

Measuring the knowledge creation process in Pakistani banks: Scale development and validation

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Abstract Knowledge creation within an organization arises from socialization, externalization, combination and internalization of knowledge resources. This paper contributes to the body of knowledge management literature by providing an empirical validation of the knowledge creation process in the context of Pakistani banks. A sample of 346 cases was selected randomly from 50 branches of three knowledge-intensive banks in Karachi. The results confirm the presence of knowledge creation in Pakistani banks and the validation process of the scale was used to measure this. Our findings can help managers develop successful knowledge creation and sharing strategies that utilize tacit and explicit knowledge resources more effectively.

Keywords Knowledge creation process · Confirmatory factor analysis · Reliability · Convergent validity · Knowledge-intensive bank.

1 Introduction

Over the past two decades, knowledge management (KM) has emerged as a separate field of management science research [Kao et al \(2011\)](#) [Rai \(2011\)](#) [Nonaka and Konno \(1998\)](#). In a knowledge economy, knowledge is the fundamental resource for companies that can form the basis of sustainable competitive advantage. Thus, an appropriate understanding of how to make optimal use of knowledge management strategies is crucial [Shih et al \(2010\)](#).

Existing global business activities are becoming more knowledge-intensive as knowledge is becoming the source of productivity within and across economies.

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However, the inability to effectively apply knowledge in the manufacturing and production processes is accelerating the economic divide between developed and developing countries [Akhtar \(2001\)](#) [Jamal and Naser \(2003\)](#).

Pakistani public and private sector organizations lack appropriate knowledge management strategies that can improve their competitive positioning in national and international markets [Khilji \(2003\)](#). The advent of globalization has brought striking changes to workplace values which reflect a modern market economy [Khilji \(2004\)](#). Pakistani organizations experience a variety of structural and institutional irregularities that diminish their capabilities to take advantage of the dynamic business environment [Bhatti and Qureshi \(2007\)](#). In 1990, a privatization program was initiated to break free off the bureaucratic culture and restructure human resource practices [Mirza \(1995\)](#). The intent was to introduce modern management practices, reduce nepotism and red tape [Khilji \(2003\)](#).

Keeping in view the importance of knowledge management, the fundamental aim of the underlying empirical study is to validate a knowledge creation process theory in Pakistani banks. This study is the first attempt to measure and validate the 'knowledge creation process' scale in Pakistani organizations (i.e. banks).

2 Theoretical perspective of knowledge creation

Early identification of the knowledge creation (KC) phenomenon by [Nonaka \(1994\)](#)(p.5) noted that "successful companies are those that constantly create new knowledge, distribute it throughout the organization and embody it in new technologies and products". [Nonaka et al \(2001\)](#) define knowledge creation as "a continuous process through which one overcomes the individual limitations and restrictions imposed by prevailing information and experience by attaining a new perspective, a new observation of the environment and new knowledge [Nonaka et al \(2000\)](#) (p.7)". In addition, the spiral of knowledge is created when both tacit and explicit knowledge is complementing and interfacing each other through four switching modes namely; socialization, externalization, combination and internalization. Hence, knowledge creation is a process in which personal knowledge is continuously validated by integrating someone else's knowledge through the four modes of the knowledge conversion spiral [Nonaka et al \(2000\)](#).

Socialization (tacit \rightarrow tacit): The first knowledge conversion mode socialisation is the "process of sharing experiences through social interaction thus creating tacit knowledge, such as shared mental models and technical skills". [Nonaka and Takeuchi \(1995\)](#)(p.62). In this phase of the knowledge conversion process, existing tacit knowledge is transformed to create a new type of tacit knowledge [Nonaka et al \(2000\)](#) [Byosiere and Luethge \(2004\)](#) [Nonaka and Takeuchi \(1995\)](#).

Externalization (tacit \rightarrow explicit): The second knowledge conversion mode typically seen in terms of concept creation is activated by conversation or collective reflection [Nonaka and Takeuchi \(1995\)](#). In this knowledge conversion mode, tacit (i.e. subjective, intangible, inexpressible) knowledge is converted into explicit (i.e. objective, tangible, expressible) knowledge. Knowledge exter-

nalization can be attained when people get help from technical terminologies and professional language in routine communications with each other in the organization.

Combination (explicit \rightarrow explicit): The third knowledge conversion mode is the process in which existing explicit knowledge is collected from knowledge repositories or databases and transformed into more customized, assimilated, remodeled and reconfigured explicit knowledge [Nonaka et al \(2000\)](#) [Byosiere and Luethge \(2004\)](#) [Nonaka and Takeuchi \(1995\)](#). In the combination phase, people can exchange and combine knowledge in tangible or intangible forms, collect new information and organize ambiguous concepts into structured form.

Internalization (explicit \rightarrow tacit): The fourth knowledge conversion mode is the last sequential stage in which tacit knowledge is created through the process of reviewing and interpreting explicit knowledge and converting it into tacit knowledge [Nonaka et al \(2000\)](#). More specifically, the internalization process involves learning by doing. It strengthens the learner's confidence and knowledge and the skills become entrenched in an individual's mind and can be deployed in specific contexts [Haag et al \(2009\)](#).

3 Knowledge creation measurement

The SECI process of the knowledge creation theory is based on four modes. It provides a distinctive framework that broadly covers the knowledge sharing and creation process [Earl \(2001\)](#) [Von Krogh et al \(2000\)](#) [Haag et al \(2009\)](#). Therefore, the SECI model is used for item specification in the context of knowledge-intensive banking organizations [Hinkin \(2005\)](#) [Song et al \(2011\)](#). The socialization and internalization modes facilitate human-oriented KM, while externalization and combination support technology-oriented KM [Maier and Remus \(2003\)](#).

Socialization and internalization processes can be triggered by face to face conversations, on the job-training, mentoring, coaching, community of practice, teamwork, employee empowerment, and reward and recognition [Vencatachelum and Jeetah \(2008\)](#). Knowledge externalization and combination processes on the other hand are associated with information systems and technology in which tacit knowledge is converted into explicit knowledge by updating and integrating business processes and I.T platforms [Maier and Remus \(2003\)](#).

The knowledge creation scale developed by [Song et al \(2011\)](#) provides an appropriate and effective measurement scale for the knowledge creation process. For empirical validation of the knowledge creation theory, a twenty-four item scale has been adapted from [Song et al \(2011\)](#). In other words, the selected scale provides a solid ground that embraces the knowledge creation process and the core behaviors deemed essential for exploring and exploiting organizational knowledge creation at tactical, operational, and technical levels [Song et al \(2011\)](#).

For the final selection of the knowledge creation scale, a detailed literature review was carried out. The researcher thoroughly assessed previous established scales (table 1) published during the period 2002 till 2011. Only those knowl-

edge creation scales were considered that had been developed deductively and in which Nonaka's SECI knowledge creation theory was taken for item specification.

Table 1: Established scales on knowledge creation

Author (Year)	Domain	Knowledge Modes
Huang & Wang (2002)	Knowledge creation and performance in teams	Team innovation effectiveness, knowledge transfer, knowledge creation, R&D performance
Chou & Tsai (2004)	Individual and organisational knowledge	Knowledge creation 'ba'
Tsai & Li (2007)	Knowledge creation process	Socialisation, externalisation, combination, and internalisation
Li et al. (2009)	Knowledge creation process	Socialisation, externalisation, combination, and internalization
Song et al. (2011)	Knowledge creation and performance improvement	Socialisation, externalisation, combination, and internalization
Kao et al. (2011)	Knowledge creation modes	Goal free and goal-framed knowledge creation modes

3.1 Quantitative survey method

The sample was randomly selected from 50 branches of Habib Bank Limited (HBL), United Bank Limited (UBL) and Allied Bank Limited (ABL), in Karachi. The contact details of bank employees were officially obtained from human resource managers of each bank. The contact details were used as a sampling frame for quantitative data collection by one of the two ways. Firstly, the researcher sent the HTML-generated link to 350 respondents on their email addresses with a formal request to complete the online survey. Secondly, a paper-based self-administered survey was randomly distributed among 250 respondents in their offices during field work, in Karachi.

The paper-based self-administered survey focused on tellers/junior officers, branch/operation managers, regional/senior managers, and clerical/non-clerical staff of various job categories such as, retail, consumer, investment, corporate, and investment banking etc. In both versions of the survey, a total of 600 questionnaires were distributed to the three commercial banks, in Karachi. As a

Table 2: Comparative framework of EFA and CFA Albright and Park (2009)

Parameter	EFA	CFA
Scope	Data-driven	Theory-driven
Constraint	Not related	Yes
Un-standardised solution	Not related	Yes
Standardised solution	Yes	Yes
Factor rotation	Yes	Not related
Factor scores	Yes	Not related
Hypothesis test	Not related	Yes
Good of fit	Not related	Yes
Software Package	Gen purpose software	EQS,LISREL,MPLUS,AMOS

result, a sum of 346 (i.e. 143 electronic + 203 paper = 346) questionnaires were returned. The total response rate was 40.85% (i.e. $143/350 \times 100 = 40.85\%$) for the electronic survey and 81.2% (i.e. $203/250 \times 100 = 81.2\%$) for the paper survey. The combined survey generated 57.6% (i.e. $346/600 \times 100 = 57.6\%$) usable response rate.

3.2 Scale validation framework

Scale validation is an important aspect of any research. Empirically, it is difficult to ensure the soundness of research without determining the reliability and validity of the scale [Sureshchandar et al \(2002\)](#). Generally, if any scale has never been tested before, or the relationship between observed and latent variables has not been theoretically established then an exploratory factor analysis is the only choice [Ahire and Devaraj \(2001\)](#).

Exploratory factor analysis (EFA) is a data-driven approach in which each common factor is assumed to affect every observed variable and the common factors are either correlated or uncorrelated [Brown \(2014\)](#). Once the model is estimated then the factor scores and proxies of latent variables are calculated and used for follow-up analysis [Albright and Park \(2009\)](#).

In contrast, confirmatory factor analysis (CFA) is theory or hypothesis-driven. The CFA allows researchers to test the hypotheses about a particular factor structure. In addition, confirmatory factor analysis (CFA) is a comprehensive statistical technique that determines the validity of theoretical structures through testing the causal links among variables [Anderson and Gerbing \(1991\)](#) [Burnette and Williams \(2005\)](#) [Kline \(2015\)](#). Table 2 summarizes the differences and similarities of EFA and CFA.

In CFA, the researchers are required to devise a hypothesis as it allows the researcher to specify a model on the basis of logic or priori. For that reason, researchers first devise some hypothetical model and then test the inference that corroborates the relationship between observed and the latent variables [Sureshchandar et al \(2002\)](#). Hence, a reasonable prior knowledge of factors that clarify the interrelationship among the measured variables is an integral part of

CFA.

CFA is more suitable than EFA because it builds on logic, particularly when a researcher has a reasonably good prior knowledge about observed variables and other theoretical findings [Bentler \(1995\)](#). It is a matter of fact that knowledge creation models are theoretically established. Therefore, CFA has been utilized for the purpose of scale refinement and validation.

A typical structural equation model consists of two components: a) measurement model; and b) structural model. CFA is a measurement model. It illustrates the relationships between a set of observed (or dependent) variables and a set of continuous, latent variables. In this study, a confirmatory factor analysis (CFA) model with a first-order factor structure (or continuous factor indicators) and a second-order factor analysis models are estimated. More specifically, the first-order CFA was used to assess the structural validity, reliability and dimensionality of the scale whereas the second-order CFA was used to assess the model fit of hypothesized second-order factors [Jöreskog and Sörbom \(1996\)](#) [Yang \(2005\)](#).

According to [Byrne \(2003\)](#), the second-order CFA is potentially applicable when the first-order CFA signifies a higher inter-correlation among the factors. In the following section, the first and second-order confirmatory factor analysis of the knowledge creation scale has been explained. However, for scale refinement and validation, the researcher followed the instructions of [Sureshchandar et al \(2002\)](#).

3.3 Reliability and validity analysis

Reliability and validity measurement is an important tool that increases research credibility and diminishes the likelihood of fabricated results [Winter \(2000\)](#). The following section summarises several measures of reliability and validity used in this study.

The reliability of the scale was measured in two phases. First, in the pilot study phase and second, after conducting confirmatory factor analysis. Numerically, reliability can be measured by various methods such as, split halve, test retest, internal consistency and equivalent form. In the pilot study phase of this research, reliability of the scale was measured using an internal consistency method. [Sureshchandar et al \(2002\)](#) and [Nunnally \(2010\)](#) found internal consistency as an effective and commonly used technique. However, measuring construct reliability (CR) after CFA was used to assess the reliability of the manifest indicators, and provide an alternative for determining measurement model fit.

The term validity refers to the methodological soundness and the appropriateness of the instrument [Hashim et al \(2007\)](#). In other words, validity is the degree to which the results of a piece of research exactly reflect the situation being researched. Like reliability, the validity of the scale has been established in both the pilot and post-hoc scale development phases. In the pilot testing phase, face and content validity were measured. In the post-hoc scale valida-

tion phase, convergent validity and discriminate validity were measured using confirmatory factor analysis approach. The subsequent section summarises the detail of both reliability and validity techniques used in this study.

3.3.1 Reliability of the scale in the pilot study phase

The online survey during the pilot study was initiated in May 2012 and completed in July 2012. The researcher sent the HTML link of the electronic survey to 75 bank employees from the target population of the banking industry, on a convenience basis. A total of 29 respondents completed the online survey. The response rate of this phase remained 38.6% (i.e. $29/75 \times 100 = 38.6\%$).

These 29 responses were utilized to measure the internal consistency or coefficient alpha (α) values of the 28 items and composite reliability of 04 dimensions. The coefficient alpha (α) values of each index ($\alpha = 0.849$, $\alpha = 0.865$, $\alpha = 0.802$ and $\alpha = 0.749$) and the composite reliability of knowledge creation ($\alpha = 0.884$) were higher than the suggested minimum threshold limit of 0.60 [Bagozzi and Yi \(1988\)](#). This result indicates an acceptable evidence of the scale's internal consistency and strong interrelationship between 28 items and 4 knowledge creation dimensions [Hatcher \(2005\)](#).

3.3.2 Validity of the scale in the pilot study phase

Unlike other scientific methods, face validity is least scientific method of measuring validity. It focuses on subjective judgment and does not make use of statistical methods. More specifically, the purpose of such type of measurement is to examine how the survey appears to be valid for respondents and whether or not subjective judgment can be made by the researcher.

Face validity was measured by sending the questionnaire to 50 PhD students of four U.K universities (Queen Margaret, Swansea, Northumbria and London Metropolitan) and two universities (SALU and SZABIST) in Pakistan. The underlying objective of this phase was to inspect language issues and face validation of the questionnaire and to ensure that whether the participants understand the survey questions and if any further amendments are required in the survey. All the responses were checked precisely, and each item was reviewed for the use of familiar words. In addition, respondents were also asked for their feedback and all suggestions were vigilantly incorporated in the final version of the survey.

Content validity refers to the extent to which an instrument provides an adequate demonstration of the conceptual underpinning that it is intended to cover. Like face validity, content validity also provides subjective justification rather than empirical or statistical evidence. For the purpose of the content validity check, an initial draft of the survey was sent to a senior HR manager in a leading commercial bank in Pakistan, and to a final year PhD scholar majoring in HRD at Swansea University U.K. The underlying purpose behind such a check was to eradicate any vagueness regarding the important areas related to knowledge creation, as most of the research on knowledge creation focuses

on western organizations and no significant standard is available for developing countries. Therefore, during the pilot study, the researcher obtained useful feedback from experts that was later used to improve and refine the survey. The researcher incorporated various changes in the initial draft based on the feedback and comments of the respondents.

3.4 Reliability and validity in the post-hoc scale validation phase

The reliability of the scale is associated with the one-dimensional nature of the scale [Anderson and Gerbing \(1991\)](#). The one-dimensional measure fits with the data reasonably well, showing low measurement error [McDonald \(1981\)](#). Furthermore, the one-dimensional test examines the measurement errors and eliminates weak factor loadings and also checks the adequacy of the model through the re-specified model and measures reliability. Therefore, the one-dimensional test was performed in the post-hoc scale development phase. The researcher initially specified the measurement model for each construct by processing survey data ($n = 346$) in the statistical package IBM AMOS v19 using maximum likelihood estimation method.

In case of the validity of the scale in the post-hoc scale validation phase, the measurement model in the CFA was used to assess both the convergent and discriminant validities. Methodologically, the CFA measurement model was processed to test the relationship between the latent construct and measure the convergent and discriminant validities. [Farrell and Rudd \(2009\)](#) (p.19) highlights that “if a factor analysis is misinterpreted, and discriminant validity is not established, then measurement scales used in research may not function correctly, and conclusions made regarding relationships between constructs under investigation may be incorrect.” Therefore, the validity of the scale was measured using CFA method based on two steps: i) application of CFA measurement model and; ii) assessment of convergent and discriminant validity.

The CFA measurement model is normally used when a solid theoretical foundation of the latent variable structure is available [Byrne \(2003\)](#). The purpose behind such a measurement model is to test the validity of the selected variables through the adequacy of the hypothesized factor structure [Byrne \(2005\)](#). In addition, the structural model should be based on a certain hypotheses (or a-priori theory). Therefore, based on the knowledge (or priori), a relationship between the observed variables and the underlying latent factors has been drawn based on a certain hypothetical model or hypothesis. In the case of this study, the SECI knowledge creation theory gives conceptual backings for the underlying latent variable structure. In this connection, the following research hypothesis (H1) has been developed.

H1: Knowledge creation scale developed for this study can be employed to enhance the insights of Pakistani banking organizations into their knowledge creation process.

The subsequent section summarises the detail of both reliability and validity techniques used in the post-hoc scale validation phase.

3.4.1 Reliability (one-dimensionality) in the post-hoc scale validation phase

The knowledge creation measurement model includes four phases: socialization, externalization, combination, and internalization. All the four phases are measured with seven observed variables each. The one-dimensional analysis was conducted using the following two steps. In the first step, initial CFA was run with the entire construct that includes a total of 60 (i.e. 28 observed + 32 unobserved and 32 exogenous + 28 endogenous) variables. However, in the next step, the re-specified measurement model runs only with those items that were generated in the initial model.

Following the instructions of Byrne (2003), each of the four factors are inter-

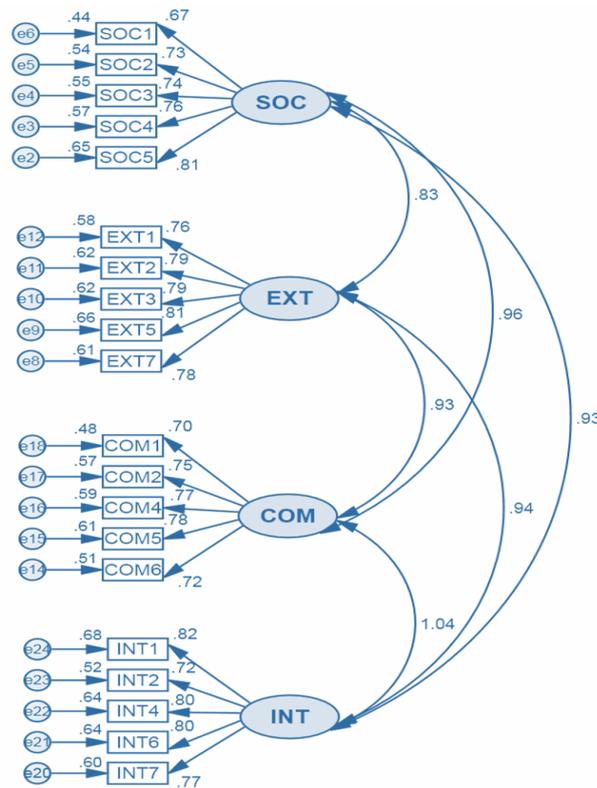


Fig. 1: AMOS path diagram of re-specified first order CFA estimates

correlated and the observed variable regressed on its respective factor. The initial findings reveal that the measurement model that includes four factors and 28 observed variables call for more re-specification to attain a model fit. For example, initial model fit estimates (i.e. $\chi^2 = 575.142$, $df = 344$, $\chi^2/df = 1.67$, CFI = 0.883, TLI = 0.871, IFI = 0.885, RFI = 0.731, NFI = 0.755 and RMSEA = 0.072) indicate that the initial model requires further re-specification. There-

fore eight items (i.e. SOC6, SOC7, EXT4, EXT6, COM3, COM7, INT3 and INT5) were deleted due to low factor loadings and corresponding low squared multiple correlations.

For the purpose of analysis in the next stage, the re-specified measurement model runs with only those items that were generated in the initial model. Figure 1 shows the AMOS path diagram of the re-specified CFA estimates and factor loadings. As shown, AMOS path diagram of the re-specified first order CFA contains a total of 44 (i.e. 20 observed + 24 unobserved) variables. In terms of adequacy, the re-specified model described the sample data fairly well. More specifically, regression weights (factor loadings) of all variables load adequately against their respective factors. All the factor loadings between 0.67 to 0.82 and all critical ratios between 7.21 to 11.01 indicated that the regression weights of all factors are statistically significant at 95 percent confidence level.

The results summarized in table 3 show the model fit results of the initial and re-specified first-order CFA. In order to examine the one-dimensionality of the knowledge creation scale, the researcher included four model fit indices such as, absolute fit indices, comparative fit indices, predictive fit indices and parsimonious fit indices. For example, the results summarized in table 3 show three absolute fit indices comprised on i) Chi-Square (χ^2); ii) Ratio of χ^2 to df and; iii) Browne Cudeck Criterion. In the present model, chi-square value ($\chi^2 = 355.736$) of the re-specified model as compared to chi-square value ($\chi^2 = 575.142$) of the initial measurement model indicates that, 44 variables (20 observed + 24 unobserved) of SECI knowledge creation scale fit very well into the data. Likewise, ratio of chi-square to degree of freedom of the re-specified model is also included.

Harrington (2008) indicated that the chi-square value is sensitive to sample size. For that reason, ratio of chi-square to degree of freedom (χ^2/df) is usually used to compensate the discrepancy in the results. The result of $\chi^2/df = 2.169$ of the re-specified model also indicates the statistical significance of the model at $*p < .000$. Additionally, the result of Browne Cudeck Criterion (BCC = 513.167) index also shows the adequacy of the factor structure of the knowledge creation measurement model in the context of Pakistani banking organizations.

However, in some situations, χ^2 does not report precise valuation of a model fit or the fit statistics may not clarify the conceptual viewpoints of the model. Thus, an alternative fit statistic is typically considered to determine the precise valuation of the model. In the present model, the Root Mean Square Error of Approximation (RMSEA) is included in table 3.

Generally speaking, RMSEA is the most important model fit statistic that may be used as an alternative for precise valuation of model fit. According to Browne et al (1993), RMSEA value less than 0.06 or 0.08 with confidence interval means that the model offers a good fit. The results of a root mean square residual (RMSEA = 0.095) also reveal the adequacy of the factor structure of the knowledge creation measurement at 95% confidence interval. The comparative fit index results summarized in table 3 also indicate that the re-specified model demonstrated a good fit in all aspects and the estimated values, for example, CFI = 0.901, TLI = 0.885, IFI = 0.90, NFI = 0.833 and RFI = 0.806 remained behind the threshold limit. Hence, this result is implying the unidimensionality

Table 3: Comparative fit results based on initial and re-specified models

Model fit Indices	Initial model fit results	Re-specified model fit results	Model fit threshold
Absolute Fit Indices			
Chi-square	575.142	355.736	Smaller the better
Degrees of freedom	344	164	Smaller the better
Ratio of χ^2 to df	1.671	2.169	≤ 2 or 3
Browne Cudeck Criterion	806.825	513.167	Smaller the better
RMSEA	0.072	0.095	$> .05$ but $< .08$ reasonable fit
Comparative Fit Indices			
Comparative Fit Index	0.883	0.901	$0 > CFI > 1$ for acceptance
TuckerLewis Index	0.871	0.885	$0 > TLI > 1$ for acceptance
Incremental Fit Index	0.885	0.902	≥ 0.95 for acceptance
Normed Fit Index	0.755	0.833	≥ 0.95 for acceptance
*Relative Fit Index	0.731	0.806	≥ 0.95 for acceptance
Predictive Fit Indices			
Akaike Information Criterion	755.142	487.736	Smaller the better
Expected Cross-Validation Index	5.809	3.752	Smaller the better
**Parsimonious Fit Indices			
Parsimony-Adjusted NFI	0.687	0.719	Closer to 1 the better
Parsimony-Adjusted CFI	0.803	0.778	Closer to 1 the better

*Similar to CFI but can be negative, therefore, CFI better choice.
 ** Very sensitive to model size
 Source: Carmines and McIver (1981), Hu and Bentler (1999), Browne and Cudek (1993)

of the factor structure.

3.4.2 Validity of knowledge creation scale in the post-hoc scale validation phase

The underlying purpose of the CFA model with a second-order factor (see figure 2) is to facilitate hypothesis testing H1 and to measure convergent and discriminate validity. The factor indicators of the first-order factors SOC, EXT, COM and INT are continuous and indicate the relationship between the latent construct in the model. The first-order factors are indicators of the second-order factor KC.

In this model, SOC is measured by SOC1, SOC2, SOC3, SOC4 and SOC5;

EXT is measured by EXT1, EXT2, EXT3, EXT5 and EXT7; COM is measured by COM1, COM2, COM4, COM5 and COM6 and INT is measured by INT1, INT2, INT4, INT6 and INT7. However, the second-order factor KC is measured by SOC, EXT, COM and INT. The results presented in table 4 show the knowledge creation measurement model. For example, the model fit result of the chi-square ($\chi^2 = 490.414$) indicates that 44 variables (20 observed + 24 unobserved) of SECI knowledge creation construct fit the data reasonably well.

The ratio of chi-square to degree of freedom ($\chi^2/df = 490.414/170 = 2.88$) indicate that the second order CFA model is statistically significant at $p < .000$. Alternatively, the results of other absolute fit indices, for example, BCC = 985.827, BIC = 108.422, CAIC = 1125.422 and RMR = 0.482 also provided a marginally acceptable fit for the knowledge creation measurement model. The comparative fit statistics of second-order CFA demonstrated a good fit in all aspects. All the estimated values, for example, NFI = 0.881, IFI = 0.932, TLI = 0.984, CFI = 0.928 and RFI = 0.832 remained behind the threshold limit.

The three parsimony correction statistics, for example, PNFI = 0.520 and PCFI = 0.562 also demonstrated a good fit to the data. Another, two predictive fit indices results i.e. AIC = 970.414 and ECVI = 7.465 also demonstrated a much better fit according to the benchmark limit. Three alternative fit results, GFI = 0.621, AGFI = 0.532 and RMSEA = 0.080 also indicated that the hypothesized model fits the data well at 90% confidence interval.

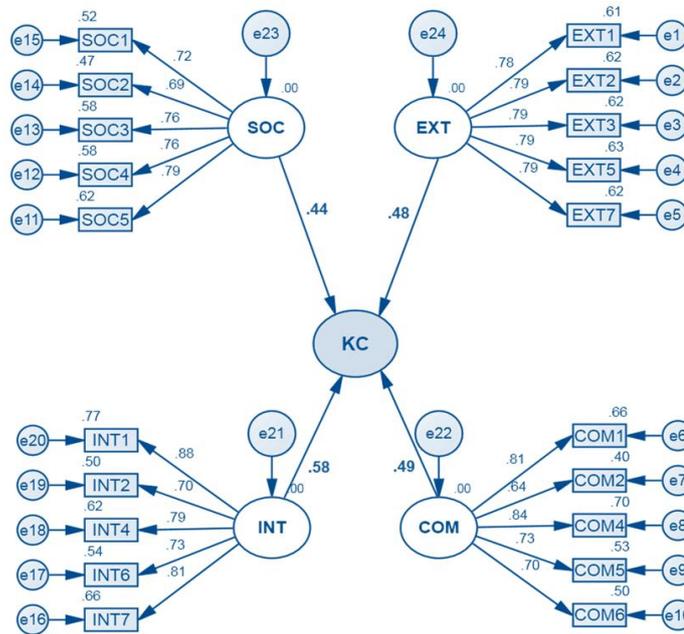


Fig. 2: AMOS path diagram second order CFA estimates

In general, model fit results of second-order CFA model provide a reasonable fit to the data in this study. In other words, all the model fit values presented in table 4 supported the usefulness of the four domains of the knowledge creation theory and items reflect the knowledge creation process in the Pakistani banking organizations. For example, the standardized estimates of this model can be used to evaluate the “relative contribution of each predictor variable” [Arbuckle \(1995\)](#). Following the suggested threshold limit of [Kline \(2015\)](#) the path coefficients ≥ 0.10 represent a small effect, path coefficients ≥ 0.30 represent a medium effect, and path coefficients ≥ 0.50 represent a large effect; the path coefficients of the 20 items and four knowledge creation domains of knowledge creation scale confirmed that the measurement model adequately described the sample data in the Pakistani banking organizations.

For measuring convergent validity of the construct, the researcher utilized the frequently used method typically known as the average variance extracted (AVE). The AVE measures the degree of variance in the indicators accounted for by the latent construct [Hair et al \(2010\)](#). According to [Fornell and Larcker \(1981\)](#), the AVE is a more conservative test of convergent validity as it measures the degree of variance determined by the construct relative to the degree of variance determined by the measurement error.

AVE can be judged to be adequate when the measured value equals or exceeds 0.50. As shown in table 5, the AVE value for SOC is 0.555. It means that the 55.5% of the variance is explained by the SOC construct, and 44.5% due to measurement error. According to [Fornell and Larcker \(1981\)](#), constructs should exhibit estimates of .50 or greater. In case of four dimensions of the knowledge creation scale, the AVE values (i.e. SOC = 0.555, EXT = 0.620, COM = 0.557 and INT = 0.616) demonstrate an acceptable fit according to the benchmark limit.

It validates that the variance captured by the factor is greater than the variance due to measurement error. Thus, variance extracted estimates meet this minimum threshold, so the validity of the latent constructs, as well as the associated constructs, is acceptable. Table 5 also contains the composite reliability (CR) results of the four latent factors included in the model. It found that, all the CR values meet that minimum acceptable level of 0.60 as suggested by [Fornell and Larcker \(1981\)](#).

In order to assess the discriminant validity, AVE values were utilized. [Fornell and Larcker \(1981\)](#) indicated that, discriminant validity can support the construct when AVE estimates are greater than the square of the inter-factor correlation. For instance, the correlation between SOC and EXT is 0.605 and the squared correlation (i.e. 0.605^2) is 0.366. In the case of knowledge creation construct, AVE for SOC and EXT is 0.557 and 0.620 respectively. As both values $0.557 > 0.366$ and $0.620 > 0.366$ they support discriminant validity within the model.

Table 4: Model fit results of second order CFA model

Model Fit Indices	Second Order CFA Model Fit Results	Model Fit threshold limits
Absolute Fit Indices		
Chi-square	490.414	Smaller the better
Ratio of χ^2 to df	2.88	≤ 2 or 3
Browne Cudeck Criterion	985.827	Smaller the better
Bayes Information Criterion	1085.422	Smaller the better
Consistent AIC	1125.422	Smaller the better
Root Mean Residual RMR	0.482	0 indicates perfect fit
Comparative Fit Indices		
Normed Fit Index	0.881	≥ 0.95 for acceptance
Incremental Fit Index	0.932	≥ 0.95 for acceptance
TuckerLewis Index	0.984	$0 > TLI > 1$ for acceptance
Comparative Fit Index	0.928	$0 > CFI > 1$ for acceptance
Relative Non-Centrality Fit Index	0.832	≥ 0.95 for acceptance
Predictive Fit Indices		
Akaike Information Criterion	970.414	Smaller the better
Expected Cross-Validation Index	7.465	Smaller the better
Parsimonious Fit Indices		
Parsimony-Adjusted NFI	0.52	Very sensitive to model size
Parsimony-Adjusted CFI	0.562	Very sensitive to model size
Alternative Fit		
Goodness of Fit	0.621	≥ 0.95 not generally recommended
Adjusted GFI	0.532	≥ 0.95 performances poor in simulation studies
RMSEA	0.08	≤ 0.06 to 0.08 with confidence interval
Source: Carmines and McIver (1981), Hu and Bentler (1999), Browne and Cudek (1993)		
Similar to CFI but can be negative, therefore, CFI better choice		

Table 5: Factor Loadings, AVE, CR and DV Analysis

Items	Std Reg Weight (Factor Loadings)	R / SMC Item Relia- bilities	Measurement Error(δ)	AVE (%)	CR	DV
SOC1	0.72	.720 = .518	1 - .518 = .482			
SCO2	0.688	.688 = .473	1 - .473 = .527			
SOC3	0.763	.763 = .582	1 - .582 = .418	55.5	0.77	0.557 > 0.366
SOC4	0.763	.763 = .582	1 - .582 = .418			
SOC5	0.786	.786 = .618	1 - .618 = .382			
EXT1	0.784	.784 = .614	1 - .614 = .386			
EXT2	0.79	.790 = .624	1 - .624 = .376			
EXT3	0.786	.786 = .617	1 - .617 = .383	62	0.83	0.62 > 0.366
EXT5	0.792	.792 = .627	1 - .627 = .373			
EXT7	0.786	.786 = .617	1 - .617 = .383			
COM1	0.811	.811 = .658	1 - .658 = .342			
COM2	0.635	.635 = .403	1 - .403 = .597			
COM4	0.836	.836 = .699	1 - .699 = .301	55.7	0.77	0.557 > 0.481
COM5	0.726	.726 = .527	1 - .527 = .473			
COM6	0.704	.704 = .496	1 - .496 = .504			
INT1	0.877	.877 = .769	1 - .769 = .231			
INT2	0.704	.704 = .496	1 - .496 = .504			
INT4	0.785	.785 = .616	1 - .616 = .384	61.6	0.83	0.616 > 0.481
INT6	0.733	.733 = .537	1 - .537 = .463			
INT7	0.815	.815 = .664	1 - .664 = .336			

Table 5: continued

AVE (SOC) = .518 + .473 + .582 + .618 = 3.21 = 2.774 / 5 = 55.5%
AVE (EXT) = .615 + .624 + .618 + .627 + .618 = 3.52 = 3.102 / 5 = 62.0%
AVE (COM) = .658 + .403 + .699 + .527 + .496 = 3.27 = 2.783 / 5 = 55.7%
AVE (INT) = .769 + .496 + .616 + .537 + .664 = 3.06 = 3.082 / 5 = 61.6%
CR (SOC) = (.51 + .47 + .58 + .61)2 / [(.51 + .47 + .58 + .61)2 + (.48 + .52 + .41 + .41 + .38)] = 2.772/ 2.772+ 2.22= 0.77
CR (EXT) = (.61 + .62 + .61 + .62 + .61)2 / [(.61 + .62 + .61 + .62 + .61)2 + (.38 + .37 + .38 + .37 + .38)] = 3.102/3.102+ 1.89 = 0.83
CR (COM) = (.65 + .40 + .69 + .52 + .49)2 / [(.65 + .40 + .69+ .52 + .49)2 + (.34 + .59 + .30 + .47 + .50)] = 2.782/2.782+2.2 = 0.77
CR (INT) = (.76 + .49 + .61 + .53 + .66)2 / [(.76 + .49 + .61 + .53 + .66)2 + (.23 + .50 + .38 + .46 + .33)] = 3.082/3.082+ 1.91 = 0.83

Standard regression weights (factor loading) for component factors (i.e., socialisation, externalisation, combination and internalisation).

Item reliabilities are the squared value of each of the factor loadings, e.g., item reliability of SOC1 = .720² = .518

The measurement error (symbolically) is also referred to as the standardized error variance. Here, delta is calculated as 1 minus the squared factor loading (or item reliability), e.g., the SOC1 delta is 1 - .518 = .482
 AVE measures the average amount of variation that a latent construct can explain in the observed variables to which it is theoretically related.

Composite Reliability (CR) can be computed by squaring the sum of factor loading divided by the sum of factor loadings plus sum of standardised error variance (the sum of the variance due to random measurement error for each loading).

Discriminant Validity (DV) is supported if variance extracted estimates are greater than the squared correlation.

4 Discussion

The theory testing results through the adequacy of the hypothesized factor structure using a confirmatory factor analysis confirmed the presence of knowledge creation process in Pakistani banks. According to the findings, the SECI process (i.e. socialization, externalization, combination, and internalization) performed an effective role in the knowledge creation within Pakistani banks. These findings were in agreement with the literature suggesting that the organizational knowledge creation occurs when all knowledge creation modes are organizationally managed to achieve a continual cycle [Nonaka and Takeuchi \(1995\)](#).

The validation of the SECI theory in Pakistani banks indicated that knowledge creation through knowledge conversion modes is not only a Japanese phenomenon, but it can also be applicable in the developing countries. These findings received support from [Von Krogh et al \(2000\)](#) [Glisby and Holden \(2003\)](#) [Haag et al \(2009\)](#) [Andreeva and Ikhilchik \(2011\)](#) which suggest that the SECI model is universally applicable if the right context of knowledge sharing is provided. This finding helps the researcher in understanding how the knowledge creation process is taking place in Pakistani banks through the four knowledge creation modes. For example, the empirical findings indicated socialization as a key antecedent for transfer of tacit knowledge in Pakistani banks.

Bank employees were involved in socialization during face to face interaction, on-the-job and off-the-job trainings. The transfer of tacit knowledge through social interaction in Pakistani banks also confirmed the characteristics of a collectivist society based on strong, cohesive groups and sound moral precepts ([Hofstede and Hofstede, 2005](#)). This finding gets support from [Rodrigues et al \(2006\)](#) that socialization can be achieved with conversation between people when they tend to share ideas and experiences. It implies that the workplace collectivism is a powerful enabler of knowledge sharing and exchange as it encourages cooperation and teamwork that could be significant in the knowledge creation process. This finding also supported the conviction that people are propelled through a strong interaction in which collectivism reinforces the culture of trust and loyalty and encourages socialization in the organization [Wang et al \(2011\)](#).

The process for making tacit knowledge explicit is externalization. In the organizational context, the externalization process can be achieved through facilitating creative and constructive conversations among group members and teams. The findings of this study indicate that the tacit knowledge of staff, colleagues, and group members was converted into explicit knowledge during face to face and online conversations in Pakistani banks. The confirmatory factor analysis showed that the respondents usually were able to explain their thoughts with examples when others cannot understand. Also, knowledge is made explicit through transcribing unorganized thoughts into concrete ideas.

The findings of this study confirmed that people transcribe intangible thoughts into concrete ideas during face to face dialogue with other members. Employees also transform tacit knowledge into explicit knowledge by describing technical or practical terminologies with conversational language, helping others to clarify their points or ideas. According to the findings, employees facilitate creative and constructive conversations among group members in which they help others

express what they have in mind and continue what they are saying. These findings are in agreement with Paz Salmador and Bueno (2007) who suggested that externalization can be achieved when people seek and receive assistance from each other regarding technical terminologies and professional language used in routine communication within the organization.

In terms of the combination process, the present Pakistani banking system allows employees to combine different types of explicit knowledge into a clearer explicit knowledge whilst performing the job. For this, the knowledge management system in Pakistani banks currently uses a method to smooth the process of collecting and updating new information and organizing ambiguous concepts into structure. Factor loading during CFA indicates that employees collect new information and make connections between new and old knowledge. The combination of knowledge is also attained in different workplace engagements, especially when employees are developing criteria to determine the value of new concepts.

However, knowledge combination may well be supported in a mutual environment. Group members tend to organize ideas and make conclusions, facilitate group discussions; apply experiences to help solve problems; take notes and make a summary of every meeting, event or discussion; and organize others thoughts and opinions in their mind Nonaka and Konno (1998). It also confirmed that employees organize ideas and make conclusion to facilitate discussion in which they get help from their previous problem solving experience. These findings are same as those of Rice and Rice (2005) Smith et al (2005) and Schulze and Hoegl (2008). They agreed that when individuals collect and reformulate relevant information and combine it in different activities, they create new knowledge.

The internalization process in knowledge creation facilitates comparing and contrasting existing and new ideas (or concepts) with personal experience in order to understand its meaning. It helps personal understanding by rectifying personal mistakes, and making concepts more eloquent and applicable. In the case of this study, respondents are in agreement that they tend to compare new ideas or concepts with experience to help comprehend the meaning.

In knowledge internalization, knowledge becomes valuable when it is internalized by individuals from tacit knowledge bases and shared mental models Nonaka et al (2000). Bank employees agreed that they combine existing and new concepts in a meaningful way in which they give others time to think about what they just discussed when communicating. The confirmatory factor analysis findings also validated that internalization activities helped Pakistani banks to internalize explicit knowledge into tacit knowledge during the knowledge creation process. It also supported Freeze and Kulkarni (2005) that the decision on knowledge acquisition and transfer originates from within the capabilities provided by a firm's human capital.

The validation of the scale provides an opportunity for banking practitioners to monitor the knowledge creation process within a bank. It will be even more beneficial to see the correlation of the knowledge creation process with other indices such as employee performance and organizational profitability.

5 Limitations

In some cases, unseen methodological issues create major limitations to validity. A confirmatory factor analysis (CFA) and the non-response bias estimates between paper and electronic survey responses are thus used to mitigate the impact of major limitations to validation. For this, numerous types of measures lend themselves particularly well to validity generalization [Schmidt and Hunter \(1998\)](#). Translation validity and criterion related validity provide a validity generalization of the statistical findings.

In spite of the limitations of the final research process including lack of representativeness and validity of statistical findings, the evidence of both convergent and discriminate validity categorically supports that the predictor variable in one specific setting can be generalized to another similar set of situations. For example, translation validity (i.e. face validity and content validity) provides a thorough definition of the construct in terms of method and design. In contrast, criterion related validity (i.e. convergent validity and discriminate validity) is a more relational approach to construct validity in relation to method and design based upon theory of the construct in a more predictable way.

6 Future direction

For this study, a total of 346 cases were drawn from 50 branches of commercial banks in Karachi. Since, additional work is needed, more cases may be required from more than three banks for more credible analysis. Also, this study considered the banking sector only. This implies that some of the results may not apply in other settings. Consequently, it would be interesting to conduct a similar research; for example, in another service sector organization or other related organizations. Nevertheless, the closeness of the findings to general, theoretical predictions may be noteworthy.

For applying the confirmatory factor analysis (CFA) and structural equation modelling (SEM) using a maximum likelihood (ML) method, the sample size must be valid. Similarly, all the conditions must be satisfied before running the CFA and SEM. However, it would be pertinent to conduct the CFA and SEM with a larger sample size for more credible results in any future research.

In terms of literary contribution, this study is an attempt to provide a comprehensive validation framework of the knowledge creation construct. However, it would be highly recommended to identify how these validated constructs act and react to other phenomenon in the industry, in the country and other countries. Indeed, it would be interesting to see the comparison of how these CFA-validated constructs act in Pakistan versus India, or other developing countries alongside Japan or USA, etc.

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