, United Kingdom: University of Brighton.

Garrard, J. (2011). *Health sciences literature review made easy: The matrix method.* Sudbury, MA: Jones & Bartlett.

Graham, J. M., Guthrie, A. C., & Thompson, B. (2003). Consequences of not interpreting structure coefficients in published CFA research: A reminder. *Structural Equation Modeling*, *10*(1), 142–153. doi:10.1207/S15328007SEM1001_7

Hair, J. F. Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Upper Saddle River, NJ: Prentice Hall.

Hoe, S. L. (2011). Measuring an organization's innovation climate: A case study from Singapore. *Development and Learning in Organizations, 25*(6), 13–15. doi:10.1108/14777281111173342

Hofstede, G. (1998). Attitudes, values and organizational culture: Disentangling the concepts. *Organization Studies*, *19*(3), 477–493. doi:10.1177/017084069801900305

Humphreys, P., McAdam, R., & Leckey, J. (2005). Longitudinal evaluation of innovation implementation in SMEs. *European Journal of Innovation Management, 8*(3), 283–304. doi:10.1108/14601060510610162

Hurley, R. F., & Hult, G. T. M. (1998). Innovation, market orientation, and organizational learning: An integration and empirical examination. *The Journal of Marketing, 62*(3), 42–54. doi:10.2307/1251742

IBM Corp. (Released 2013). IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.

Kimberlin, C. L., & Winterstein, A. G. (2008). Validity and reliability of measurement instruments used in research. *American Journal of Health-System Pharmacy*, *65*(23), 2276–2284. doi:10.2146/ajhp070364

Kleinschmidt, E. J., De Brentani, U., & Salomo, S. (2007). Performance of global new product development programs: A resource-based view. *Journal of Product Innovation Management*, *24*(5), 419–441. doi:10.1111/j.1540-5885.2007.00261.x

Kline, R. B. (2011). *Principles and practice of structural equation modeling*. New York, NY: Guilford Publications.

Kuczmarski, T. D. (2003). What is innovation? And why aren't companies doing more of it? *Journal of Consumer Marketing*, *20*(6), 536–541.

Kuščer, K. (2013). Determining factors of mountain destination innovativeness. *Journal of Vacation Marketing*, *19*(1), 41–54. doi:10.1177/1356766712461404

Lawson, B., & Samson, D. (2001). Developing innovation capability in organizations: A dynamic capabilities approach. *International Journal of Innovation Management*, *5*(3), 377–400. doi:10.1142/S1363919601000427

Lindell, M. K., & Whitney, D. J. (2001). Accounting for common method variance in cross-sectional research designs. *Journal of Applied Psychology*, *86*(1), 114–121. doi:10.1037/0021-9010.86.1.114

Mardia, K. V. (1985). Mardia's test of multinormality. In S. Kotz & N. L. Johnson (Eds.), *Encyclopedia of Statistical Sciences* (pp. 217 – 221). New York, NY: Wiley.

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York, NY: McGraw-Hill.

O'Reilly, C. A. (1989). Corporations, culture and commitment: Motivation and social control in organizations. *California Management Review*, *31*, 9–25. doi:10.2307/41166580

O'Sullivan, D., & Dooley, L. (2009). *Applying innovation*. Thousand Oaks, CA: Sage Publications.

Panayides, P. (2006). Enhancing innovation capability through relationship management and implications for performance. *European Journal of Innovation Management*, *9*(4), 466–483. doi:10.1108/14601060610707876

Patterson, M. G., West, M. A., Shackleton, V. J., Dawson, J. F., Lawthom, R., Maitlis, S., … & Wallace, A. M. (2005). Validating the organizational climate measure: Links to managerial practices, productivity, and innovation. *Journal of Organizational Behavior*, *26*(4), 379–408. doi:10.1002/job.312

Perel, M. (2005). You can innovate in hard times. *Research Technology Management*, *48*(4), 14–23.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. doi:10.1037/0021-9010.88.5.879

Rao, J., & Weintraub, J. (2013). How innovative is your company's culture? *MIT Sloan Management Review*, *54*(3), 28–37.

Remneland-Wikhamn, B., & Wikhamn, W. (2011). Open innovation climate measure: The introduction of a validated scale. *Creativity and Innovation Management*, *20*(4), 284–295. doi:10.1111/j.1467-8691.2011.00611.x

Sarros, J. C., Cooper, B. K., & Santora, J. C. (2008). Building a climate for innovation through transformational leadership and organizational culture. *Journal of Leadership & Organizational Studies*, *15*(2), 145–158. doi:10.1177/1548051808324100

Satorra, A., & Bentler, P. M. (1988). Scaling corrections for chi-square statistics in covariance structure analysis. *ASA 1988 Proceedings of the Business and Economic Statistics, Section* (308–313). Alexandria, VA: American Statistical Association.

Schein, E. H. (1984). Coming to a new awareness of organizational culture. *Sloan Management Review*, *25*(2), 3–16.

Schein, E. H. (1999). The corporate culture survival guide: Sense and nonsense about culture change. *Warren Bennis Signature Series*. San Francisco, CA: Jossey-Bass.

Schneider, B., Ehrhart, M. G., & Macey, W. H. (2013). Organizational climate and culture. *Annual Review of Psychology*, *64*, 361–388. doi:10.1146/annurev-psych-113011-143809

Scientific Software International. (2015). LISREL 9.2 for Windows. Retrieved from http://www.ssicentral.com/lisrel/upgrade9.1.html

Shahin, A., & Zeinali, Z. (2010). Developing a relationship matrix for organizational learning and innovativeness with a case study in a manufacturing company. *International Journal of Business & Management*, *5*(7), 187–203. doi:10.5539/ijbm.v5n7p187

Sharifirad, M. S., & Ataei, V. (2012). Organizational culture and innovation culture: Exploring the relationships between constructs. *Leadership & Organization Development Journal*, *33*(5), 494–517. doi:10.1108/01437731211241274

Silva, A. (2014). How to become an innovative company: A case study. *International Journal of Innovation Science*, *6*(3), 177–182. doi:10.1260/1757-2223.6.3.177

Spanish Society for Quality. (2015). Participate in the culture of innovation index. Retrieved from http://www.aec.es/web/guest/cultura-innovacion/indice-cultura-innovacion-2015

Sun, H., Wong, S. Y., Zhao, Y., & Yam, R. (2012). A systematic model for assessing innovation competence of Hong Kong/China manufacturing companies: A case study. *Journal of Engineering and Technology Management*, *29*(4), 546–565. doi:10.1016/j.jengtecman.2012.03.005

Sušanj, Z. (2000). Innovative climate and culture in manufacturing organizations: Differences between some European countries. *Social Science Information*, *39*(2), 349–361. doi:10.1177/053901800039002011

Switzer, G. E., Wisniewski, S. R., Belle, S. H., Dew, M. A., & Schultz, R. (1999). Selecting, developing, and evaluating research instruments. *Social Psychiatry and Psychiatric Epidemiology*, *34*(8), 399–409. doi:10.1007/s001270050161

Tellis, G. J., Prabhu, J. C., & Chandy, R. K. (2009). Radical innovation across nations: The preeminence of corporate culture. *Journal of Marketing*, *73*(1), 3–23. doi:10.1509/jmkg.73.1.3

Tello, F. P., Moscoso, S., García, I. B, & Abad, E. (2010). Polychoric versus Pearson correlations in exploratory and confirmatory factor analysis of ordinal variables. *Quality & Quantity, 44*(1), 153–166. http://dx.doi/10.1007/s11135-008-9190-y

Tello, F. P., Moscoso, S., García, I. B., & Chaves, S. S. (2006). Training satisfaction rating scale: Development of a measurement model using polychoric correlations. *European Journal of Psychological Assessment*, *22*(4), 268–279.

Thompson, B. (2003). Understanding reliability and coefficient alpha, really. In Bruce Thompson (Ed.), *Score reliability: Contemporary thinking on reliability issues* (pp. 3-23). Thousand Oaks, CA: Sage.

Tohidi, H., Seyedaliakbar, S. M., & Mandegari, M. (2012). Organizational learning measurement and the effect on firm innovation. *Journal of Enterprise Information Management*, *25*(3), 219–245. doi:10.1108/17410391211224390

Velasco, E., Zamanillo, I., & Del Valle, T. G. (2013). Mobilizing company members' full innovative potential. *Human Factors and Ergonomics in Manufacturing & Service Industries*, *23*(6), 541–559. doi:10.1002/hfm.20341

Weiss, D. S., & Legrand, C. (2011). *Innovative intelligence: The art and practice of leading sustainable innovation in your organization*. Toronto, Canada: John Wiley & Sons.

Zairi, M., & Al-Mashari, M. (2005). Developing a sustainable culture of innovation management: A prescriptive approach. *Knowledge and Process Management*, *12*(3), 190–202. doi:10.1002/kpm.229

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