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MATURITY ASSESSMENT OF SOCIAL CUSTOMER KNOWLEDGE MANAGEMENT (SCKM) USING FUZZY EXPERT SYSTEM

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Abstract. Organizations which provide electronic services do not have a logically structured strategy for implementing Customer Knowledge Management through Social media (SCKM). By assessing the position of SCKM, organizations can have a clear understanding of their maturity level and find their future investment interests. This research examined the maturity assessment of SCKM utilizing a fuzzy expert system. It consisted of a-four-stage procedure. The maturity model is based on 11 critical success factors, including strategy, leadership, information technology, knowledge management, culture, process, resources, business intelligence, security, social customer, and assessment. Results showed that the studied organization has covered 48.2% of maturity on the first level and 51.8% on the second level. Thus, to increase productivity, it is indispensable for organizations to act in a targeted way. The fuzzy expert system is not designed specifically for a case study, but can be utilized as a reference for in-depth analysis of the organizational readiness for SCKM implementation and development within organizations, which provide e-services applications.

Keywords: expert system, fuzzy logic, maturity assessment, Customer Knowledge Management (CKM), Social media, critical success factors.

JEL Classification: L86, C18, C52, D83, L82, C39.

Introduction

As a component of external knowledge, customer knowledge is viewed as an important resource that can be managed to support new product development, to facilitate the sensing of emerging market opportunities and to improve long-term customer relationships (Mehdibeigi *et al.* 2016). Customer Knowledge Management (CKM) is one of the approaches of knowledge management implementation in organizations (Yong, Yongqing 2015). In recent years, the organizations are trying to integrate CRM (Customer Relationship Management)

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and Knowledge Management (KM) (Sindakis *et al.* 2015). While CRM is focused on customer knowledge and preferences, KM systems can create, organize and construct applied knowledge and thereby improve organizational performance (Fidel *et al.* 2015). In fact, KM encompasses a wide range of strategies and methods to identify, create, display, distribute, activate and gain insights and experiences. It is considered as an important factor for maturity assessment, which is an increasingly growing phenomenon (Lee *et al.* 2010).

There are three kinds of knowledge that play critical roles in the organization-customers interaction, namely, knowledge for/about/from customers (Salomann *et al.* 2005). In today's competitive market, those companies can survive that can create and distribute new knowledge and turn it into goods and services. Currently, the problem of organizations is that they fail to provide CRM processes in the context of social media, in order to construct an integrated architecture based on the customer knowledge (Harrigan *et al.* 2015). Researchers have identified several benefits from social media marketing activities. The researchers define "social media" as a series of both hardware and software technological innovations (Web 2.0) that facilitate creative online users' inexpensive content creation, interaction, and interoperability (Berthon *et al.* 2012). In fact, it helps organizations to take logical steps to adopt an appropriate management strategy, based on the target community, to elicit a competitive advantage.

An assessment of the 4-way interactions between Electronic CRM, knowledge creation process, customer knowledge and social media provides a deeper insight into ECRM. Customers have begun using social media networking to connect with other individuals and firms and through user-generated information and interactivity within the network (Wang, Kim 2017). Apart from the possibilities and prospects that accompany new technologies and the new generation of Media, the big change stems from the strength gained by the contemporary Social Consumer which brings firms to operate within a Customer Ecosystem (Giannakis-Bompolis, Boutsouki 2014). Social Customer Knowledge Management (SCKM) is a framework that indicates the 4-way interactions of electronic CRM systems, a variety of customer knowledge, knowledge creation processes and social media. SCKM is in connection with the acquisition, sharing and the development of customer knowledge through social media and it aims to create benefits between customers and organizations. In addition to SCKM technological factors, there are other involved factors that should be taken into consideration and be strengthened (Lak, Rezaeenour 2017). Therefore, assessment of the SCKM position should be considered as a starting point in SCKM processes in organizations providing e-services.

Obviously, due to the high risks of implementing ECRM projects, it is essential to do proper planning before implementing ECRM in the organization. For this purpose, before conducting related organizational investment, it is necessary to recognize the gap between the current and desired status and the path to the desired status. Thus, it seems indispensable to do an in-depth analysis of organizational readiness for deployment and improvement of SCKM. The importance of SCKM maturity assessment is that the organization has had a clear understanding of each level of maturity and understands the interests of their future investments. In other words, within this model of assessment, the organization can find a clear vision of the potential options and exact priorities of SCKM. This study is an application of

fuzzy logic in assessing maturity for timely and logical decision making within organizational information systems.

1. Review of the literature

Integrating CRM and KM systems can increase their benefits and reduce the risk associated with each system. CRM requires managing Knowledge *for/from/about* the customer. To build better relationships with customers, it is essential that services be provided to each customer by his preferred method via using CKM. However, investment in knowledge management and CKM is risky, but it has many advantages (Jafari *et al.* 2011). By using KM, the advantages of CRM and KM increase and the risks of failure decrease. Major studies (from 2005 to 2017) related to the concepts of CRM, KM, CKM, ECRM and social media are shown in Table 1.

Table 1. Reviewing the literature of CRM, KM, CKM, ECRM and social media

Paper	Topics discussed				
	CRM	KM	CKM	ECRM	Social media
(Yong, Yongqing 2015), (Mukherji 2012), (Mehdibeigi *et al.* 2016)	×	✓	✓	×	×
(Harrigan *et al.* 2015)	✓	×	×	×	✓
(Sindakis *et al.* 2015), (Fidel *et al.* 2015), (Srisamran, Ractham 2014), (Al-Shammari 2014), (Wu *et al.* 2013), (Attafar *et al.* 2013), (Li *et al.* 2013), (Aghamirian *et al.* 2013), (Sedighi *et al.* 2012)	✓	✓	✓	×	×
(Aghamirian *et al.* 2015)	✓	✓	✓	✓	×
(Akhavan *et al.* 2014)	×	✓	×	×	×
(Buchnowska 2014), (Chua, Banerjee 2013)	✓	✓	✓	×	✓
(Zembik 2014)	×	✓	×	×	✓
(Treem, Leonardi 2012)	×	×	×	×	✓
(Samizadeh, Mehr 2012)	×	×	✓	×	✓
(Nejatian *et al.* 2011), (Jafari *et al.* 2009), (Salomann *et al.* 2005)	✓	✓	×	×	×
(Wang, Kim 2017)	✓	×	✓	×	✓
(Valentin *et al.* 2016)	✓	×	×	✓	✓
(Sarka, Ipsen 2017)	×	✓	×	×	✓
(Rosa *et al.* 2016)	×	✓	×	×	✓

As outlined above, many studies have been conducted on 2-way interactions among CRM systems/processes, knowledge creation and customer knowledge. However, the 4-way interactions between ECRM systems, the types of customer knowledge, knowledge creation processes and social media have rarely been considered, or the discussion has been restricted

to only one type of ECRM system (primarily analytical systems) or one type of customer knowledge.

A Maturity Model represents a path towards an increasingly organized and systematic way of doing business in organizations (Proença, Borbinha 2016). It consists of multiple levels of maturity which an organization can achieve step by step and over the years. Each maturity level includes a range of background processes that shows an organization focus of attention for improving their processes (Backlund *et al.* 2014). Von Scheel *et al.* (2015) acknowledge that maturity models can be considered as a structured collection of elements in which certain aspects of the capability maturity in an organization are described. In most studies, it has been recommended to use the base Capability Maturity Model Integration (CMMI) model for Maturity assessment in the IT industry (Rogers 2009). Other important research assessing maturity is shown in Table 2.

Table 2. Important researches on assessing maturity

Maturity Model	Results
KM in organizations	Obtained based on the distribution of the relevant factors and indicators (Khatibian *et al.* 2010).
E_ Government in public organizations	Including the integration of assessment of technological organizational operational and human resources capital capabilities, and under a multi-dimensional, comprehensive and developmental approach (Valdés *et al.* 2011).
Open-government for general interaction based on social media	Including the initial conditions (Level 1), transparency of information (Level 2), open participation (Level 3), Open cooperation (Level 4), and interaction available everywhere (Level 5) (Lee, Kwak 2012).
DI-CMM for Digital Research	Evaluation of current capacities of organization from digital point of view (Kerrigan 2013).
Impact-oriented for IT-based management	This model focuses on the impact of technology and is associated to a map of the affected areas and risk benefits (Koehler *et al.* 2015).
Industry 4.0	The dimensions "Products", "Customers", "Operations" and "Technology" have been created to assess the basic enablers. Additionally, the dimensions "Strategy", "Leadership", Governance, "Culture" and "People" allow for including organizational aspects into the assessment (Schumacher *et al.* 2016).
The product lifecycle management (PLM) in small and medium size enterprises (SME)	This model brings out current situation in: Strategy & Policy, Management & Control, Organization & Processes, Information technology, People & Culture (Paavel *et al.* 2017).

Features and capabilities of an organization in different aspects of the SCKM are, in fact, the organizational maturity in SCKM. Any organization, based on its activities in SCKM, is in a level of maturity and this level represents the current state of the organization in SCKM. Recommendations and guidelines related to SCKM can be presented by maturity models similar to those already used in various industries.

According to the literature, firstly, there are limited models for assessing the maturity of ECRM; secondly, current models have a narrow view of the concept; and thirdly the provider

has dealt with them only from one aspect. Most of these maturity models have a Key Process Area (KPA) approach to this concept, and they consider the excellence in customer relationship processes due to the improvement of these processes; however, this concept has broad dimensions that mobilize all parts of the organization and its resources, so maturity and excellence in the organizational sense require step by step attention to all these dimensions and factors. In addition, none of the existing methods have accurately assessed the maturity level and they have introduced a specific maturity level. Meanwhile, maturity assessment through Critical Success Factor (CSF) indicators guarantees the accuracy and validity of results to a great extent.

One of the most important steps to implement a technology-based strategy such as SCKM is to assess the organizational readiness for implementing it. In fact, this stage has a vital role in the success or failure of SCKM strategy. Therefore, the fundamental difference of this study with other research, as well as this study's innovations are as follows:

1. Examining the 4-way interactions (ECRM, process of creating knowledge, customer knowledge and social media) in order to find the managers' decision-making model and to identify strengths and weaknesses of an organization;
2. Presenting the SCKM Maturity Assessment Model based on the distribution of CSF indicators rather than KPAs;
3. Developing a Fuzzy Expert System for SCKM Maturity Assessment in order to increase the measurement accuracy of organizational gaps;
4. Finally, testing the proposed system for assessing maturity and finding gaps of the studied organization.

2. Research methodology

This paper is a mixed-method study, utilizing a combination of qualitative and quantitative approaches. Due to the small size of the statistical population, sampling has not been done and the statistical population consisted of all participants. The statistical population of the second stage includes the first stage also. The process of developing a fuzzy expert system for SCKM Maturity Assessment is shown in Figure 1. It consisted of a-four-stage procedure.

***Stage 1*:** The CSF and SCKM indicators are extracted through a systematic literature review and grounded theory method, and a questionnaire is used for verifying the factors and indicators of the SCKM maturity assessment model. The validity of questionnaires is determined by 17 experts, who have experience and practical knowledge in electronic services. The Cronbach's alpha coefficient is used to measure the reliability through SPSS software. Reliability is calculated in two stages: in the first stage a pre-test and in the second stage a post-test. Obtained values of 0.7 to 0.9 indicate that questionnaire has appropriate and acceptable reliability.

***Stage 2*:** Another questionnaire is designed, including confirmed indicators of the first phase which consisted of 83 questions; it was sent to 65 experts of the first phase who have experience and practical knowledge in the field of ECRM, KM, CKM and social media. The

experts are asked to express their comment on the indicators' classification of each of the CSFs in different levels of the SCKM maturity model (In the form of numbers from 1 to 5). In this phase, 51 questionnaires are returned in full and the experts' comments are collected. Chi- square test and Simple Additive Weighting (SAW) are used to classify the CSFs and its indicators at different levels. After selecting the best model for maturity assessment, theoretical aspects of SCKM maturity assessment model will be developed, and its validity has been verified.

***Stage 3*:** To assess the maturity level of SCKM in the study, a questionnaire with a 7-choice Likert scale is used. For assessing the maturity level of the organization, the population of the study consists of 38 experts of the organization. The organization of the study is one of the most important e-government service providers in Iran.

***Stage 4*:** Finally, the expert system based on inference rules is designed and analyzed to assess the SCKM maturity level and its successful implementation in the organization.

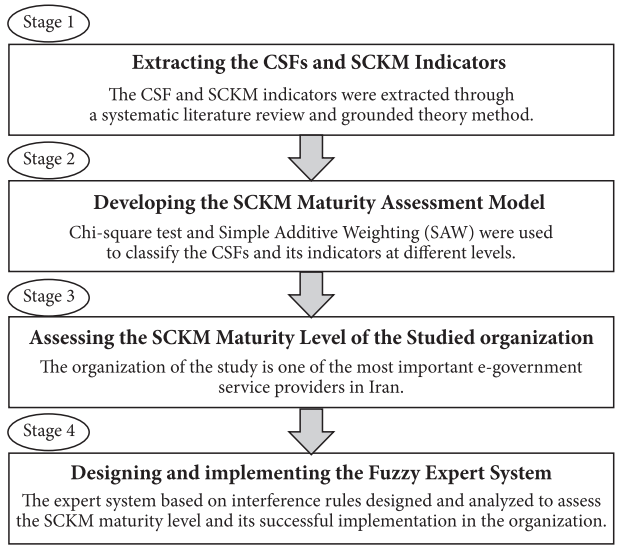

Figure 1. Research design framework

3. Analysis

3.1. Extracting the CSFs and SCKM indicators

It should be noted, none of the previous research on SCKM critical success factors has done a separate work, and they only examined some of the main success factors in the areas of KM, CRM; each concentrated on one specific domain or factors. Therefore, the extracted factors in this study (Table 3), compared to other previous research, are more complete and more comprehensive and represent a more general view of the concept of SCKM.

Table 3. CSFs and indicators of SCKM model (Lak, Rezaeenour 2017)

CSF	Indicators
Strategy (N = 8)	Organizing the SCKM strategy (CSF1_I1), Defining the mission and vision of SCKM project (CSF1_I2), Clarifying the Social customer relationship strategy (CSF1_I3), Clarifying the strategy of creating value for Social customer (CSF1_I4), Clarifying the organization brand strategy (CSF1_I5), Clarifying the strategy of Continuous interaction with the social customer (CSF1_I6), Developing the SCKM Strategy (CSF1_I7), Reviewing the obligations and strategic imperatives of KM (CSF1_I8).
Leadership (N = 9)	Senior manager Support of SCKM strategy (CSF2_I1), Attention to employees skill (CSF2_I2), Delegation of authority (CSF2_I3), Monitoring the processes (CSF2_I4), Leadership and guidance (CSF2_I5), Commitment and involvement of senior management (CSF2_I6), Risk Management (CSF2_I7), Planning and Controlling the Project (CSF2_I8), Managing the employees' participation (CSF2_I9).
Information Technology (N = 9)	Developing and improving the SCKM technical infrastructure (CSF3_I1), Sofware and hardware quality improvement of database architecture (CSF3_I2), Customizing information systems (CSF3_I3), Strengthening the research and development department (CSF3_I4), Developing and utilizing the applications and social tools for better access (CSF3_I5), Integrating the interactive channels software and technological integration (CSF3_I6), Architectural designing and utilizing the tools of marketing, sales and customer service for SCKM (CSF3_I7), Developing the CRM solutions in operational, analytical and collaborative levels (CSF3_I8), Information management (CSF3_I9).
Knowledge Management (N = 10)	Developmening the customer knowledge processes (CSF4_I1), Sharing Customer knowledge (CSF4_I2), Utilizing Customer knowledge (CSF4_I3), Reviewing Customer knowledge (CSF4_I4), Learning (CSF4_I5), Deploying the CRM processes at the operational, analytical and collaborative levels (CSF4_I6), Managing the knowledge for/about/from customer (CSF4_I7), Developing the KM architecture based on social media (CSF4_I8), Establishing the SCKM information systems (CSF4_I9), Developing the systems and mechanisms of social customer-driven (CSF4_I10).
Culture (N = 5)	Increasing the dimension of Customer-orientated culture (CSF5_I1), Increasing the dimension of adoptability culture (CSF5_I2), Increasing the dimension of cooperation culture (CSF5_I3), Increasing the dimension of learning culture (CSF5_I4), Boosting the human and system view to SCKM (CSF5_I5).
Process (N = 8)	Reengineering the processes for development and integration of social knowledge creation processes (CSF6_I1), Targeting the processes (CSF6_I2), Strengthening the customer development process (CSF6_I3), Improving the decision-making processes based on customer knowledge (CSF6_I4), Synchronizing the supply chain and SCKM processes (CSF6_I5), Supporting the processes of social knowledge creation (CSF6_I6), SCKM processes Management (CSF6_I7), Integrating the Customer complaints' management process with SCKM processes (CSF6_I8).
Resources (N = 8)	Managing resources needed to establish the SCKM framework (CSF7_I1), Establishing the reward system (CSF7_I2), Employment of competent staff (CSF7_I3), Increasing the employee satisfaction (CSF7_I4), Staff training (CSF7_I5), Providing the framework and documented system of services pricing (CSF7_I6), Estimating the exact cost to establish SCKM (CSF7_I7), Systematic coordination of people, processes and technology in SCKM (CSF7_I8).
Business Intelligence (N = 8)	Instantaneous web mining and data analysis (CSF8_I1), Information analysis using data Ming soft wares (CSF8_I2), Online analysis of social customers (CSF8_I3), Establishing the KM intelligent system (CSF8_I4), Innovation in Services (CSF8_I5), Improving the services and alternative services (CSF8_I6), Expanding and improving services quality (CSF8_I7), Making the smart, accurate, timely and on-line services for customers (CSF8_I8).

End of Table 3

CSF	Indicators
Security (N = 2)	Defining the security framework to maintain knowledge (CSF9_I1), Defining the security framework to maintain knowledge and Privacy (CSF9_I2).
Social customer (N = 10)	Classifying the customers (CSF10_I1), Management and analysis of customer needs based on interactions via social media (CSF10_I2), Determining the educational system for social customer (CSF10_I3), Improving the customer information (CSF10_I4), Improving the customer information (CSF10_I5), Strengthening the trust and loyalty of customers (CSF10_I6), Providing the incentive systems for KM (CSF10_I7), Identifying and managing the customers value (CSF10_I8), Boosting the relationships with loyal social customers (CSF10_I9), Managing the active participation with customers (CSF10_I10).
Assessment (N = 6)	Measurement of organizational profit increase (CSF11_I1), Measurement of market share increase (CSF11_I2), Measurement of customer satisfaction increase (CSF11_I3), Measurement of customer loyalty increase (CSF11_I4), Performance evaluating and monitoring the SCKM (CSF11_I5), Measuring the Critical Success Factors of SCKM (CSF11_I6).
Sum: CSF = 11, Indicators = 83	

3.2. Developing the SCKM maturity assessment model

One of the recognized gaps in KM maturity models, as well as ECRM, is that all indicators related to the above CSF concepts are at one level of maturity. Based on the standard CMMI model, it is possible to distribute indicators at different levels; however, in this study, this problem is also solved. The process of evaluating the previous models, which have proven to be quite traditional and absolute, are unsuitable for modern organizations due to the complexity of the situation. This study is to determine the precise level of maturity, and also assists in to the decision process for adopting appropriate strategies to improve the status and quality of corporate processes/projects. In this research, CSF levels of maturity and related indicators of SCKM are based on the main CMMI model. Assessment of maturity levels based on CMMI model has five levels, which are localized and approved by experts according to the features of SCKM model.

For ranking indicators as well as critical success factors, the pair-wise comparisons were completed by experts and then by calculating the geometric mean, using Expert Choice software, weights of the results are obtained (Appendix A and B). The statistical sample in this section includes 18 participants who were experts on the topic. A Chi- square test is used to classify CSFs and its indicators at different levels, and based on the weight that is obtained through AHP, critical success factors and each maturity level indicator are rated accordingly. The Chi- square is a nonparametric test, and its core function is to examine the significant difference between observed and expected frequencies. In this part, 11 questions (for 11 critical success factors) are designed as illustrated by the following examples, which have been answered by Chi- square test:

Question 1:

What is the level of SCKM maturity for each indicator of the "strategy" critical success factor? Hypotheses (H0 and H1) in this test are as follows:

H0: There is no significant difference between the SCKM maturity levels and each indicator of the "strategy" critical success factor.

H1: There is a significant difference between the SCKM maturity levels and each indicator of the "strategy" critical success factor.

Since the level of significance is smaller than the error value of 0.05 (Table 4), with 95% confidence, the null hypothesis is rejected and consequently, there is a significant difference between the SCKM maturity levels and each indicator of the "strategy" critical level success factor. Based on the results of this test, the maturity level of each in indicator is specified. As shown in the table, according to the indicator frequency of maturity levels, indicators of first to sixth are in the second level of maturity and indicators of seventh and eighth are in the third level.

Table 4. Results of chi- square test for classifying the indicators of "strategy" critical success factor between maturity levels

CSF1 indicators	Frequency				Chi-square	df	Sig.	The selective ML
	ML*2	ML3	ML4	ML5				
CSF1_I1	31	13	7	0	18.353	2	0.000	2
CSF1_I2	36	7	8	0	31.882	2	0.000	2
CSF1_I3	31	13	7	0	18.353	2	0.000	2
CSF1_I4	39	8	4	0	43.176	2	0.000	2
CSF1_I5	41	10	0	0	18.843	1	0.000	2
CSF1_I6	37	14	0	0	10.373	1	0.001	2
CSF1_I7	17	34	0	0	5.667	1	0.017	3
CSF1_I8	15	36	0	0	8.647	1	0.003	3

* ML: Maturity Level.

Based on the prioritizing CSF indicators, the final model for SCKM maturity assessment is shown in Figure 2.

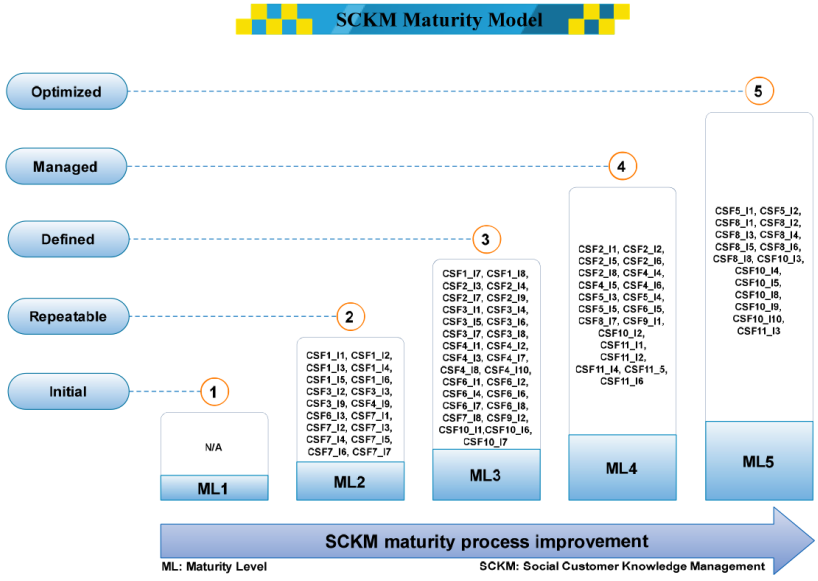

Figure 2. The final model for maturity assessment via disaggregated indicators

3.3. Assessing the SCKM maturity level of the studied organization

In this part of the research, the questionnaire contains close-ended and the seven-item Likert scale that is considered one of the most common measurement scales. Thus, the qualitative and non-parametric data with numerical values are interpreted and acted upon in the calculation. Average rating of all variables determines the factors score and the maturity of the organization.

To examine the applicability of the research model, the model was tested in one of the organizations for providing electronic services. For evaluation, a questionnaire consisting of 83 questions based on the following criteria was designed; in the questionnaire, respondents were asked to rate their organization's compliance with each of the items based on the Likert scale ranging from strongly disagree (–6) to strongly agree (6). After collecting data from the study, indicators and factor scores were calculated, and based on these scores, strengths and weaknesses of the organization of the study was investigated in each factor, compared with ideal score and acceptable minimum score. Finally, according to the scores of the level of the SCKM maturity factors, and through the expert system based on inference rules, levels of the model were determined. Frequencies of questions and reliability evaluation results are shown in Table 5. To check the validity of the questionnaire in this study, the questionnaires were approved by the experts and professors.

Table 5. Frequency of questions and results of questionnaire reliability

CSF	Number of questions	Cronbach's alpha	CSF	Number of questions	Cronbach's alpha
Strategy	8	0.807	Resources	8	0.739
Leadership	9	0.739	Business Intelligence	8	0.785
Information Technology	9	0.739	Security	2	0.709
Knowledge Management	10	0.785	Social Customer	10	0.836
Culture	5	0.785	Assessment	6	0.798
Process	8	0.785			

Cronbach's alpha value should be above 0.7 to less than or equal to 1. Given that Cronbach's alpha coefficient is above 0.7, so the questionnaire has good reliability.

3.4. Designing and implementing the fuzzy expert system

An Expert System is an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough and requires no specific human expertise (Cohen, Feigenbaum 2014). To create this kind of system, knowledge must be gained from experts at first and then be defined as rules. The hesitant fuzzy set is a very useful tool to deal with uncertainty. More and more multiple attribute decision-making theories and methods under hesitant fuzzy environment have been developed (Wei 2016a; Wei *et al.* 2016). Using fuzzy numbers to describe the qualitative values, due to its proximity to reality, has increased considerably. The advantage of picture fuzzy set is easily reflecting the ambiguous nature

of subjective judgments because the picture fuzzy sets are suitable for capturing imprecise, uncertain, and inconsistent information in the multiple attribute decision making analysis (Wei 2016b). Fuzzy expert systems utilize fuzzy data, fuzzy suggestions and fuzzy logic. Fuzzy rules and membership functions are key constitutive elements of a fuzzy expert system. The reason is that it seeks to demonstrate the approximately, uncertainty and quality of boundary conditions through fuzzy sets with membership functions (Zadeh 1965). In the present study, it is assumed that the decision-making judgments about the utility or elements preferences are in form of trapezoidal fuzzy numbers. In fact, qualitative data can be modelled as fuzzy sets (Phillips *et al.* 1996). In non-fuzzy logic, there are only true or false values, logic of 0 and 1. This is not a perfect logic, because in many cases understanding and decision-making process of human is not quite definite and depending on the time and place, it is partly true and partly false. In order to create a fuzzy expert system, MATLAB software is used to assess SCKM maturity. In maturity assessment, the indicators that affect the success of SCKM are grouped based on the Criteria Success Factors (CSFs). The designed system is tested for the study, and the relevant results are presented. The general schema of SCKM maturity assessment expert system is shown in Figure 3.

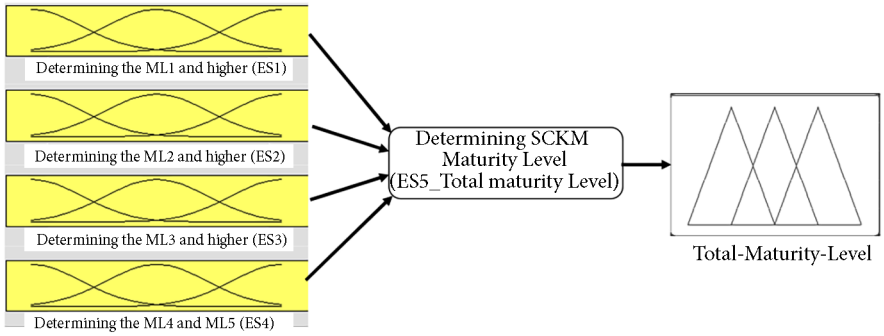

Figure 3. The schema for expert system of SCKM maturity assessment

As it stands, the system is composed of five expert systems, the output of the first four expert systems is the inputs of fifth expert system for measuring the SCKM maturity level. Each expert system is described in Table 6.

By entering the input arguments of expert systems, the output is returned to the non-fuzzy format whose structure is formed by Evalfis function:

- *Fismat = readfis ('title of the fuzzy expert system function'),*
- *Out = evalfis ([value inputs], title of the fuzzy expert system function).*

According to the maturity assessment model, the rules are designed in sharing format, using the AND operator as well as the Mamdani inference engine product. The process of calculating a precise and non-fuzzy number in the output of fuzzy expert system is called defuzzification (Taber 1995). In this study, the center of in order to defuzzifie the output of the Mamdani inference engine, the Centroid method is used. The result will be the maturity of the organization under study. To calculate the final weight of CSFs in maturity levels, the

CSF weight and indicators as well as the importance and priority of each maturity level, is extracted by the AHP method (Appendix 1 and 2). Results and instruction of work for the second level of (Repeatable) maturity are shown in Appendix 3. The final weight of other CSFs in the corresponding maturity levels is extracted in the same way.

Table 6. The specification of expert systems

ES*	Input	Number of rules	Output
ES1 – The second level (Repeatable)	The mean of 18 indicators	16	Determining the ML1 and higher
ES2 – The third level (Defined)	The mean of 29 indicators	72	Determining the ML2 and higher
ES3 – The fourth level (Managed)	The mean of 20 indicators	75	Determining the ML3 and higher
ES4 – The fifth level (Optimized)	The mean of 16 indicators	9	Determining the ML4 and ML5
Method of determining the rules for ES1, ES2, ES3 and ES4			
1. Condition sets of "final CSF weight" which are greater than or equal (>=) to half of the "total sum weights". 2. Condition sets of "final CSF weight" which are less than (<) half of the "total sum weights".			
ES5 –Total SCKM maturity Level	ES1, ES2, ES3 and ES4 outputs	16	SCKM maturity level
Method of determining the rules for ES5			
According to 4 inputs, there are $2^4 = 16$ rules			

* ES: Expert System.

As specified in the rules (Appendix 4), to determine the ML1, the set of cases of the final CSF weight selected in the second maturity level (Repeatable), is considered as less than half of the "total sum weights" and to determine the maturity level of more than ML1, this set of cases selected as the final weight of CSF in the second maturity level (Repeatable), is greater than or equal to half of the "total sum weights". For the second (ES2), third (ES3) and fourth (ES4) expert systems is acted in the same way.

To implement the first expert system, the mean of 18 extracted indicators from the questionnaires will be considered as input of expert system. The first expert system output is equal to 0.552, which has been shown in Figure 8, with radar graph of the second maturity level (Repeatable) of the organization under study. To implement the second, third and fourth expert systems, the mean values of 29, 20 and 16 indicators derived from the questionnaire are considered as input respectively. Outputs of second, third and fourth expert systems are 1.54, 2.51 and 3.43 respectively, which has been shown with radar graph of the related maturity level of the organization under study in Figure 4.

To implement the fifth expert system, the output of the four expert systems of first (ES1), second (ES2), third (ES3) and fourth (ES4) will be considered as input of the expert system. The ES5- Total Maturity Level rules are shown in Appendix 5. The final output of expert system equals 0.759, which is shown in Figure 5.

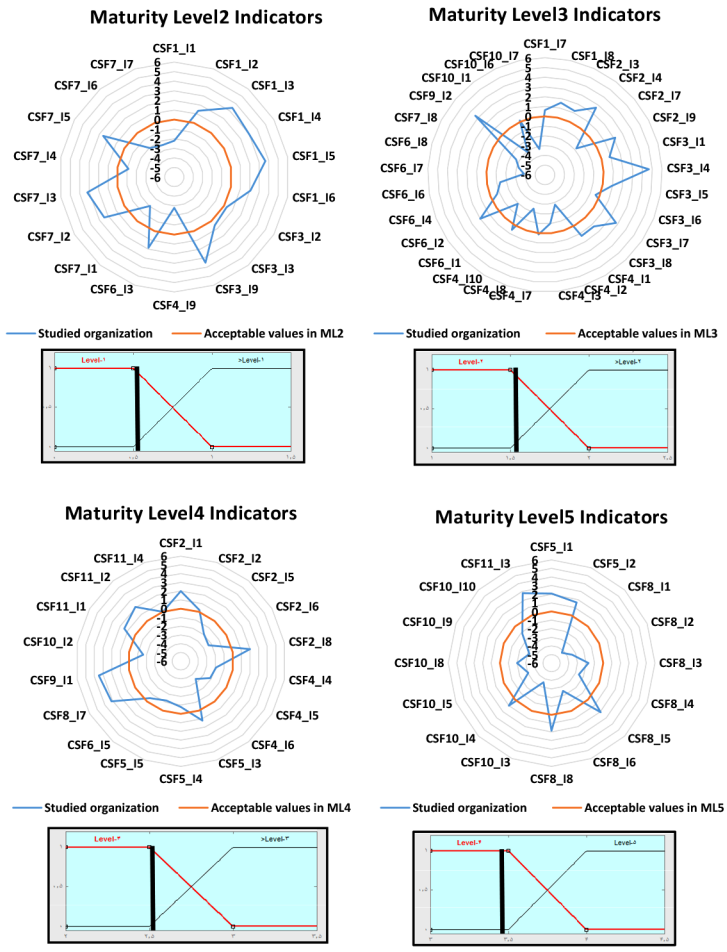

Figure 4. Radar graph, ES1 (the second level (repeatable)), ES2 (the third level (defined)), ES3 (the fourth level (managed)) and ES4 (the fifth level (optimized)) outputs

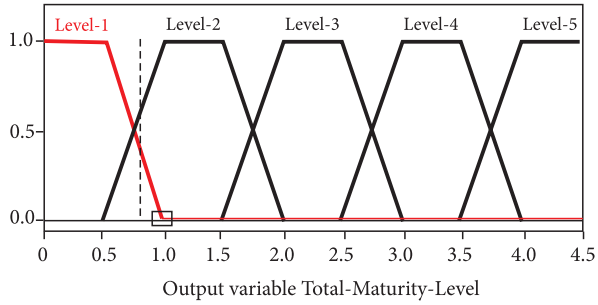

Figure 5. Final output of ES5_Total Maturity Level

Membership function and output for five levels of maturity can be defined as follows:

$$\widetilde{L_1}(x)=\begin{cases}1 & 0\le x\le 0.5,\\ \dfrac{1-x}{0.5} & 0.5\le x\le 1.\end{cases} \tag{1}$$

$$\widetilde{L_2}(x)=\begin{cases}\dfrac{x-0.5}{0.5} & 0.5\le x<1,\\ 1 & 1\le x\le 1.5,\\ \dfrac{2-x}{0.5} & 1.5<x\le 2.\end{cases} \tag{2}$$

$$\widetilde{L_3}(x)=\begin{cases}\dfrac{x-1.5}{0.5} & 1.5\le x<2,\\ 1 & 2\le x\le 2.5,\\ \dfrac{3-x}{0.5} & 2.5<x\le 3.\end{cases} \tag{3}$$

$$\widetilde{L_4}(x)=\begin{cases}\dfrac{x-2.5}{0.5} & 2.5\le x<3,\\ 1 & 3\le x\le 3.5,\\ \dfrac{4-x}{0.5} & 3.5<x\le 4.\end{cases} \tag{4}$$

$$\widetilde{L_5}(x)=\begin{cases}\dfrac{x-3.5}{0.5} & 3.5\le x<4,\\ 1 & 4\le x.\end{cases} \tag{5}$$

With regard to the membership functions for maturity levels, the outputs of the final expert system for any of levels of maturity assessment are extracted (Table 7).

Table 7. Calculate the share of each maturity level based on membership functions

Output range	Maturity Level	Calculate the share of each maturity level
[0–0/5]	First	First level: 100%
[0/5–1]	First and Second	First level: $\frac{1-x}{0/5}\times 100$, Second level: $\frac{x-0/5}{0/5}\times 100$
[1–1/5]	Second	Second level: 100%
[1/5–2]	Second and Third	Second level: $\frac{2-x}{0/5}\times 100$, Third level: $\frac{x-1/5}{0/5}\times 100$
[2–2/5]	Third	Third level: 100%
[2/5–3]	Third and Fourth	Third level: $\frac{3-x}{0/5}\times 100$, Fourth level: $\frac{x-2/5}{0/5}\times 100$
[3–3/5]	Fourth	Fourth level: 100%
[3/5–4]	Fourth and Fifth	Fourth level: $\frac{4-x}{0/5}\times 100$, Fifth level: $\frac{x-3/5}{0/5}\times 100$
[4–4/5]	Fifth	Fifth level: 100%

According to the value of the expert system output, the maturity level is interpreted as follows:

$$x = 0.759 \Rightarrow \widetilde{L_1}(0.759) = \frac{1 - 0.759}{0.5} = \frac{0.241}{0.5} = 0.482,$$

$$\widetilde{L_2}(0.759) = \frac{0.759 - 0.5}{0.5} = \frac{0.259}{0.5} = 0.518.$$

The percentage of first level (Level-1): 48.2%.

The percentage of second level (Level-2): 51.8%.

The Organization of the study has covered 48.2% of the first level of maturity and 51.8% of the second level of maturity. But given that the CSF in each maturity level has covered some indicators; however, by observing the radar graph for each maturity level in the organization, gaps can be displayed (Table 8).

Table 8. Status of CSF indicators and maturity levels within the studied organization

	ML2	ML3	ML4	ML5	Sum
The total number of indicators	18	29	20	16	83
The number of covered indicators (>0)	12	16	8	6	42
The number of weak indicators (≤0)	6	13	12	10	41

As the results show, in order to reach full maturity in SCKM, it is indispensable for the studied organization to have treatment strategies for its 41 poor indicators. In other words, for converging the second, third, fourth and fifth maturity assessment levels, there are 6, 13, 12 and 10 indicators gaps respectively. Table 9 shows the gaps in each CSF. Therefore, the most frequent extracted gaps in the studied organization are related to the knowledge management CFS; obviously, the organization condition from the security CSF is in desired level (Table 9). This management dashboard gives a clear vision to executives and decision makers about the current situation in organizations, the future perspective, and the improvement situation.

Table 9. The number of weak indicators

CSF	Indicators
Strategy (N = 1)	(CSF1_I1).
Leadership (N = 3)	(CSF2_I5), (CSF2_I6), (CSF2_I7).
Information Technology (N = 1)	(CSF3_I6).
Knowledge Management (N = 7)	(CSF4_I2), (CSF4_I3), (CSF4_I4), (CSF4_I5), (CSF4_I6), (CSF4_I8), (CSF4_I9).
Culture (N = 2)	(CSF5_I4), (CSF5_I5).
Process (N = 6)	(CSF6_I1), (CSF6_I4), (CSF6_I5), (CSF6_I6), (CSF6_I7), (CSF6_I8).
Resources (N = 5)	(CSF7_I1), (CSF7_I4), (CSF7_I6), (CSF7_I7), (CSF7_I8).
Business Intelligence (N = 5)	(CSF8_I1), (CSF8_I2), (CSF8_I3), (CSF8_I4), (CSF8_I6).
Security (N = 0)	----------

End of Table 9

CSF	Indicators
Social customer (N = 8)	(CSF10_I1), (CSF10_I2), (CSF10_I3), (CSF10_I5), (CSF10_I7), (CSF10_I8), (CSF10_I9), (CSF10_I10).
Assessment (N = 3)	(CSF11_I4), (CSF11_I5), (CSF11_I6).
Sum: CSF = 10, Indicators = 41	

The results of previous studies show that most the organizational investments have been made in the field of technology and security. On the other hand, the research results related to CSFs of strategies, information technology, culture, knowledge management, resources and assessments, are in accordance to the findings of previous researchers, including (Khatibian *et al.* 2010; Kerrigan 2013; Koehler *et al.* 2015; Lee, Kwak 2012; Valdés *et al.* 2011); however, since this study has covered all aspects of SCKM, other CSFs have been emerged and matured including Social Customer, Leadership, Security, and Business Intelligence.

Conclusions

CKM is one of the approaches of implementing knowledge management in organizations. Social media can generate a huge amount of information, and customers can decide on the format and content of that information. One of the major aspects that have not been discussed is the interaction between concepts (including ECRM, process knowledge, customer knowledge and social media) which is used to construct necessary insight for decision-making management.

One of the most important steps before implementing a technology-based strategy such as SCKM is to assess organizational readiness for it. In fact, this stage possesses a vital role in the success or failure of SCKM strategy. From the point of view of most of the maturity assessment models in the literature, the concept is a process, and the customers' excellence is due to the development of this process. Therefore, maturity levels in these models are provided generally by KPAs. Another difference between this study and other related studies is that due to utilizing systems which are based on fuzzy logic, the results and findings favour high accuracy and validity.

In this research, the fuzzy expert system is presented to assess the SCKM maturity based on the distribution of each CSF indicator in the related maturity levels, therefore the accuracy and quality of results will increase. The system is applicable in those organizations providing e-services, as a reference for in-depth analysis of organizational readiness for SCKM deployment and its improvement.

The main difference between studies involving an expert system and other similar studies is that this expert system is not designed specifically for a case study, but all organizations providing electronic services can use this expert system and evaluate their maturity level in the field of SCKM. According to the results of the study, it has covered 48.2% of the first level of maturity and 51.8% of the second level of maturity. Six poor indicators of the second level of the organization of the study include: organizing the SCKM strategy, establishing the SCKM information systems, managing resources needed to establish the SCKM framework,

increasing the employee satisfaction, providing the framework and documented system of services pricing, and estimating the exact cost to establish SCKM. Other poor indicators in another maturity levels are provided via radar graph.

The expert system will check the company's capability to utilize SCKM effectively and based on the results, will help organizations to prepare themselves for successful implementation of ECRM through social media and to do investing and planning for such a momentous and important activity with more knowledge. It can be used to measure the current maturity level of a certain aspect of an organization in a meaningful way, enabling stakeholders to clearly identify strengths and improvement points, and accordingly prioritize what to do in order to reach higher maturity levels. These findings provide several contributions to the SCKM maturity assessment and offer managerial insight into the efficacy of social media technology use.

This study provides evidence that investment in SCKM maturity assessment can grant organizations substantial relationship management benefits. Organizations should focus on strategies that emphasize customer relationship building on social media, which allows more customer involvement and more interactions between customer and business. Moreover, this study suggests that understanding the SCKM maturity level makes organizations aware of social media. When the organization's maturity level is reduced, the organization has left the competition in the digital world, and it is necessary to adopt strategies for their development. SCKM maturity assessment capabilities cannot only drive customer engagement but also boost organizations' value in the long run.

Implications for future research include:

- The expert system of "gap treatment strategy for the SCKM Maturity Assessment" should be developed via disaggregated CSF indicators. Therefore, administrators can use a road map to develop strategies for improvement;
- The above-mentioned expert system can be combined with the organization business intelligence and displayed in the results of a management dashboard of the organization.

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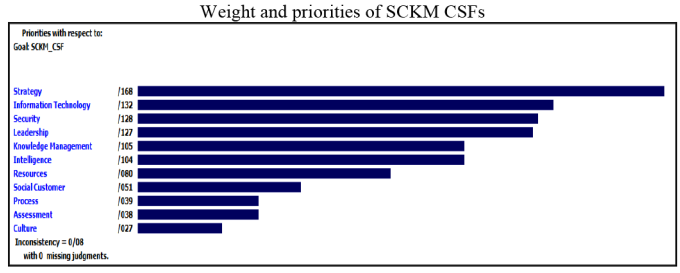
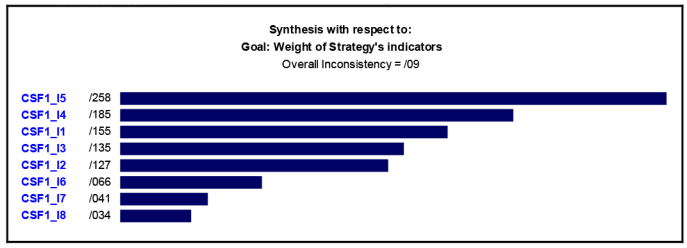
APPENDIX 1

Weight and priorities of SCKM CSFs



APPENDIX 2

Calculating the weight of indicators related to "Strategy" Critical Success Factor and their rating



APPENDIX 3

Calculation of Final weight and Total weight of each CSF in the second maturity level (Repeatable)

CSF	Indicators	Indicator Weight	CSF Weight	Final weight	Final CSF weight
strategy	CSF1_I1	0.155	0.168	0.026	0.156
	CSF1_I2	0.127	0.168	0.021	
	CSF1_I3	0.135	0.168	0.023	
	CSF1_I4	0.185	0.168	0.031	
	CSF1_I5	0.258	0.168	0.043	
	CSF1_I6	0.066	0.168	0.011	
Information Technology	CSF3_I2	0.165	0.132	0.022	0.052
	CSF3_I3	0.191	0.132	0.025	
	CSF3_I9	0.04	0.132	0.005	
Knowledge Management	CSF4_I9	0.04	0.105	0.004	0.004
Process	CSF6_I3	0.094	0.039	0.004	0.004
Resources	CSF7_I1	0.183	0.080	0.015	0.077
	CSF7_I2	0.144	0.080	0.012	
	CSF7_I3	0.061	0.080	0.005	
	CSF7_I4	0.168	0.080	0.013	
	CSF7_I5	0.23	0.080	0.018	
	CSF7_I6	0.11	0.080	0.009	
	CSF7_I7	0.061	0.080	0.005	
Total sum weights:	0.292				

APPENDIX 4

ES1 Rules

1. If (CSF1-I1 is AVE(<=0)) and (CSF1-I2 is AVE(<=0)) and (CSF1-I3 is AVE(<=0)) and (CSF1-I4 is AVE(<=0)) and (CSF1-I5 is AVE(<=0)) and (CSF1-I6 is AVE(<=0)) and (CSF3-I2 is AVE(<=0)) and (CSF3-I3 is AVE(<=0)) and (CSF3-I9 is AVE(<=0)) and (CSF4-I9 is AVE(<=0)) and (CSF6-I3 is AVE(<=0)) and (CSF7-I1 is AVE(<=0)) and (CSF7-I2 is AVE(<=0)) and (CSF7-I3 is AVE(<=0)) and (CSF7-I4 is AVE(<=0)) and (CSF7-I5 is AVE(<=0)) and (CSF7-I6 is AVE(<=0)) and (CSF7-I7 is AVE(<=0)) then (ES1-Level is Level-1) (1)
2. If (CSF1-I1 is AVE(>0)) and (CSF1-I2 is AVE(>0)) and (CSF1-I3 is AVE(>0)) and (CSF1-I4 is AVE(>0)) and (CSF1-I5 is AVE(>0)) and (CSF1-I6 is AVE(>0)) then (ES1-Level is >Level-1) (1)
3. If (CSF3-I2 is AVE(>0)) and (CSF3-I3 is AVE(>0)) and (CSF3-I9 is AVE(>0)) and (CSF4-I9 is AVE(>0)) and (CSF6-I3 is AVE(>0)) and (CSF7-I1 is AVE(>0)) and (CSF7-I2 is AVE(>0)) and (CSF7-I3 is AVE(>0)) and (CSF7-I4 is AVE(>0)) and (CSF7-I5 is AVE(>0)) and (CSF7-I6 is AVE(>0)) and (CSF7-I7 is AVE(>0)) then (ES1-Level is >Level-1) (1)
4. If (CSF3-I2 is AVE(>0)) and (CSF3-I3 is AVE(>0)) and (CSF3-I9 is AVE(>0)) then (ES1-Level is Level-1) (1)
5. If (CSF4-I9 is AVE(>0)) then (ES1-Level is Level-1) (1)
6. If (CSF6-I3 is AVE(>0)) then (ES1-Level is Level-1) (1)
7. If (CSF7-I1 is AVE(>0)) and (CSF7-I2 is AVE(>0)) and (CSF7-I3 is AVE(>0)) and (CSF7-I4 is AVE(>0)) and (CSF7-I5 is AVE(>0)) and (CSF7-I6 is AVE(>0)) and (CSF7-I7 is AVE(>0)) then (ES1-Level is Level-1) (1)
8. If (CSF3-I2 is AVE(>0)) and (CSF3-I3 is AVE(>0)) and (CSF3-I9 is AVE(>0)) and (CSF4-I9 is AVE(>0)) then (ES1-Level is Level-1) (1)
9. If (CSF3-I2 is AVE(>0)) and (CSF3-I3 is AVE(>0)) and (CSF3-I9 is AVE(>0)) and (CSF6-I3 is AVE(>0)) then (ES1-Level is Level-1) (1)
10. If (CSF3-I2 is AVE(>0)) and (CSF3-I3 is AVE(>0)) and (CSF3-I9 is AVE(>0)) and (CSF7-I1 is AVE(>0)) and (CSF7-I2 is AVE(>0)) and (CSF7-I3 is AVE(>0)) and (CSF7-I4 is AVE(>0)) and (CSF7-I5 is AVE(>0)) and (CSF7-I6 is AVE(>0)) and (CSF7-I7 is AVE(>0)) then (ES1-Level is Level-1) (1)
11. If (CSF3-I2 is AVE(>0)) and (CSF3-I3 is AVE(>0)) and (CSF3-I9 is AVE(>0)) and (CSF4-I9 is AVE(>0)) and (CSF6-I3 is AVE(>0)) then (ES1-Level is Level-1) (1)
12. If (CSF3-I2 is AVE(>0)) and (CSF3-I3 is AVE(>0)) and (CSF3-I9 is AVE(>0)) and (CSF4-I9 is AVE(>0)) and (CSF7-I1 is AVE(>0)) and (CSF7-I2 is AVE(>0)) and (CSF7-I3 is AVE(>0)) and (CSF7-I4 is AVE(>0)) and (CSF7-I5 is AVE(>0)) and (CSF7-I6 is AVE(>0)) and (CSF7-I7 is AVE(>0)) then (ES1-Level is Level-1) (1)
13. If (CSF4-I9 is AVE(>0)) and (CSF6-I3 is AVE(>0)) then (ES1-Level is Level-1) (1)
14. If (CSF4-I9 is AVE(>0)) and (CSF7-I1 is AVE(>0)) and (CSF7-I2 is AVE(>0)) and (CSF7-I3 is AVE(>0)) and (CSF7-I4 is AVE(>0)) and (CSF7-I5 is AVE(>0)) and (CSF7-I6 is AVE(>0)) and (CSF7-I7 is AVE(>0)) then (ES1-Level is Level-1) (1)
15. If (CSF4-I9 is AVE(>0)) and (CSF6-I3 is AVE(>0)) and (CSF7-I1 is AVE(>0)) and (CSF7-I2 is AVE(>0)) and (CSF7-I3 is AVE(>0)) and (CSF7-I4 is AVE(>0)) and (CSF7-I5 is AVE(>0)) and (CSF7-I6 is AVE(>0)) and (CSF7-I7 is AVE(>0)) then (ES1-Level is Level-1) (1)
16. If (CSF6-I3 is AVE(>0)) and (CSF7-I1 is AVE(>0)) and (CSF7-I2 is AVE(>0)) and (CSF7-I3 is AVE(>0)) and (CSF7-I4 is AVE(>0)) and (CSF7-I5 is AVE(>0)) and (CSF7-I6 is AVE(>0)) and (CSF7-I7 is AVE(>0)) then (ES1-Level is Level-1) (1)

APPENDIX 5

ES5- Total Maturity Level rules

1. If (ES1 is Level-1) and (ES2 is Level-2) and (ES3 is Level-3) and (ES4 is Level-4) then (Total-Maturity-Level is Level-1) (1)
2. If (ES1 is Level-1) and (ES2 is Level-2) and (ES3 is Level-3) and (ES4 is Level-5) then (Total-Maturity-Level is Level-1) (1)
3. If (ES1 is Level-1) and (ES2 is Level-2) and (ES3 is >Level-3) and (ES4 is Level-4) then (Total-Maturity-Level is Level-1) (1)
4. If (ES1 is Level-1) and (ES2 is Level-2) and (ES3 is >Level-3) and (ES4 is Level-5) then (Total-Maturity-Level is Level-1) (1)
5. If (ES1 is Level-1) and (ES2 is >Level-2) and (ES3 is Level-3) and (ES4 is Level-4) then (Total-Maturity-Level is Level-1) (1)
6. If (ES1 is Level-1) and (ES2 is >Level-2) and (ES3 is Level-3) and (ES4 is Level-5) then (Total-Maturity-Level is Level-1) (1)
7. If (ES1 is Level-1) and (ES2 is >Level-2) and (ES3 is >Level-3) and (ES4 is Level-4) then (Total-Maturity-Level is Level-1) (1)
8. If (ES1 is Level-1) and (ES2 is >Level-2) and (ES3 is >Level-3) and (ES4 is Level-5) then (Total-Maturity-Level is Level-1) (1)
9. If (ES1 is >Level-1) and (ES2 is Level-2) and (ES3 is Level-3) and (ES4 is Level-4) then (Total-Maturity-Level is Level-2) (1)
10. If (ES1 is >Level-1) and (ES2 is Level-2) and (ES3 is Level-3) and (ES4 is Level-5) then (Total-Maturity-Level is Level-2) (1)
11. If (ES1 is >Level-1) and (ES2 is Level-2) and (ES3 is >Level-3) and (ES4 is Level-4) then (Total-Maturity-Level is Level-2) (1)
12. If (ES1 is >Level-1) and (ES2 is Level-2) and (ES3 is >Level-3) and (ES4 is Level-5) then (Total-Maturity-Level is Level-2) (1)
13. If (ES1 is >Level-1) and (ES2 is >Level-2) and (ES3 is Level-3) and (ES4 is Level-4) then (Total-Maturity-Level is Level-3) (1)
14. If (ES1 is >Level-1) and (ES2 is >Level-2) and (ES3 is Level-3) and (ES4 is Level-5) then (Total-Maturity-Level is Level-3) (1)
15. If (ES1 is >Level-1) and (ES2 is >Level-2) and (ES3 is >Level-3) and (ES4 is Level-4) then (Total-Maturity-Level is Level-4) (1)
16. If (ES1 is >Level-1) and (ES2 is >Level-2) and (ES3 is >Level-3) and (ES4 is Level-5) then (Total-Maturity-Level is Level-5) (1)