Quantitative assessment of spiritual capital in changing organizations by principal component analysis and fuzzy clustering

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Abstract

Purpose – The purpose of this paper is to illustrate the application of statistical tools and techniques for quantitative assessment of spiritual capital (SC) based on a questionnaire survey in the organizations which undergo large-scale organizational change projects.

Design/methodology/approach – A sample of 65 individuals from three organizations were interviewed. The paper uses the 12 principles of transformation available to spiritual intelligence (referred to as SQ characteristics) to assess SC in a two-phase integrated algorithm of principal component analysis (PCA) and fuzzy clustering.

Findings – The paper proposes a two-phase integrated algorithm. In the first phase, PCA is used to reduce the scores of items related to each of SQ characteristics and aggregate them into a single and unique measure. In the second phase, PCA is applied for total SQ quantification. For verification and validation, fuzzy clustering is employed along with PCA to cluster the people in the survey into different classes, which may possess different stocks of SC and rank them based on their level of SQ. The results of PCA are verified and validated by fuzzy clustering revealing the applicability and usefulness of PCA for SC quantification.

Research limitations/implications – The paper is based on individual judgments about their own SQ characteristics hence the results of questionnaire survey may be biased by individual personal characteristics. Future research can apply the proposed algorithm and check for its reliability using other psychometric instruments available in the field.

Originality/value – The paper contributes by filling a gap in the quantitative management tools literature, in which empirical studies on validated multivariate analysis of spirituality have been scarce until now.

Keywords Fuzzy clustering, Principal component analysis, Spiritual capital, Spiritual intelligence

Paper type Research paper

1. Introduction

In recent years, spirituality has been considered as an element of intelligence because it predicts functioning and adaptation and offers capabilities that enable people to solve problems and attain goals. Zohar and Marshall (2000) defined spiritual intelligence as intelligence with which people address and solve problems of meaning and value, place their actions and live their life meaningfully.

Spiritual intelligence is important to assist a person in finding the deepest and most inner resource from which the capacity to care, the power to tolerate and adapt is obtained. In workplace, spiritual intelligence helps workers in the context of relationships and align personal values with a clear sense of purpose that demonstrate a high level of integrity in work (Chin *et al.*, 2011). As discussed by Zohar and Marshall (2004), spiritual intelligence is a shared field of meaning in the organization hence

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spiritual capital (SC) could be considered as a cultural aspect of the organization, which includes shared motives, common behavior, and joint attitudes. Behavioral change can be brought about by changing in the business culture and the stock of SC could ease the process of transformation or change. Accordingly, one may assume that successful changing organizations that have undergone massive change projects might have benefited from their stock of SC.

Researchers have been gathering evidence that workplace spirituality may offer further insight into organizational effectiveness (Jurkiewicz and Giacalone, 2004). Some reported on the relationships between spiritual intelligence and workforce performance (Karakas, 2010; Rani *et al.*, 2013). Boettke (2010) pursued the notion that the greater the stock of SC, then the lower the transaction costs will be in adopting institutions that promote wealth creation and with it economic development. Howard (2002) examined the significant relationship between spiritual intelligence and learning. Milliman *et al.* (2003) empirically examined the relationship between workplace spirituality and five prevalent employee job attitudinal variables. Rego and Cunha (2008) suggested that when people experience workplace spirituality, they feel stronger sense of commitment and loyalty toward their organizations. These studies have gained new insights into the importance of managing SC in the organizations and indeed managing spirituality first calls for measuring spirituality.

There are research articles aimed to advance psychometric scale development in the burgeoning field of workplace spirituality (King and Crowther, 2004; Moore and Casper, 2006; Petchsawang and Duchon, 2009) and some criticized past literature for their applicability to workplace contexts (Miller and Ewest, 2013). Krahnke *et al.* (2003) discussed implications of extreme objectivity in spirituality research and stated that "Managers in the workplaces/environment will tend to emphasize the measurable (productivity, accountability, equity). The immeasurable and the undefinable will be trivialized or ignored." Therefore, objective measurement of spirituality is a primary issue in this research line. Another issue in measuring spirituality is the multi-faceted nature of spiritual intelligence which makes the measuring instruments to be multivariate. Developing a unique and single measure of spirituality may be of interest especially for comparing spirituality in different workplaces. This paper aims to address this later issue and develop a single and unique measure of spirituality which, in its case, enables comparison of SQ between individuals.

The first step to quantification of SC is to recognize different aspects of spiritual intelligence. Spiritual intelligence involves different concepts. Amram and Dryer (2008) have identified five constructs of spiritual intelligence namely consciousness, transcendence, grace, meaning, and truth. Boettke (2010) stated that SC could promote honesty, trustworthiness, the respect for property, the appreciation of talent, and the recognition of universal humanity and the need for forgiveness and hope for the future. Liu and Robertson (2010) developed a new scale of spirituality which is captured by three correlated, yet distinct, factors: interconnection with a higher power, interconnection with human beings, and interconnection with nature and all living things. Borrowing from nonhuman complex adaptive systems characteristics, Zohar and Marshall (2004) introduced 12 qualities definitive of a human being with spiritual intelligence. These principles of transformation are needed to shift human motives from old attractors to new ones. They are the active principles with which organizations can build SC.

Here, in this paper, we conduct a survey in three changing organizations which undergone large-scale organizational change projects and collect data regarding their stock of SC in terms of their people with high level of spiritual intelligence. The main

purpose of this paper is to develop a quantitative measure to assess the overall level of spiritual intelligence in a given employee. To this end, the paper uses the 12 principles of transformation introduced by Zohar and Marshall (2004) to collect the required data and then assesses SC through a two-phase integrated algorithm of principal component analysis (PCA) and fuzzy C-means (FCM) clustering technique. In the first phase, PCA is used to reduce the scores of items related to each of SQ characteristics and aggregate them into a single and unique measure. In the second phase, PCA is applied for total SQ quantification. For verification and validation, fuzzy clustering is employed along with PCA to calculate an overall SQ score. The results of PCA scoring verified and validated by FCM scoring illustrates the applicability and usefulness of PCA for SC quantification. This is the first study that proposes a verified and validated methodology for total SQ quantification based on data mining techniques.

The remainder of the paper is organized as follows. In Section 2, a brief description of the 12 qualities distinctive of spiritual intelligence is presented. Section 3 illustrates the integrated methodology, survey study, questionnaire design, and data validation. The results of the assessment with PCA and fuzzy clustering are presented in section 4 and. The main findings and proper conclusions are given in the last section.

2. Principles of transformation

This section is devoted to description of the 12 principles of transformation introduced by Zohar and Marshall (2004). These principles also are the main characteristics of the spiritual intelligence. Following each characteristic, a short list of descriptive phrases is given. For comprehensive description of these characteristics, interested reader is referred to Zohar and Marshall (2004):

(1) *Self-awareness.* To know what I believe in and value and what deeply motivates me. Awareness of my deepest life's purposes.

(2) *Spontaneity.* To live in and be responsive to the moment and all that it contains.

(3) *Being vision and value led.* Acting from principles and deep beliefs, and living life accordingly.

(4) *Holism* (a sense of the system or of connectivity). Ability to see larger patterns, relationships, connections. A strong sense of belonging.

(5) *Compassion.* Quality of "feeling-with" and deep empathy. Ground-work for *universal sympathy.*

(6) *Celebration of diversity.* Valuing other people and unfamiliar situations for their differences, not despite them.

(7) *Field independence.* To be able to stand against the crowd and maintain my own convictions.

(8) *Tendency to ask fundamental why? questions.* Need to understand things, to get to the bottom of them. Basis for criticizing the given.

(9) *Ability to reframe.* Stand back from the problem or situation and look for the bigger picture, the wider context.

(10) *Positive use of adversity.* Ability to own and learn from mistakes, to see problems as opportunities. Resilience.

(11) *Humility*. Sense of being a player in a larger drama, sense of my true place in world. Basis for self-criticism and critical judgment.

(12) *Sense of vocation*. Being "called" to serve something larger than myself. Gratitude toward those who have helped me, and a wish to give something back. Basis for the "servant leader."

3. The integrated methodology

Figure 1 shows a step-by-step representation of the integrated methodology. A full description on the theory of PCA and FCM will be presented in this section. In the first step, an SQ questionnaire is designed referring to the 12 characteristics of SQ described in Section 2. Then data are collected using questionnaire and then the reliability of questionnaire will be tested. After reliability test, PCA is used for data reduction. Since each SQ characteristic is tested for by several questions, having a unique measurement for each characteristic is of interest and this is done through PCA. In the next step, the results of data reduction are analysed by PCA and clustering, in parallel. Here PCA is used for calculating an overall SQ score for each of individuals who had filled in the questionnaire. Please note that the application of PCA in this study is twofold. First, PCA is used for data reduction in the sense that the answers of the questions regarding

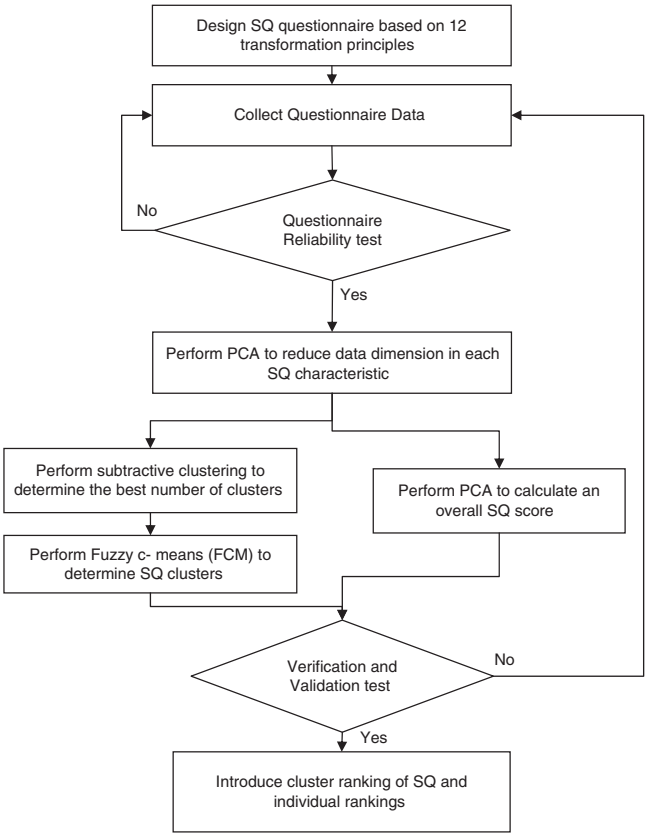

Figure 1.
The integrated methodology for SQ quantification

each of 12 SQ characteristics are reduced to a unique measurement. Hence, the result of the first PCA is a 65×12 reduced matrix indicating the SQ characteristics measurement (in columns) for all the respondents (in rows). Second, the PCA process is applied on the reduced SQ matrix in order to find overall SQ scores for each of the respondents. In parallel with PCA ranking, subtractive clustering is performed to determine the best number of clusters and then FCM is used to determine the cluster centers and the individuals' degrees of membership to each cluster, which enable categorizing and ranking of individuals' SQ. Then the ranking results of PCA and FCM are compared and their correlation is tested through statistical Spearman test. This is performed for verification and validation of PCA results. In the final step, the cluster ranking as well as PCA individual ranking is introduced. Here an overall description of the proposed integrated methodology is presented. Detailed descriptions will be given in the following sections.

3.1 Survey

This study is descriptive and inferential and it was conducted with a total number of 65 key personnel involved in three large-scale organizational change projects in Iran. These projects include adoption a new international market strategy in power supply industry, a merger and acquisition project in construction industry, and a reengineering project in a manufacturer of gas and steam turbines for industrial and power generation.

In Zohar and Marshall (2004), a full description of the principles includes a check section with some questions for checking the status of each characteristic in a person. The full list of these check questions are presented in the Appendix. As examined by Zohar and Marshall (2004), these questions can be combined in a questionnaire for qualitative measurement of spiritual intelligence. Accordingly, the spiritual intelligence questionnaire of this study includes 59 questions. Every five questions check for a single characteristic except for *Celebration of diversity* which involves four questions.

Statistical population of this survey included about 200 key personnel involved in three large-scale organizational change projects in Iran. To determine the sample size, the Kukran formula was used and a sample size of 65 key personnel was calculated. In order to adjust for return rate, questionnaires were distributed 25 percent more than the calculated sample size and finally 65 filled questionnaires were verified to be included in the analysis.

The authors have held several meetings with the respondents in each project to closely communicate the concepts of spiritual intelligence and definitions encountered in the questionnaire. Please note that the respondents are asked to answer the questions bearing in mind a working context rather than a living context. By working context we mean those circumstances and situations which are more related to work and organization issues. Regarding each question, respondents answered with a six-point Likert scale (never or almost never; very infrequently; somewhat infrequently; somewhat frequently; very frequently; always or almost always), showing their agreement/disagreement with the question statement.

The questionnaire was answered by 65 key personnel and its validity and reliability was checked with Cronbach's α coefficient. According to Majid (1997), the acceptance level of Cronbach's α coefficient in assessment of personnel skills and attitudes is 0.7 or above. These coefficients for the 12 characteristics of spiritual intelligence are calculated in Table I, indicating that the result of questionnaires is accepted and admissible.

Table I.
Cronbach's α coefficients for the 12 SQ characteristics

SQ characteristic	Self-awareness	Spontaneity	Vision and value led	Holism	Compassion	Diversity	Field independence	Asking why?	Reframing	Use of adversity	Humility	Sense of vocation
Cronbach's α	0.79	0.87	0.70	0.84	0.70	0.70	0.80	0.70	0.71	0.81	0.74	0.79

To achieve the main objective of the present study, the collected data are processed by two data mining methods of PCA and FCM. The theories of these methods are presented in the following sections.

3.2 PCA

PCA is widely used in multivariate statistics and usually applied for data reduction. The objective of PCA is to identify a new set of variables such that each new variable, called a principal component, is a linear combination of original variables. The first new variable $y1$ accounts for the maximum variance in the sample data and so on. The new variables (principal components) are uncorrelated. PCA is performed by identifying the eigen-structure of the covariance or singular value decomposition of the original data. PCA also is used for ranking of DMUs. This ranking is based on finding some weights for the variables based on combining the eigen values and eigen vectors of the covariance/correlation matrix. A precise description of procedure of ranking with PCA can be found in Zhu (1998) and Premachandra (2001).

3.3 Subtractive clustering

Since, there is no optimal solution for the best number of clusters in FCM, prior to FCM, subtractive clustering is used to determine the number of clusters for SQ. The subtractive clustering method assumes each data point is a potential cluster center and calculates a measure of the likelihood that each data point would define the cluster center, based on the density of surrounding data points. The algorithm does the following:

(1) Selects the data point with the highest potential to be the first cluster center.

(2) Removes all data points in the vicinity of the first cluster center, in order to determine the next data cluster and its center location.

(3) Iterates on this process until all of the data are within a pre-determined acceptable vicinity of a cluster center.

Subtractive clustering method is an extension of the mountain clustering method proposed by Yager and Filev (1994). To perform subtractive clustering, *subclust* function in fuzzy logic toolbox of MATLAB® software is used.

3.4 FCM

FCM is a method of clustering which allows one piece of data to belong to two or more clusters. This method, developed by Dunn (1973) and improved by Bezdek (1981), is frequently used for clustering applications. It is based on minimization of the objective function (1):

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^{m}\left\|x_i - c_j\right\|^2 \tag{1}$$

where m is any real number greater than 1, u_{ij} is the degree of membership of x_i in the cluster j, x_i is the ith of d-dimensional measured data and ||*|| is any norm expressing the similarity between any measured data and the center.

Fuzzy partitioning is carried out through an iterative optimization of the objective function shown above, with the update of membership u_{ij} and the cluster centers c_j by:

$$u_{ij} = \sum_{k=1}^{C}\left(\frac{\left\|x_i - c_j\right\|}{\left\|x_i - c_k\right\|}\right)^{\frac{-2}{m-1}} \text{ and } c_j = \frac{\sum_{i=1}^{N} u_{ij}^{m}.x_i}{\sum_{i=1}^{N} u_{ij}^{m}} \tag{2}$$

This iteration will stop when $\max_{ij}\left\{\left|u_{ij}^{(k+1)}-u_{ij}^{(k)}\right|\right\}<\varepsilon$, where ε is a termination criterion between 0 and 1, and k is the iteration step. In the application of FCM in this study, the MATLAB default values of 2 for m, 1e-5 for ε and maximum of 100 for k are considered.

4. Results

4.1 PCA data reduction results

As mentioned before, the application of PCA in this study is twofold. First, PCA is used for data reduction in the sense that the answers of the questions regarding each of the 12 SQ characteristics are reduced to a unique measurement. Hence, the result of the first PCA is a 65×12 reduced matrix indicating the SQ characteristics measurement (in columns) for all the respondents (in rows). Second, the PCA process is applied on the reduced SQ matrix in order to find overall SQ scores for each of the respondents. The PCA process is implemented using the *princomp* function in MATLAB and the efficiency scores are mapped into interval [1,6]. Therefore, the respondent with PCA-SQ Score of 6 is the respondent with the highest spiritual intelligence level.

4.2 PCA-SQ scoring results

For these 65 respondents, a PCA is designed to rank them and determine the respondents with high SQ; 12 SQ characteristics with the reduced data of Section 4.1 are considered as PCA variables. The PCA process is implemented using the *princomp* function in MATLAB and the results are presented in the last column of Table II. Please note that the SQ scores are mapped into interval [1,6] hence the respondent with PCA-SQ score of 6 is the respondent with the highest spiritual intelligence level.

4.3 Fuzzy clustering results

In the application of fuzzy clustering for SQ quantification, first subtractive clustering is applied on the data of the first 12 columns in Table II and three clusters are formed. Therefore, the number of clusters in FCM is considered to be three. Moreover, FCM is applied on the data of the first 12 columns in Table II in order to find the cluster centers. Results of cluster centers are presented in Table III and the results of membership degrees are presented in the first three columns of Table IV. For instance, the first row indicates that Respondent No. 1 is powerfully belongs to the third cluster c_3 with the membership degree of 0.997. This respondent can also be considered to belong to the first and the second cluster with membership degrees of 0.002 and 0.001, respectively.

Here we use FCM cluster centers as well as membership degrees for SQ quantification. It should be noted that the FCM membership degrees can be served as a criteria for SQ scoring. For example if a respondent highly belongs to the second cluster, it means that this respondent is high in SQ. This is true because the second cluster dominates other clusters in every SQ characteristic. In other words, the central vector of cluster 2 is greater than the central vectors of clusters 1 and 3. Here we propose to use a sum-product of membership degrees and cluster centers as a criteria for SQ scoring. The following equation represents this sum-product relationship in a concise way:

$$FCM\_SQ_i = \sum_j u_{ij} \times \hat{c}_j \tag{3}$$

Table II.
The results of PCA data reduction and PCA-SQ quantification

	Self-awareness	Spontaneity	Vision and value led	Holism	Compassion	Diversity	Field independence	Asking why?	Reframing	Use of adversity	Humility	Sense of vocation	PCA-SQ
Resp1	2.1	1.9	2.1	1.8	2.8	2.4	2.4	4.6	2.1	2.1	1.8	2.1	1.45
Resp2	5.6	5.5	5.8	5.1	5.5	4.7	5.4	2.4	4.6	5.2	5.4	5.5	5.98
Resp3	3.5	3.3	4.3	2.8	1.9	3.7	4.3	2.1	4.6	2.2	3.5	4.3	3.74
Resp4	2.3	1.4	1.7	1.7	1.7	1.0	2.3	4.9	2.5	2.1	2.8	2.1	1.27
Resp5	5.5	4.6	6.0	5.4	4.6	4.8	5.3	3.3	4.1	4.3	4.3	5.5	5.44
Resp6	2.5	3.8	4.9	3.2	1.7	5.1	3.5	2.8	5.2	2.2	4.3	4.5	3.99
Resp7	1.2	2.6	2.6	1.3	3.3	2.1	2.7	4.0	2.6	1.8	1.9	3.5	1.82
Resp8	5.0	4.5	5.0	5.5	5.8	5.5	4.9	2.9	4.8	5.2	4.8	5.2	5.59
Resp9	3.6	4.0	4.0	1.7	1.3	3.1	4.8	2.3	3.4	2.1	3.8	3.0	3.33
Resp10	3.1	1.2	2.7	1.7	2.8	3.2	2.4	4.4	2.1	1.9	1.0	1.5	1.48
Resp11	5.2	4.8	5.6	5.1	4.2	4.0	4.7	1.4	4.8	5.6	4.8	5.8	5.71
Resp12	3.7	2.9	4.5	3.5	1.9	3.9	3.4	2.5	4.7	2.7	4.0	5.1	3.93
Resp13	1.9	2.4	1.8	1.1	3.1	1.4	2.5	4.1	1.6	3.2	1.4	1.1	1.24
Resp14	5.5	5.0	4.5	5.1	4.6	4.4	5.1	2.9	4.5	5.4	4.8	4.6	5.32
Resp15	3.7	3.1	5.5	2.2	1.7	4.0	4.0	2.7	3.3	1.9	4.6	5.0	3.81
Resp16	3.3	2.4	2.8	1.9	2.2	3.6	2.8	5.9	1.8	2.2	2.3	1.0	1.64
Resp17	4.7	5.0	4.3	4.8	6.0	5.4	4.6	1.1	4.4	4.9	5.4	4.4	5.52
Resp18	2.9	3.3	3.9	3.0	2.2	3.0	4.8	2.6	4.6	2.6	3.5	5.2	3.75
Resp19	1.2	1.9	1.5	1.9	1.9	3.7	3.0	5.3	1.1	1.5	1.4	1.9	1.05
Resp20	5.6	5.4	4.7	4.4	5.1	5.3	5.8	1.3	5.5	4.9	5.2	5.6	6.00
Resp21	3.9	3.0	3.9	3.3	1.3	4.3	4.1	2.3	4.9	2.0	3.0	4.6	3.73
Resp22	3.3	1.1	1.9	1.8	2.0	3.4	2.6	4.6	2.6	2.2	1.7	2.9	1.71
Resp23	5.7	5.9	4.8	3.8	5.4	5.2	6.0	2.3	2.9	5.7	4.9	5.8	5.68
Resp24	3.4	3.3	5.6	3.5	1.0	4.8	4.1	3.5	4.8	2.6	3.6	5.1	4.03
Resp25	1.7	2.3	1.2	1.0	2.7	2.8	1.8	3.5	1.6	1.6	2.1	2.3	1.32
Resp26	4.7	5.6	5.9	5.1	5.2	5.0	5.3	2.5	4.7	4.8	5.3	5.4	5.82
Resp27	3.7	3.8	4.3	3.5	1.8	3.3	4.3	2.3	2.9	2.0	2.9	4.2	3.54
Resp28	2.5	2.4	3.0	1.6	3.8	3.1	2.5	3.5	1.5	2.6	2.3	1.6	1.97
Resp29	5.1	5.1	4.0	5.3	4.7	5.0	5.5	2.9	4.4	3.8	4.7	5.0	5.22
Resp30	3.8	3.1	3.8	2.8	1.4	4.5	3.6	2.9	5.4	2.7	3.8	4.4	3.75
Resp31	2.4	2.0	2.5	1.7	2.5	2.1	2.3	3.8	2.6	1.9	2.1	2.3	1.74
Resp32	5.3	4.7	4.3	5.5	5.0	5.1	4.4	2.2	4.9	5.2	5.3	4.9	5.51

(*continued*)

Table II.

	Self-awareness	Spontaneity	Vision and value led	Holism	Compassion	Diversity	Field independence	Asking why?	Reframing	Use of adversity	Humility	Sense of vocation	PCA-SQ
Resp33	3.2	3.4	4.9	2.7	1.3	3.9	4.4	2.7	4.8	2.0	3.3	4.8	3.75
Resp34	2.0	1.2	1.9	1.7	3.8	1.1	1.3	5.4	2.6	1.0	1.4	2.4	1.00
Resp35	4.1	5.5	5.5	4.3	5.3	4.3	4.3	2.4	4.3	6.0	4.8	4.8	5.34
Resp36	3.2	2.5	5.6	2.7	2.2	5.2	4.5	2.6	5.0	3.3	2.7	4.1	3.91
Resp37	3.2	1.0	2.1	2.2	2.6	1.9	1.0	4.2	2.3	1.6	1.4	2.2	1.30
Resp38	5.2	5.7	4.7	5.5	5.1	4.9	5.6	2.3	5.6	5.0	5.5	5.0	5.95
Resp39	2.9	3.2	3.3	2.8	2.6	4.1	3.8	2.3	4.5	2.3	3.1	4.4	3.50
Resp40	2.6	2.3	2.3	1.2	1.9	2.8	1.2	5.2	3.1	1.2	1.8	1.6	1.26
Resp41	4.9	4.9	5.8	5.2	5.0	4.4	4.8	3.4	6.0	4.5	5.0	4.7	5.51
Resp42	2.3	3.6	4.9	2.3	1.6	4.8	5.0	2.5	4.1	2.7	3.7	4.5	3.84
Resp43	1.9	1.6	1.4	1.5	3.5	1.6	2.8	4.5	3.2	2.3	1.4	2.9	1.53
Resp44	4.7	5.0	5.2	4.7	5.0	5.1	5.0	1.5	5.3	5.7	5.1	5.2	5.81
Resp45	4.2	3.1	2.9	2.4	2.0	2.6	3.6	2.4	5.8	1.8	3.3	3.2	3.31
Resp46	1.4	2.0	2.3	2.0	2.7	3.6	3.0	4.7	1.9	2.2	2.8	1.7	1.70
Resp47	5.3	5.6	5.7	4.8	5.8	3.9	5.9	2.4	6.0	4.1	5.3	4.7	5.87
Resp48	3.6	3.3	4.7	2.9	1.7	3.7	4.2	2.2	3.2	2.3	2.9	3.9	3.49
Resp49	2.7	1.8	2.2	1.3	2.8	3.2	2.0	6.0	2.4	1.3	1.6	2.3	1.29
Resp50	5.1	6.0	4.4	5.4	4.2	4.2	4.8	1.0	2.9	4.2	5.3	5.6	5.46
Resp51	2.5	2.6	5.5	2.6	1.4	2.7	3.6	2.0	4.3	2.6	3.7	3.9	3.46
Resp52	2.6	1.4	1.9	1.3	2.7	2.1	2.6	4.1	3.5	1.4	2.0	2.1	1.57
Resp53	4.7	4.9	5.6	4.7	5.2	5.1	5.5	2.5	5.3	4.2	6.0	6.0	5.86
Resp54	1.9	2.8	4.0	3.1	1.9	3.8	3.4	3.3	4.7	2.5	3.3	4.4	3.28
Resp55	1.3	2.3	2.6	1.6	2.9	1.7	3.1	4.1	1.9	2.7	1.7	1.7	1.52
Resp56	4.5	4.7	4.8	4.6	5.0	2.9	5.6	2.5	4.4	4.7	5.2	4.6	5.13
Resp57	1.9	3.3	4.8	1.9	2.1	4.3	3.8	2.5	4.7	1.7	4.0	4.5	3.56
Resp58	1.0	2.1	1.7	2.3	3.4	2.2	3.2	4.4	2.2	2.5	2.0	2.1	1.59
Resp59	4.6	4.8	5.9	6.0	4.5	3.6	5.0	2.2	3.7	5.6	5.7	4.8	5.53
Resp60	3.2	2.9	3.8	3.7	2.3	4.4	4.7	2.7	4.0	1.7	3.4	3.8	3.55
Resp61	2.0	1.0	2.4	1.7	1.7	1.5	2.8	5.5	3.5	2.7	2.4	1.7	1.40
Resp62	6.0	4.4	5.2	5.4	5.1	6.0	4.9	2.0	3.4	4.7	4.9	4.8	5.54
Resp63	4.6	3.6	3.7	1.8	1.9	4.0	4.4	1.9	4.2	1.8	3.7	3.7	3.64
Resp64	1.0	1.1	1.0	2.3	2.3	3.0	2.8	5.1	1.0	2.4	1.3	2.7	1.04
Resp65	5.5	4.4	5.0	5.4	5.2	3.6	5.0	1.9	4.5	5.4	5.1	4.7	5.48

SQ characteristic	Self-awareness	Spontaneity	Vision and value led	Holism	Compassion	Diversity	Field independence	Asking why?	Reframing	Use of adversity	Humility	Sense of vocation	Average cluster center (€)
Cluster center													
Cluster Center 1	3.2	3.2	4.4	2.8	1.8	4.0	4.1	2.6	4.4	2.3	3.5	4.3	*3.4*
Cluster Center 2	5.1	5.1	5.1	5.0	5.0	4.7	5.1	2.3	4.6	5.0	5.1	5.1	*4.8*
Cluster Center 3	2.1	1.8	2.1	1.7	2.7	2.4	2.4	4.6	2.3	2.0	1.9	2.1	*2.3*

Table III.
The results of FCM cluster centers

Respondents	u_1	u_2	u_3	FCM_SQ
Resp1	0.002	0.001	0.997	2.35
Resp2	0.030	0.958	0.012	4.70
Resp3	0.976	0.012	0.012	3.39
Resp4	0.095	0.034	0.870	2.53
Resp5	0.104	0.860	0.036	4.54
Resp6	0.820	0.103	0.077	3.45
Resp7	0.141	0.043	0.816	2.59
Resp8	0.055	0.922	0.023	4.64
Resp9	0.737	0.101	0.162	3.36
Resp10	0.087	0.031	0.882	2.51
Resp11	0.083	0.888	0.028	4.58
Resp12	0.882	0.068	0.050	3.43
Resp13	0.096	0.042	0.862	2.55
Resp14	0.050	0.930	0.020	4.65
Resp15	0.801	0.105	0.095	3.43
Resp16	0.157	0.062	0.781	2.66
Resp17	0.097	0.862	0.041	4.53
Resp18	0.862	0.071	0.067	3.42
Resp19	0.118	0.044	0.838	2.57
Resp20	0.079	0.893	0.028	4.59
Resp21	0.901	0.049	0.050	3.40
Resp22	0.124	0.037	0.839	2.56
Resp23	0.128	0.814	0.058	4.45
Resp24	0.801	0.116	0.082	3.46
Resp25	0.095	0.034	0.871	2.52
Resp26	0.033	0.955	0.012	4.69
Resp27	0.792	0.095	0.113	3.40
Resp28	0.149	0.058	0.793	2.64
Resp29	0.107	0.857	0.037	4.53
Resp30	0.872	0.065	0.063	3.41
Resp31	0.050	0.014	0.936	2.43
Resp32	0.049	0.932	0.019	4.65
Resp33	0.943	0.029	0.029	3.40
Resp34	0.108	0.047	0.846	2.57
Resp35	0.096	0.865	0.039	4.54
Resp36	0.764	0.132	0.104	3.46
Resp37	0.099	0.037	0.863	2.54
Resp38	0.047	0.934	0.018	4.66
Resp39	0.877	0.053	0.070	3.39
Resp40	0.109	0.037	0.855	2.55
Resp41	0.107	0.855	0.038	4.53
Resp42	0.856	0.077	0.067	3.42
Resp43	0.089	0.033	0.878	2.52
Resp44	0.051	0.931	0.018	4.65
Resp45	0.669	0.123	0.208	3.34
Resp46	0.105	0.036	0.859	2.54
Resp47	0.104	0.855	0.040	4.53
Resp48	0.872	0.055	0.073	3.39
Resp49	0.088	0.033	0.879	2.51
Resp50	0.170	0.766	0.064	4.38
Resp51	0.801	0.083	0.116	3.38

Table IV.
The results of FCM membership degrees and FCM-SQ quantification

(*continued*)

Respondents	u_1	u_2	u_3	FCM_SQ
Resp52	0.079	0.024	0.897	2.48
Resp53	0.084	0.887	0.029	4.58
Resp54	0.833	0.061	0.106	3.36
Resp55	0.081	0.030	0.889	2.50
Resp56	0.125	0.829	0.046	4.48
Resp57	0.849	0.067	0.085	3.39
Resp58	0.083	0.032	0.885	2.51
Resp59	0.105	0.853	0.042	4.52
Resp60	0.849	0.069	0.082	3.40
Resp61	0.126	0.044	0.831	2.58
Resp62	0.105	0.852	0.043	4.52
Resp63	0.793	0.097	0.110	3.41
Resp64	0.115	0.047	0.838	2.58
Resp65	0.056	0.922	0.022	4.64

Table IV.

Where u_{ij} is the membership degree of respondent i to the cluster j, and $\hat{c}_j$ is the average of cluster center j, and FCM_SQ_i is the SQ score that is calculated for respondent i by the FCM approach. For FCM_SQ results, see the last column in Table IV.

4.4 Comparison

The spearman correlation coefficient between SQ scores of PCA and FCM is 0.9842 which is significant at 99 percent confidence level. This significant correlation indicates that the results of PCA for SQ quantification is verified by the results of FCM clustering and this can be served for verification and validation of the SQ results. The results of SQ quantification in a descending order are presented in Figure 2. The FCM-SQ scores exhibit a stepwise decrease in three levels referring to three FCM clusters and as seen these clusters are also formed in PCA-SQ scoring. However, the results of PCA are different from FCM in that in each cluster, PCA differentiates more between respondents and this may be considered as an advantage of PCA over FCM because PCA is more sensitive to the changes in SQ level.

5. Conclusion

This paper proposed an integrated methodology for quantitative assessment of spiritual intelligence. The paper designed a 59-item validated and reliable questionnaire and used it to assess SQ characteristics. The analysis was based on questionnaire

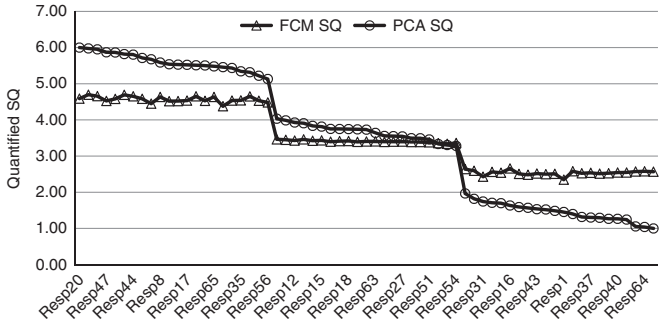

Figure 2.
Comparison of FCM-SQ and PCA-SQ quantification results

survey in the organizations which undergo large-scale organizational change projects. The paper employed PCA for both data reduction and ranking. First, the results of questionnaire are reduced to 12 SQ characteristics measurements and then PCA is applied for total SQ quantification. For verification and validation, FCM results was calibrated to calculate an overall SQ score and then the correlation test of the PCA and FCM results was based for verification and validation. The results of the case study showed that there were a significant correlation between the results of PCA and FCM. However, PCA may be preferred due to its sensitivity to the changes in SQ level. The main finding of the paper is to unveil the applicability and usefulness of PCA for SC quantification.

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Appendix. A psychometric instrument based on Zohar and Marshall (2004)

Self-awareness check:

- Do you have much sense of an inner life?
- At the end of the day, do you reflect on the day's events and experiences?
- Do you have any sense of a deeper presence within you?
- Are you comfortable with silence?
- Can you confront uncomfortable truths about yourself?

Spontaneity check:

- Do you follow your gut instincts, even if it means taking risks?
- Do you allow yourself to be open and vulnerable with others?
- Do you enjoy talking to and playing with young children?
- Do you ever feel an ecstatic sense that the whole of reality or existence is present for you now, "in this moment"?
- Do you feel that an underlying sense of direction or inner compass guides you?

Vision and values check:

- Are you motivated by ideals like helping others or serving some higher cause?
- Do you live by your ideals?
- Do you feel called upon "to go that extra mile" to bring excellence to whatever you do?
- Do you feel inspired by great leaders or public figures, historical or contemporary?

- Do you reflect on questions like the meaning of life, the purpose of your life, the meaning behind your work or relationships?

Holism check:

- Do you tend to look for relationships between apparently different things?
- Do you look for a wider context into which you can put problems or events?
- Do you have a sense that events or problems that come to your attention are interconnected?
- Do you have experiences of anticipating or knowing the unspoken thoughts of others, or sense a flow of energy coming from other people?
- Do you ever have a sense of everything being permeated by infinite love, infinite clarity or infinite presence?

Compassion check:

- Do you feel the feelings of others? Their pain? Their joy?
- Have you ever felt a universal sense of gentleness or nurturing love?
- Would you agree with the statement, "I am my brother's keeper because my brother is myself"?
- Have you ever felt a sense of reverence or awe for all of existence?
- Can you empathize with the pain, suffering, or anger of people who radically disagree with you, or who may even be a threat to you?

Diversity check:

- Do you relate easily to people who are different from yourself?
- At a party, do you reach out to meet new people rather than chatting to those you already know?
- Do you feel there is more than one way to solve a problem or reach a goal?
- When having a conversation with people you disagree with, can you see their side of the issue?

Field independence check:

- Are you willing to stand by your convictions when all around you disagree?
- Are you willing to be unpopular in a good cause?
- Do you dress to please yourself instead of others?
- Do you enjoy your own company?
- Do you consider carefully and listen to others before going your own way?

Why? check:

- Do you try to understand the meaning behind rules, customs, and events?
- Are you dissatisfied with first explanations?
- Do you like to glean the thinking behind other people's pronouncements, to understand "where they are coming from"?
- Do you sometimes reflect on cultural or behavioral trends and wonder why they are as they are?
- Do you like to keep up to date with current affairs?

Reframing check:

- Are you good at looking at questions from many angles?
- Do you go outside your comfort zone when seeking new experiences?
- Do you "cast your net wide" for information that might bear on the problem at hand? That is, do you go outside the box?
- Do you question the value of things' being left just as they are?
- Are you good at seeing the big picture?

Use of adversity check:

- Do you learn from and grow beyond past failures?
- When bad things happen to you, do you find some way to carry on despite them?
- Do you bounce back reasonably quickly from periods of gloom or dark depression?
- Does the loss of certainties lead you to a deeper faith or vision?
- Do you find some reason to cling to ideals despite all the evil and mess in the world?

Humility check:

- Are you happy to recognize that you are but one player in a larger drama?
- If you make a mistake, can you admit it gracefully?
- Do you think that your importance comes from something larger than yourself? That you owe your gifts to a deeper or higher source?
- Do you remain open to the suggestions and contributions of others, even if they take you by surprise?
- Do you accept that you have limitations, that there is only so much that you can or should do?

Sense of vocation check:

- Do you feel that you want your life to "make a difference"?
- When someone does you a favor, do you feel you should pass a gift on to the next person?
- Do you feel called upon to repay all the good things that have been given to you in life?
- Do you feel a sense of responsibility to others, the community, or the world that goes beyond your official duty or commitments?
- Do you feel your life has a sense of direction that you should follow?

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