Principal Component Analysis on Morphological Variability of Critical Success Factors for Enterprise Resource Planning

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***Abstract*—The concept of critical success factors (CSFs) has been widely used as a measure to tackle the hurdles associated with numerous implementations of enterprise resource planning (ERP) systems. This study evaluates the morphological variability of CSFs using the analytical principal component analysis technique to identify principal components (PCs) that can be adopted for a successful ERP system implementation. The dataset of 205 CSFs from 127 different studies was evaluated for the morphological variability in those studies. According to the results, 66 PCs were identified and ranked accordingly. The first 49 PCs with eigenvalues greater than 1 accounted for 89.67 % of the variability recorded. The first 6 PCs respectively accounted for 13.67%, 19.37%, 24.67%, 29.41%, 33.52% and 36.94% cumulative variations. In general, the graphical illustration of the study results show the palpable division between the taxonomic groups for 3 PCs.**

Keywords*—Enterprise resources; morphological variability; principal component; resource planning; success factor

I. Introduction

Critical success factors (CSFs) have been identified to be an essential precept for a successful ERP system implementation [1]. A critical success factor is a variable that has a significant impact on delivering a measurable improvement to project success [2]. The relevance of CSFs classification in ERP systems has been emphasised in various studies using different methods [1,3]. Certain authors, Hentschel, Leyh and Baumhauer [4] as well as Denolf, Trienekens, Wognum, van der Vorst and Omta [5], have postulated that despite the strong focus on avoiding failure in system implementation using CSFs approach, CSFs remain rarely researched. On the other hand, Saxena and McDonagh [6], have contended that CSFs remain the most-researched areas over the past years within the domain of enterprise systems.

However, despite this contention, there exists a consensus among researchers that CSF is a highly significant concept that can help address the inherent challenges associated with ERP system implementation [7]. Moreover, this has led to the identification of diverse CSFs in the literature. Consequently, the overarching objective of this study is to apply principal component analysis (PCA) to analyse morphological variability of CSFs for successful implementation of ERP systems. The realisation of the objective of this study affords the following distinctive contributions. An enhanced understanding of the concept of CSFs that acknowledges their morphological variability for an efficacious implementation of ERP systems. The application of a robust analytical method to provide valued acumen to the CSFs phenomena of ERP system implementation. The remainder of this paper is succinctly summarized as follows. The next section provides the background discussion with respect to the related literature. This is followed by the description of the material and methods of the study. Next is the presentation of results and discussion and the paper is briefly concluded.

II. Background

The nature of CSFs has been reported in the literature to be inconsistent and repetitive, yielding the need for more analytical scientific methods [8-10]. Epizitone and Olugbara [11] highlighted this need by emphasising on the holistic nature of CSFs in different application settings. This view is further supported by the adoption of a mixed method research approach to tackle the complex phenomena of CSFs [12]. The determination of morphological variability of CSFs is a significant part of a successful implementation of an ERP project. The significance of CSFs classification has been emphasised in various related studies with a lot of attentions paid to the importance of CSFs and the success of ERP system implementations [9]. Consequently, the application of PCA to extract relevant information regarding CSFs from a large dimensional dataset is considered to enhance a deeper understanding of the intrinsic characteristics of CSFs [13].

PCA is a useful mathematical technique for emphasising variations and exposing hidden patterns in a dataset. It is predominantly applied for dimensionality reduction in application domains such as computer vision and pattern discovery in data mining [14]. It has been successfully used to specify principal components in varieties of datasets in many other areas of data science [14-18]. The technique has the potential to reveal essential characteristics while capturing the main structures of CSFs variability [19]. It is useful for discovering, reducing and identifying meaningful variables in a dataset. Hanci and Cebeci [15] have reported PCA to be a multivariate statistical technique with the capability of converting a lot of likely correlated factors into a set of smaller factors called principal components (PCs). The direction of the first PC is the same with the largest eigenvalue allied with its

eigenvector. While the direction of the second PC is determined by the eigenvector, which is related to the second largest eigenvalue.

The PCA technique involves a mathematical procedure that is based on the eigen analysis, which computes eigenvalues and corresponding eigenvectors of a square symmetric matrix with sums of squares and cross products [20]. The paramount objective of this study as earlier stated is to apply the PCA technique to analyse morphological variability of CSFs for successful implementation of ERP systems. The analysis technique would help to identify different PCs for promoting ERP system adoption [21]. It is assumed that the results of this study will provide the knowledge of CSFs that is appropriate for use in a successful implementation of an ERP system.

III. Material and Methods

In this study, a total of 205 CSFs identified from 127 studies [22-27] was compiled and represented in a binary format displaying the feature of the identified variables for further analysis. The study dataset shown in Table S1 describes each factor as well as provides 205 qualitative CSFs and 127 quantitative instances that are suitable for PCA. The dataset was subjected to PCA to characterise the CSFs and identify the weight of each factor. The PCA technique was applied to a transformed dataset that was standardised into units of classes and attributes to determine the morphological variability. The number of PCs was determined using the minimal eigenvalue of unity called Kaiser criterion [28]. The dataset consisted of attributes 1 to 205 coded numerically as @ ATTRIBUTE F1-F205, while the related papers investigated for the extraction of factors were coded as @ATTRIBUTE class (P1-P127). All statistical procedures for the evaluation of morphological variability were obtained using the IBM SPSS statistics version 25 and WEKA 3.8.3. These statistical tools mutually afford an added validation advantage in identifying variations among the CSFs for ERP system implementation. The focus was on their morphological variation as it influences implementation success whilst providing the chance to analyse more than one factors in association.

IV. Results and Discussion

Table S2 illustrates the 66 PCs and 49 PCs identified by WEKA and SPSS with their corresponding eigenvalue, variance, and cumulative percentage. The WEKA statistical software identified 66 PCs with eigenvalue 28.015 to 0.518, variance 13.667 to 0.253 and cumulative variance 13.666 to 95.205 %. Each component of the 49 PCs identified by the IBM SPSS accounted for the following percentage range: eigenvalue 28.015 to 1.007, variance 13.667 to 0.491 and cumulative variance 13.666 to 89.199. The 49 PCs identified by the SPSS tool also featured in the 66 PCs identified by the WEKA software and they constitute the first 49 components in the WEKA result. These 49 components only consider the eigenvalues that are greater than unity as in other studies that applied PCA to different practical problems [28-30]. However, the 49 PCs had eigenvalue ranging from 28.015 for the first component to 1.007 for the last component. In addition, the 17 subsequent PCs had eigenvalues less than unity falling in the range of 0.962 to 0.517 for the PC 50 and PC 66, respectively.

Fig. 1 shows the ranking of the 66 PCs with the first six components respectively having the following scores: 86.33%, 80.00%, 75.36%, 70.59%, 66.45% and 63.06%.

The Vendor (F1) extraction value for PC represents the lowest value of 0.631, while the maximum extracted values are for F31-Professional training services, F32-Setting realistic deadlines, F37-User participation in defying new processes, F58-Deep understanding strategy, F60-Former major change experience, F81-Business change is first to be considered, F85-Level of implementation acceleration, F139- Opportunities for growth and F146-Data model is compatible with data requirements. It can be noted from the first component that these factors loadings were integrated to account for the high eigenvalue.

The first 6 PCs cumulative variations are 13.67%, 19.37%, 24.67%, 29.41%, 33.52% and 36.94% respectively as shown in Table I. These PCs can be seen to be distinctively illustrated by screen plot in Fig. 2, while Fig. 3 represents the component transformation matrix and Fig. 4 is the component matrix. These results illustratively provide the appropriate visualisation of the CSFs morphological variability that justifies the significance of these factors and their interpretations. The communalities shown in Table II, present each factor loading used for extraction that can be seen within a range of 0.631 minimum to 0.995 maximum for the component extracted. Table II further shows the result of the analysis presented for the communality showing the contribution of each factor.

The PC one (PC1) has an eigenvalue of 28.015, which explains 13.667 as the total variance with the same value for the cumulative variance. Taking into composition the contributions of individual weighted factor values for the PC occurring from the factors in Table II. The contribution of 10 factors can be seen in the table identifying different groups for the 6 PCs (Table I). Fig. 5 shows the first six components in rotated space. The contribution can further be seen in Table S3. The first group for PC 1 includes CSF such as Business change is first to be considered with eigenvector of 0.166 variation that reflects environment to the level of implementation acceleration and using ERP to fulfil cross-functional areas with 0.15 variation. This component presents the largest variability in the dataset as compared to the subsequent components [15, 29].

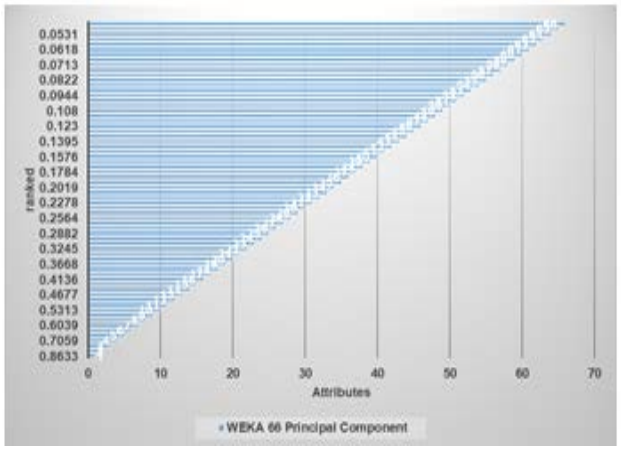

Fig. 1. Ranking of 66 PCs.

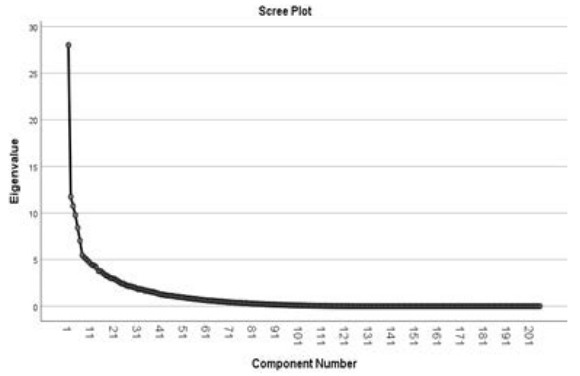

Fig. 2. Scree Plot of the PCs.

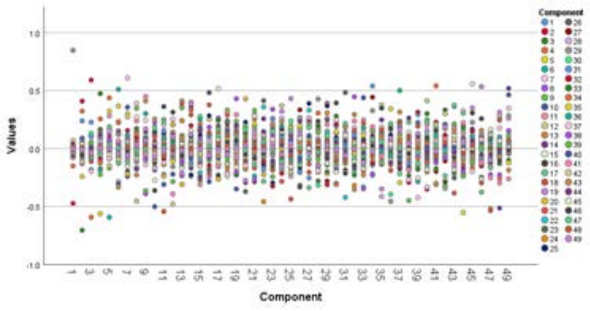

Fig. 3. Component Transformation Matrix for the Identified Components.

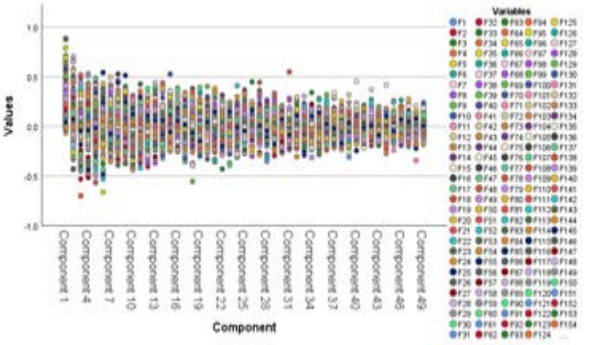

Fig. 4. Component Matrix of 49 PCs.

TABLE I. FIRST SIX COMPONENTS 10 FACTOR LOADINGS

PC1	0.166F81+0.166F37+0.166F146+0.166F32+0.166F60 +0.166F31+0.166F85+0.166F58+0.166F139+0.15 F117...
PC2	0.205F118+0.193F133+0.189F178+0.169F13+0.162F132 +0.148F173+0.145F66+0.143F14+0.14 F41+0.136F131...
PC3	-0.213F128-0.213F181-0.213F184-0.162F182+0.157F17 +0.157F171+0.148F14-0.137F114+0.134F18-0.134F121...
PC4	-0.169F149+0.165F177-0.161F88+0.159F125+0.159F20 +0.159F117+0.149F94+0.149F92+0.148F87+0.144F93...
PC5	-0.195F17-0.195F171-0.172F18-0.172F109+0.168F137 +0.167F134-0.161F15+0.151F74-0.15F172+0.149F21...
PC6	0.25 F95-0.205F77-0.204F175+0.2 F82+0.184F97+0.183F145 +0.171F91+0.164F107-0.164F170-0.146F28...

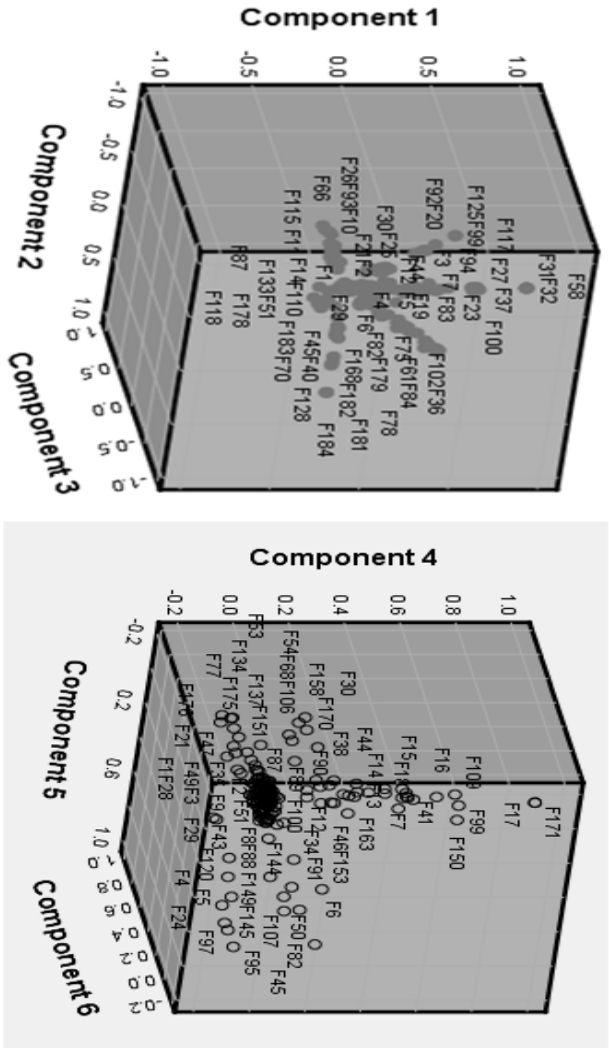

Fig. 5. Principal Component Plot in Rotated Space Graph for the First Six-Component (PC1 – PC6).

Several other groups were identified that consisted of different variational contributions from CSFs. In the second PC, the only factor that reached the eigenvector value of 0.205 is End users' attitudes (F118). The second component also had high eigenvector for the ERP easy to learn (Learnability/ awareness (F133): 0.193, Availability of reliable data networks (F178): 0.189, Assign responsibility/Clear roles and responsibilities (F13), 0.169 and ERP usefulness (F132) 0.162.The highest eigenvector for PC three was achieved by Defined project miles' stones (F17): 0.157, Coordinate project activities (F171): 0.157 and subsequently Social influence (F177): 0.165. For PC four, software configuration (F137): 0.168, Vanilla ERP (F134): 0.167 for PC five and Education on new business processes (F95):0.25, Architecture choices (F82): 0.2 for PC six.

TABLE II. COMMUNALITY

Factors	Initial(I)	Extraction									
F1	1.000	0.631	F53	1.000	0.874	F105	1.000	0.881	F157	1.000	0.847
F2	1.000	0.833	F54	1.000	0.869	F106	1.000	0.840	F158	1.000	0.860
F3	1.000	0.949	F55	1.000	0.969	F107	1.000	0.821	F159	1.000	0.856
F4	1.000	0.898	F56	1.000	0.870	F108	1.000	0.929	F160	1.000	0.963
F5	1.000	0.873	F57	1.000	0.838	F109	1.000	0.983	F161	1.000	0.887
F6	1.000	0.926	F58	1.000	0.995	F110	1.000	0.814	F162	1.000	0.903
F7	1.000	0.887	F59	1.000	0.791	F111	1.000	0.862	F163	1.000	0.874
F8	1.000	0.816	F60	1.000	0.995	F112	1.000	0.814	F164	1.000	0.886
F9	1.000	0.911	F61	1.000	0.881	F113	1.000	0.863	F165	1.000	0.855
F10	1.000	0.881	F62	1.000	0.928	F114	1.000	0.914	F166	1.000	0.958
F11	1.000	0.950	F63	1.000	0.778	F115	1.000	0.816	F167	1.000	0.776
F12	1.000	0.862	F64	1.000	0.960	F116	1.000	0.902	F168	1.000	0.817
F13	1.000	0.860	F65	1.000	0.895	F117	1.000	0.985	F169	1.000	0.886
F14	1.000	0.962	F66	1.000	0.869	F118	1.000	0.983	F170	1.000	0.851
F15	1.000	0.751	F67	1.000	0.827	F119	1.000	0.885	F171	1.000	0.974
F16	1.000	0.910	F68	1.000	0.829	F120	1.000	0.847	F172	1.000	0.871
F17	1.000	0.974	F69	1.000	0.982	F121	1.000	0.970	F173	1.000	0.985
F18	1.000	0.969	F70	1.000	0.987	F122	1.000	0.862	F174	1.000	0.817
F19	1.000	0.793	F71	1.000	0.841	F123	1.000	0.908	F175	1.000	0.875
F20	1.000	0.985	F72	1.000	0.884	F124	1.000	0.930	F176	1.000	0.872
F21	1.000	0.866	F73	1.000	0.930	F125	1.000	0.985	F177	1.000	0.950
F22	1.000	0.902	F74	1.000	0.854	F126	1.000	0.888	F178	1.000	0.947
F23	1.000	0.890	F75	1.000	0.928	F127	1.000	0.838	F179	1.000	0.958
F24	1.000	0.887	F76	1.000	0.823	F128	1.000	0.984	F180	1.000	0.963
F25	1.000	0.809	F77	1.000	0.890	F129	1.000	0.960	F181	1.000	0.984
F26	1.000	0.889	F78	1.000	0.861	F130	1.000	0.947	F182	1.000	0.951
F27	1.000	0.896	F79	1.000	0.880	F131	1.000	0.907	F183	1.000	0.862
F28	1.000	0.912	F80	1.000	0.855	F132	1.000	0.960	F184	1.000	0.984
F29	1.000	0.824	F81	1.000	0.995	F133	1.000	0.918	F185	1.000	0.877
F30	1.000	0.895	F82	1.000	0.923	F134	1.000	0.886	F186	1.000	0.719
F31	1.000	0.995	F83	1.000	0.902	F135	1.000	0.797	F187	1.000	0.830
F32	1.000	0.995	F84	1.000	0.942	F136	1.000	0.831	F188	1.000	0.981
F33	1.000	0.885	F85	1.000	0.995	F137	1.000	0.892	F189	1.000	0.934
F34	1.000	0.835	F86	1.000	0.960	F138	1.000	0.854	F190	1.000	0.869
F35	1.000	0.829	F87	1.000	0.876	F139	1.000	0.995	F191	1.000	0.890
F36	1.000	0.874	F88	1.000	0.863	F140	1.000	0.785	F192	1.000	0.843
F37	1.000	0.995	F89	1.000	0.809	F141	1.000	0.980	F193	1.000	0.932
F38	1.000	0.846	F90	1.000	0.896	F142	1.000	0.972	F194	1.000	0.885
F39	1.000	0.868	F91	1.000	0.829	F143	1.000	0.809	F195	1.000	0.796
F40	1.000	0.914	F92	1.000	0.979	F144	1.000	0.823	F196	1.000	0.947
F41	1.000	0.905	F93	1.000	0.921	F145	1.000	0.886	F197	1.000	0.925
F42	1.000	0.839	F94	1.000	0.979	F146	1.000	0.995	F198	1.000	0.970
F43	1.000	0.806	F95	1.000	0.926	F147	1.000	0.887	F199	1.000	0.790
F44	1.000	0.903	F96	1.000	0.844	F148	1.000	0.841	F200	1.000	0.878
F45	1.000	0.819	F97	1.000	0.909	F149	1.000	0.928	F201	1.000	0.832
F46	1.000	0.835	F98	1.000	0.856	F150	1.000	0.969	F202	1.000	0.972
F47	1.000	0.867	F99	1.000	0.984	F151	1.000	0.878	F203	1.000	0.972
F48	1.000	0.902	F100	1.000	0.941	F152	1.000	0.822	F204	1.000	0.904
F49	1.000	0.867	F101	1.000	0.772	F153	1.000	0.812	F205	1.000	0.883
F50	1.000	0.883	F102	1.000	0.977	F154	1.000	0.775			
F51	1.000	0.938	F103	1.000	0.817	F155	1.000	0.972			
F52	1.000	0.839	F104	1.000	0.880	F156	1.000	0.936			

These results report the presence of great morphological variability for some of the CSFs presenting specification of the CSFs diversification of ERP system implementation based on the taxonomy of the groups possibly identified by the selection of these CSFs. In this paper, we have explained the morphological variability and tried to model the CSFs to diverse components that are relevant to ERP system implementation. It can be seen from these results that taxonomic groups were conceivably attained by selecting these features. Azadeh, Afshari-Mofrad and Khalojini [30] and García, Rivera and Iniesta [31] applied PCA to their studies to characterised CSFs. The current study explicates on the diversity of CSFs variability based on different identity groups. Many studies undertaken on CSFs have selected certain CSFs to contextualise their results. However, results of the current study are attained from the inclusion of all the identified CSFs to provide a holistic nature of CSFs with different morphology. A similar approach to Ahmad, Haleem and Syed [22], study where all CSFs identified were retained for further analysis [3], characterised CSFs using a hybrid approached of PCA and impact factor analysis to identify, validate, rank and classify factors as critical, active, inert and reactive. Bhatti [32] applied PCA on a smaller dataset consisting of data from 53 inputs, using the reliability and validity scale to explain and characterise 11 CSFs with eigenvalue greater than 1 that only assimilation factor loads greater than 0.5. Madapusi and Ortiz [33] report findings on ERP, discussing two factors that account for 50.315 of the variability following a lesser Cronbach alpha statistic of 0.60 as compared to Bhatt [32] who used 0.75.

The projection of the 205 CSFs morphology in the two-dimensional graph of the component plot is shown in Fig. 3 and Fig. 4. The first, second and third PC coordinates of the PCA is realised using the morphological data accounted for 24.67% of the diversity observed (Fig. 3). While the subsequent three PCs four, five and six in Fig. 4 accounted for 12.30%. Overall, these displays denote an obvious division between taxonomic groups of CSFs relevant for the success of ERP system implementation.

V. Conclusion

Employing different markers of the CSFs, diversification was estimated by exploring the morphological attributes that provide essential preliminary method for gauging different CSFs while concurrently elucidating their performance under successful implementation. The substantial knowledge presented by the results of this study is the CSFs variability applicable to various implementations of ERP systems. In this study, 205 different CSFs were analysed by using data obtained from 127 studies presenting different morphological findings of CSFs. The low variability of the first six principal components demonstrates that the diversity of the pool was significantly with the highest CSFs having eigenvectors not limited to values such as 0.25, 0.205, 0.193, 0.169 and 0.157.

The results of this study provide an important contribution to the ERP CSFs body of knowledge with a special attention paid to the morphological features of a disparate model from several morphological taxonomies of the identified CSFs using a robust analytical method. The study results can help practitioners not to neglect any CSF, rather they should attach significant consideration to their roles in ensuring a successful implementations of ERP systems.

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SUPPLEMENTARY DOCUMENTS

PRINCIPAL COMPONENT ANALYSIS ON MORPHOLOGICAL VARIABILITY OF CRITICAL SUCCESS FACTORS FOR ENTERPRISE RESOURCE PLANNING

TABLE SI. QUALITATIVE AND QUANTITATIVE ERP CSFS FOR PCA

CSF Factors	Description	Occurrences
F1	Vendor	4
F2	Selection of appropriate vendor	5
F3	ERP vendor characteristics /reputation	4
F4	Partnership with vendor	26
F5	Vendor support	33
F6	Use of vendors’ tools	17
F7	Keeping suppliers and customers informed	5
F8	Project Management	71
F9	Project leader	9
F10	Appointment & availability of competent project manager	4
F11	project manager /Full time	8
F12	Scope creep Management (Detail schedule)	19
F13	Assign responsibility/ Clear roles & responsibilities	7
F14	control project scope	6
F15	Evaluate any propose change	3
F16	Control and assess scope expansion requests/ assessment	3
F17	Define project miles stones	1
F18	Set realistic milestone and end dates	3
F19	Knowledge transfer management	9
F20	Management of conflicts	2
F21	Management of legacy systems	18
F22	Clear and defined project plan	4
F23	Planning required upgrades	2
F24	Management of expectations	21
F25	Management of risks	14
F26	Effective project management methodology	7
F27	Project tracking	1

F28	Total quality management approach	9
F29	Interdepartmental communication and cooperation	81
F30	Open and honest communication (Targeted and effective communication, among stakeholders, expectations communicated at all level and progress communication)	15
F31	Professional training services	1
F32	Setting realistic deadlines	1
F33	Project Management to implement project plan	3
F34	Change management	70
F35	Change management program	18
F36	Understanding the political structure (Political influence)	4
F37	User participation in defying new processes	1
F38	Understanding the organizational culture / (norms, values & beliefs)	36
F39	Developing a culture of continuous improvement	5
F40	National culture	3
F41	Recognizing the need for change	4
F42	Commitment to change -perseverance and determination	4
F43	Project team competence (formulation, composition and involvement)	67
F44	Team finest cross functional knowledge /small internal team	11
F45	Trust between various shareholders	5
F46	Good relations between project team and users (Partnership, trust, risk-sharing and incentives)	14
F47	Team morale and motivation	18
F48	Full time team members	8
F49	Balanced and cross functional project team	16
F50	Allocating valuable resources/Dedicating resources	25
F51	Culture of resistance/ enabling constraints	8
F52	Counselling to staff to minimize resistance to change	6
F53	Staff retention	6
F54	Empowered decision makers	18
F55	Work time schedule	4
F56	Performance tied to compensation	7
F57	Availability of qualified implementation team	4
F58	Deep understanding strategy	1
F59	Organizational characteristics	5
F60	Former major change experience	1
F61	Having in place advanced technology	4
F62	Former major IT change experience/Previous organization’s experience with complex IS	3
F63	Interdepartmental coordination/ company wide	9
F64	Organization transformation and software migration	1
F65	Clear organizational strategy	7
F66	Organization encouragement of continuous learning	2
F67	Organization structure	16
F68	Implementation strategy	16
F69	Project definition and organization	1
F70	Implementation promotion	2
F71	Consultant's domain knowledge & experience	7
F72	Appointment of consultant/ external consultant involve in implementation (third party)	12
F73	Managing consultants	3
F74	Use of consultants (Consultant selection and relationship)	42
F75	Decision making process style/Strategic Decision making	7
F76	Focused performance measures plan	5
F77	Planning the cost of ERP implementation-Project cost planning and management	11
F78	Regard as a technological, business, and organizational project	8
F79	Alignment between business strategy and IT strategy	17
F80	Ensuring fair time to fulfil the implementation	6
F81	Business change is first to be considered	1
F82	Architecture choices	10

F83	Functional requirements are clearly defined before deciding on ERP adaptation/country related/carefully defined information and system requirement	9
F84	Continues focus on organizational resistance	4
F85	Level of implementation acceleration	1
F86	Implementation approach	1
F87	Implementer's domain knowledge & experience	3
F88	Project champion	49
F89	Education and training	58
F90	Education and training to technical staff /IT workforce re-skilling	21
F91	Education and training to end users	48
F92	Education on future business processes	3
F93	Adequate training to the implementation team	2
F94	Developing a clear education and training plan	3
F95	Education on new business processes	11
F96	Top management support	105
F97	Management and project steering committees	17
F98	management leadership	10
F99	Willingness to become involved	2
F100	Developing an understanding of the needs, capabilities & IT limitations	2
F101	Exhibiting strong commitment	4
F102	Resolving political conflicts (Political influence)	3
F103	Willingness to adopt modern technologies/Adaption Mechanism	5
F104	dedicated staff of vendor and institute for implementation	4
F105	Financial budget /funding Model	16
F106	Business vision	37
F107	Project mission /goals (Clear Goals and Objective)	42
F108	beliefs on ERP (management, users, teams and managers)/ Perception	5
F109	Justification for investment in ERP (investment plan)	2
F110	BPR	79
F111	User involvement	38
F112	User participation in the overall process approach	11
F113	User uses the system according to guidance	6
F114	Users' trust	2
F115	Key users' business knowledge	2
F116	Appointment & availability of competent key users	3
F117	Using ERP to fulfil cross functional areas	2
F118	End users' attitudes	3
F119	ERP System	4
F120	Level of Customization	43
F121	System flexibility to changing conditions	3
F122	System integration	16
F123	Systems reliability	5
F124	System interoperability	1
F125	System cross functionality	2
F126	System testing	13
F127	System quality	7
F128	Systems Changes and Upgrade	1
F129	System support	2
F130	ERP Version	1
F131	ERP ease of use/complexity	7
F132	ERP usefulness	5
F133	ERP easy to learn (Learnability/ awareness)	3
F134	Vanilla ERP	10
F135	Suitability of software and hardware considerations	9
F136	IT Infrastructure	32
F137	software configuration	15

F138	Environment	7
F139	Opportunities for growth	1
F140	Competition in industry/trend	7
F141	External/stakeholder pressure	3
F142	Competitors' adoption of ERP	2
F143	Uncertainty about environment	4
F144	Data Management	24
F145	Data analysis Plan	14
F146	Data model is compatible with data requirements	1
F147	Data quality control	7
F148	Developing a plan for migrating and cleaning up data	5
F149	Data conversion Plan	20
F150	Selection of data to be converted	2
F151	Data accuracy and integrity	14
F152	Package selection	39
F153	Careful and professional package selection process/modules	15
F154	Fit between ERP and business process, information needs and strategic goals/multi-site issues	15
F155	Planning the package selection process	2
F156	Software development	4
F157	Developing a plan for testing interfaces with integrated legacy systems	8
F158	Developing proper troubleshooting tools /Troubleshooting/crises management	18
F159	Robustness and Error Prevention (Working closely with vendors and consultants to resolve software problems and troubleshooting errors)	6
F160	Developing proper troubleshooting skills and techniques for the IT workers	4
F161	Planning and Establishing Software development, testing and troubleshooting architecture	17
F162	Appropriate modelling methods and Techniques (pre-implementation analysis) / Necessary preconditions	12
F163	Configuration of overall ERP architecture	7
F164	Monitoring management	28
F165	Monitoring and evaluation of performance metrics (fast effects)	31
F166	Monitoring progress against clear milestones	4
F167	User support organization and involvement	8
F168	User friendliness, Help, and Documentation/Document ERP success	5
F169	User acceptance feedback management/Analysis of user feedback (user satisfaction/satisfaction and system satisfaction)	21
F170	Enforce project timeliness /Timeframe	12
F171	Coordinate project activities	1
F172	Track milestones and targets	3
F173	Implementation experience/ with ERP implementation in similar scope	3
F174	Appropriate business and legacy systems including building a business case	23
F175	Post-implementation evaluation/audit	10
F176	Client consultation	8
F177	Social influence	1
F178	Availability of reliable data networks	3
F179	standardization and process measurement	5
F180	Follow the PDCA cycle	1
F181	System's Response Time to Users' Requests	1
F182	Interest/users groups	2
F183	Policies and Standards/ Government policies/Model	4
F184	Availability of applications (as result of Obsolescence of Hardware and Software)	1
F185	Discipline/Base point analysis; Process discipline; benchmarking	7
F186	Contingency plans (Co-ordinated analysis; contingency plans)	3
F187	Effective management techniques	2
F188	Controlled ROI on ERP implementation	2
F189	Operational Efficiency	1
F190	Internal readiness	2
F191	security of interface	4

F192	Integrated department and solve the problem of human resources management/Allocation of Best Internal Business Personnel	9
F193	Cost of update/upgrade/maintenance and integration	3
F194	Confidentiality	1
F195	Feasibility /evaluation of ERP project	1
F196	Strategic initiatives	2
F197	stimuli (environmental and customer needs)	3
F198	ERP treated as a program not a project	1
F199	Technical task and tools/Factors	4
F200	Reporting structure (project manager reporting to mgmt.	2
F201	Required Organizational Buy-In and Project Ownership	2
F202	Value Chain Connectivity	2
F203	IT provider and Integrator Push	2
F204	Globalization	1
F205	Procurement Management	2

TABLE SII. COMPARATIVE RESULTS PCS OF THE CSF WITH RESPECT TO WEKA AND SPSS

WEKA 66 Principal Components								SPSS 49 Principal Components			
Initial Eigenvalue								Component	Initial Eigenvalues		
Principal Component	eigenvalue	proportion	cumulative	Principal Component	eigenvalue	proportion	cumulative		Eigen-value	% of Variance	Cumulative %
PC1	28.01467	0.13666	0.13666	PC50	0.96216	0.00469	0.89668	PC1	28.015	13.666	13.666
PC2	11.74692	0.05730	0.19396	PC51	0.95278	0.00465	0.90133	PC2	11.747	5.730	19.396
PC3	10.75159	0.05245	0.24641	PC52	0.88444	0.00431	0.90564	PC3	10.752	5.245	24.641
PC4	9.78366	0.04773	0.29413	PC53	0.86610	0.00422	0.90987	PC4	9.784	4.773	29.413
PC5	8.41872	0.04107	0.33520	PC54	0.83310	0.00406	0.91393	PC5	8.419	4.107	33.520
PC6	7.02066	0.03425	0.36944	PC55	0.79243	0.00387	0.91780	PC6	7.021	3.425	36.944
PC7	5.46663	0.02667	0.39611	PC56	0.77909	0.00380	0.92160	PC7	5.467	2.667	39.611
PC8	5.19389	0.02534	0.42145	PC57	0.74995	0.00366	0.92526	PC8	5.194	2.534	42.145
PC9	4.97628	0.02427	0.44572	PC58	0.70508	0.00344	0.92870	PC9	4.976	2.427	44.572
PC10	4.71714	0.02301	0.46873	PC59	0.67867	0.00331	0.93201	PC10	4.717	2.301	46.873
PC11	4.44978	0.02171	0.49044	PC60	0.65077	0.00317	0.93518	PC11	4.450	2.171	49.044
PC12	4.38653	0.02140	0.51184	PC61	0.62464	0.00305	0.93823	PC12	4.387	2.140	51.184
PC13	4.18899	0.02043	0.53227	PC62	0.60563	0.00295	0.94118	PC13	4.189	2.043	53.227
PC14	3.77951	0.01844	0.55071	PC63	0.59025	0.00288	0.94406	PC14	3.780	1.844	55.071
PC15	3.76175	0.01835	0.56906	PC64	0.57522	0.00281	0.94687	PC15	3.762	1.835	56.906
PC16	3.55745	0.01735	0.58641	PC65	0.54523	0.00266	0.94953	PC16	3.557	1.735	58.641
PC17	3.32842	0.01624	0.60265	PC66	0.51769	0.00253	0.95205	PC17	3.328	1.624	60.265
PC18	3.22817	0.01575	0.61839					PC18	3.228	1.575	61.839
PC19	3.03787	0.01482	0.63321					PC19	3.038	1.482	63.321
PC20	3.00068	0.01464	0.64785					PC20	3.001	1.464	64.785
PC21	2.90889	0.01419	0.66204					PC21	2.909	1.419	66.204
PC22	2.75999	0.01346	0.67550					PC22	2.760	1.346	67.550
PC23	2.59826	0.01267	0.68818					PC23	2.598	1.267	68.818
PC24	2.44134	0.01191	0.70009					PC24	2.441	1.191	70.009
PC25	2.40218	0.01172	0.71180					PC25	2.402	1.172	71.180
PC26	2.23643	0.01091	0.72271					PC26	2.236	1.091	72.271
PC27	2.15058	0.01049	0.73320					PC27	2.151	1.049	73.320
PC28	2.13079	0.01039	0.74360					PC28	2.131	1.039	74.360
PC29	2.05022	0.01000	0.75360					PC29	2.050	1.000	75.360
PC30	1.98248	0.00967	0.76327					PC30	1.982	0.967	76.327
PC31	1.84063	0.00898	0.77225					PC31	1.841	0.898	77.225
PC32	1.83486	0.00895	0.78120					PC32	1.835	0.895	78.120
PC33	1.79143	0.00874	0.78994					PC33	1.791	0.874	78.994

PC34	1.68255	0.00821	0.79815					PC34	1.683	0.821	79.815
PC35	1.65753	0.00809	0.80623					PC35	1.658	0.809	80.623
PC36	1.61361	0.00787	0.81410					PC36	1.614	0.787	81.410
PC37	1.53884	0.00751	0.82161					PC37	1.539	0.751	82.161
PC38	1.51210	0.00738	0.82899					PC38	1.512	0.738	82.899
PC39	1.40574	0.00686	0.83584					PC39	1.406	0.686	83.584
PC40	1.34829	0.00658	0.84242					PC40	1.348	0.658	84.242
PC41	1.26481	0.00617	0.84859					PC41	1.265	0.617	84.859
PC42	1.25485	0.00612	0.85471					PC42	1.255	0.612	85.471
PC43	1.17802	0.00575	0.86046					PC43	1.178	0.575	86.046
PC44	1.14210	0.00557	0.86603					PC44	1.142	0.557	86.603
PC45	1.13026	0.00551	0.87154					PC45	1.130	0.551	87.154
PC46	1.10956	0.00541	0.87695					PC46	1.110	0.541	87.695
PC47	1.05925	0.00517	0.88212					PC47	1.059	0.517	88.212
PC48	1.01597	0.00496	0.88708					PC48	1.016	0.496	88.708
PC49	1.00652	0.00491	0.89199					PC49	1.007	0.491	89.199

TABLE SIII. RANK ATTRIBUTES WITH 5 FACTOR LOADINGS

Ranked	Attributes	Contribution
0.8633	1	0.166F81+0.166F37+0.166F146+0.166F32+0.166F60...
0.806	2	0.205F118+0.193F133+0.189F178+0.169F13+0.162F132...
0.7536	3	-0.213F128-0.213F181-0.213F184-0.162F182+0.157F17...
0.7059	4	-0.169F149+0.165F177-0.161F88+0.159F125+0.159F20...
0.6648	5	-0.195F17-0.195F171-0.172F18-0.172F109+0.168F137...
0.6306	6	0.25 F95-0.205F77-0.204F175+0.2F82+0.184F97...
0.6039	7	-0.212F72-0.18F65-0.178F9-0.178F67-0.177F105...
0.5786	8	0.232F196+0.203F98+0.196F205+0.191F63-0.17F203...
0.5543	9	-0.23F55-0.181F112-0.175F123+0.168F203+0.168F202...
0.5313	10	0.202F11+0.191F73+0.187F55+0.184F26+0.176F83...
0.5096	11	-0.202F203-0.202F202+0.198F22+0.176F104-0.169F154...
0.4882	12	0.194F2-0.182F180+0.18 F1-0.178F126+0.176F104...
0.4677	13	0.216F127+0.199F197+0.188F112+0.185F113+0.184F86...
0.4493	14	-0.225F201-0.213F160-0.203F105-0.198F200-0.194F34...
0.4309	15	-0.272F130-0.184F63-0.182F135-0.179F16-0.173F22...
0.4136	16	0.203F173+0.193F180+0.186F69+0.166F191+0.166F162...
0.3974	17	-0.195F90+0.186F4-0.18F162-0.177F194+0.17 F80...
0.3816	18	0.308F69+0.219F157+0.218F70-0.212F64-0.212F86...
0.3668	19	0.225F179+0.223F180+0.197F186+0.189F122-0.172F111...
0.3521	20	0.232F189-0.189F64-0.189F86+0.173F39+0.172F28...
0.338	21	0.225F170-0.209F168+0.208F204+0.201F46-0.2F186...
0.3245	22	0.258F33-0.19F194-0.179F75+0.173F71+0.163F26...
0.3118	23	0.242F197+0.227F189+0.173F190+0.171F174+0.161F12...
0.2999	24	-0.263F52+0.198F89+0.193F167-0.192F204+0.188F129...
0.2882	25	-0.236F194-0.21F204-0.208F131-0.206F193+0.176F38...
0.2773	26	0.3 F33-0.2F8-0.178F110+0.167F175+0.166F187...
0.2668	27	-0.303F198-0.247F53-0.221F18+0.195F204-0.195F188...
0.2564	28	-0.241F151-0.221F45-0.211F96-0.192F8+0.184F161...
0.2464	29	0.235F191+0.22 F198-0.207F10-0.202F62+0.192F124...
0.2367	30	-0.193F131-0.178F136-0.172F45-0.151F124-0.151F10...
0.2278	31	-0.404F198-0.208F188-0.195F18+0.172F193+0.162F194...
0.2188	32	0.224F204-0.216F192-0.203F174-0.184F164+0.164F63...
0.2101	33	-0.226F88+0.217F25+0.193F205+0.177F111+0.174F136...
0.2019	34	-0.263F183+0.241F79+0.179F66-0.175F62-0.168F177...
0.1938	35	0.219F23-0.216F62-0.21F126+0.2 F11+0.18 F51...
0.1859	36	0.252F9+0.212F27+0.211F52-0.186F198+0.18 F172...

0.1784	37	0.274F195+0.239F192+0.229F8-0.175F35-0.161F108...
0.171	38	-0.208F110+0.188F72+0.181F43+0.172F198-0.168F89...
0.1642	39	0.268F192-0.259F151-0.221F135+0.203F29-0.18F63...
0.1576	40	0.391F195-0.21F205+0.2 F71+0.182F10+0.18 F105...
0.1514	41	-0.192F195+0.191F176-0.189F15+0.185F108+0.167F29...
0.1453	42	0.329F7+0.243F96+0.207F158+0.204F172+0.188F38...
0.1395	43	-0.182F29+0.175F183+0.173F28+0.167F135-0.156F80...
0.134	44	0.391F195-0.256F144-0.215F201-0.2F80-0.19F154...
0.1285	45	-0.242F108-0.228F27-0.227F172+0.225F191+0.167F59...
0.123	46	-0.251F96-0.194F161-0.189F168+0.181F164-0.178F91...
0.1179	47	0.265F200+0.221F163+0.214F27+0.201F195-0.196F66...
0.1129	48	-0.34F101-0.219F115+0.204F7-0.192F78-0.176F163...
0.108	49	-0.239F91-0.227F190-0.219F16-0.208F108-0.185F195...
0.1033	50	-0.289F186-0.219F103+0.202F66+0.201F19+0.183F45...
0.0987	51	-0.383F1+0.228F195-0.211F199+0.172F201-0.172F98...
0.0944	52	-0.203F52+0.202F110+0.177F205-0.176F34-0.171F41...
0.0901	53	-0.242F101+0.242F1+0.225F115-0.169F23-0.16F195...
0.0861	54	0.246F42-0.225F101+0.215F176+0.21 F57+0.172F103...
0.0822	55	0.232F45+0.217F143-0.206F168+0.201F1+0.163F7...
0.0784	56	-0.218F140+0.186F127+0.18 F169-0.18F168+0.171F119...
0.0747	57	0.202F68+0.202F154-0.178F1+0.166F2-0.156F195...
0.0713	58	-0.253F112+0.221F107-0.219F113-0.191F144+0.189F8...
0.068	59	0.202F152+0.2 F83+0.188F38-0.178F71-0.178F25...
0.0648	60	0.187F74+0.175F105-0.171F157-0.17F96-0.161F136...
0.0618	61	-0.241F107-0.231F89+0.225F8+0.202F122+0.159F172...
0.0588	62	-0.203F43+0.187F2+0.183F106+0.177F71+0.17 F82...
0.0559	63	0.21 F46+0.202F29-0.194F115-0.18F25+0.172F91...
0.0531	64	-0.308F167+0.207F194-0.183F144-0.178F23-0.177F135...
0.0505	65	0.271F76+0.253F43+0.199F144+0.197F151-0.166F35...
0.0479	66	-0.209F122-0.187F21-0.184F63-0.182F91-0.178F101...