A System Dynamics Approach for Knowledge Management and Business Excellence: An Application in Iran

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Abstract

One of the excellence enablers is KM[1]. In order to evaluate the KM processes, a comprehensive model is required, which should be able to capture all aspects of KM. One of such models is KMAT[2]. This research exploits system dynamics in order to measure the effects of KM on business excellence with a combination of KMAT and EFQM[3].Relationships between KM and EFQM are analyzed and demonstrated by means of the literature reviews, expert interviews and system dynamics .The results of this study could be useful for knowledge management planners and managers in organizations.

***Key words*:** Knowledge Management; Business Excellence; System Dynamics

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[1] Knowledge Management

[2] knowledge Management Assessment Tool

[3] European Foundation for Quality Management

1. Introduction

In a world of dynamic and discontinuous change, organizations are constantly seeking ways to adapt themselves to new conditions so that they are prepared to survive and flourish in a competitive marketplace (Albert 1997). The proliferation of the knowledge economy (Castells 1996), emphasizing the value of information as an enabler of competitive advantage, is naturally driving many companies to re-examine the ways they have treated their knowledge assets in the past and to identify ways in which they can exploit them more effectively in the future.

Drucker(1993) has described knowledge, rather than capital or labor as the only meaningful economic resource in the knowledge society, and Senge(1990) has warned that many organizations are unable to function as knowledge based organizations, because they suffer from learning disabilities those organizations that will succeed in the global information society are those which can identify, value, create and evolve their knowledge assets (Rowley 1999; Lai 2007).In such a landscape, it is not surprising that knowledge and information management has emerged as one of the most popular strategic change management approaches in the dawn of the twenty-first century (Davenport and Prusak 1997). Its supporters argue that organizations may achieve significant competitive advantages by analyzing the data and information that often remain unexploited in organizational systems and by transforming them into useful and actionable knowledge (Giaglis 2002). Although there could be found some researches about the improvement and application of EFQM model and KM (Jager 1999; Yim et al. 2004; Bose 2004; Kumar 2010; Pal et al. 2004; Smits and Moor 2004; Waraporn et al. 2010) and also about utilization of system dynamics in EFQM model(Dehghani et al. 2009; Eskildsen et al. 2001; Sadeh and Arumugam 2010) in the literature, there have been no attention paid to simultaneous investigation of EFQM and KM for finding the effects of KM on business excellence. Accordingly, this research tries to depict these effects by combining the EFQM model and KM Assessment Tool. The conducted studies that exploit system dynamics in the knowledge management are as follows:

- Drew and A. Smith (1996) in which, with regard to the importance of knowledge resources (as a competitive advantage) in increasing the market share of a business, it is stated that the nature of these intellectual capitals and the interactions of their system dynamics are recognized weakly yet.

- Eklöf et al. (2004), the main goal of which is to survey the knowledge management in a Law Firm with focus on the supportive role of information technology. For this aim, system dynamics simulation tool is applied to present diagrams of cause and effect loops, stock and flows, in order to describe different variables and their effects on each other. These diagrams indicate variables influencing the general level of organization's knowledge and the need to knowledge management.

Knowledge could be managed regarding different aspects of process, leadership, culture, technology, and measurement (i.e. KMAT dimensions) and its effects on results components of EFQM, including customers, employees, society, and key performance indicators, could be assessed. The proposed model could not illustrate the effectiveness of KM unless it is applied and evaluated regarding apt performance indicators. These

indexes should be of both types of quantitative and qualitative and should be measure via a systematic approach. This is the only way managers can understand the critical success factors of KM in their organizations. One of the appropriate systematic approaches is system dynamics, which provide the opportunity to model and analyze the behavioral patterns in phenomena with the goal of decision making based on prediction (Jager 1999; Yim et al. 2004).

This research aims at developing a dynamic model for measuring the effectiveness of Knowledge Management (KM) processes on excellence of organizations. It focuses on analyzing the key aspects of KM which affect business excellence. This analysis would be conducted through simulation and by using the mentioned dynamic model. The case study will describe in this article is concerned about the Pars Refractories company in Iran. For relating the KM and the business excellence, it is required to understand and establish the "cause and effect" relationships between the KMAT dimensions and results indexes of EFQM. Systematic approach shed light on the cause and effect relationships. Furthermore, it states that all diverse aspects and sections of an organization are related to each other and nobody could improve on section or whole of an organization without enhancing others. On the other hand, amongst the numerous variables and their relations, only some especial cause and effect loops dominate and are significant to overall behavior of the system. In this paper, after defining the relationships between variables and formulating a combinational dynamic model for measuring the effectiveness of KM, different policies are designed for developing KM plans and their results are evaluated. Amongst the various methods for modeling system dynamics, a simple one consisting of problem definition, cause and effect diagram modeling, dynamical model generation, simulation, analysis, and application steps is utilized.

2. Theoretical Bases

2.1. The EFQM Excellence Model

European Foundation for Quality Management (EFQM) has nine criteria. Five criteria are known as enablers and four other ones are called results. "Enablers" cover what an organization performs and "results" include what an organization obtains. "Results" are obtained by implementing "enablers" and "enablers" are improved by getting a feedback from "results" (Dehghani Saryazdi 2006).Enablers include leadership, strategy, people, Partnerships & Resources and Processes, Products & Services. Results consist of the results for customers, people, society and key results. All enablers, except strategy, include 5 sub-criteria. Strategy criterion includes 4 sub-criteria. Each of results also includes two sub-criteria. Thus, 24 sub-criteria and 8 sub-criteria respectively have been defined for enablers and results.

2.2. KMAT Model

The knowledge management assessment tool (KMAT) is designed to help organizations make an initial high-level assessment of how well they manage knowledge. Completing

the KMAT can direct organizations toward areas that require more attention, as well as identify knowledge management practices in which they excel.

2.3. System Dynamics

System dynamics is an approach to understanding the behavior of complex systems over time. It deals with internal feedback loops and time delays that affect the behavior of the entire system (Sterman 2000).

3. Modeling Process

3.1 Cause-and-Effect Diagram Modeling

In the first phase, the cause-and-effect diagram of the combinational model of KMAT and EFQM is designed regarding the identified variables (see figure 1). It can be seen in this diagram that in the forward direction the business strategy and policy affects the KMAT dimensions and consequently KMAT dimensions influence the performance indicators of the results section of EFQM, which in its turn changes the outcome indexes of the results section. Furthermore, in the backward direction, the performance and outcome indexes influence KM separately and KM impacts the business strategy and policy. Thus, these forward and backward paths create some loops in the model.

Naturally, if the business strategy and policy are improved, knowledge would be managed better and when the KM in enhanced, the performance indicators would be amended in the result section. Increasing the values of performance indicators, results in the raise of outcome indexes. On the other hand, the better the KM, the more appropriate the business strategies and policies, and superior results decrease the need to KM improvement. Accordingly, the focus should be on the processes for which the results (i.e. performance indicators and outcome indexes) are smaller. So, the loops of this diagram are negative (balancing) feedback loops which are illustrated by 

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It is notable that changes occurred for KMAT dimensions impact the performance indicators after a delay, like what happens between performance indicators and outcome indexes in the results section of the EFQM model. Other relationships have specific delay times too. In the diagram these delays in relationships between two variables are shown by two parallel lines (||) on the corresponding arrows. Furthermore, in the designed model three extra variables namely, customer loyalty, image, and employee satisfaction are included which will be elaborated in the next section. Regarding the relationships between variables the following points could be seen in figure 1:

- Because one of the dimensions of KMAT is measurement, so this variable is included in the performance and outcome indicators of EFQM model and there is no obligation for defining a new variable under the name of ‘measurement’.
- Regarding that the business strategy and policy affects the leadership dimension of KM, and because leadership, on its own turn, affects the dimensions of processes, technology, and organizational culture, their impacts are illustrated in

the cause-and-effect diagram through the relationships between them. On the other hand processes, technology, and organizational culture influence the results indexes and increasing the amounts of result indexes decreases the required effort for KM.

- Performance indicators affect the outcome indexes. Customer loyalty is influenced by outcome indexes of customer results. Image is affected by outcome indexes of customer and society results. Employee results impacts employee satisfaction. The culture variable influences the employee results index. Technology impacts the society results indexes and key performance indicators. Customer results, society results, and key performance indicators are impacted by processes variable.

- In the model, letter 'a' indicates the outcome indexes and letter 'b' addresses performance indicators.

- In the model, processes, leadership, culture, and technology variables are exhibited by signs I, II, III, and IV respectively.

- In the proposed model, the measurement variable includes all the indexes of the EFQM results section (i.e. customer results, employees, society and key performance indicators).

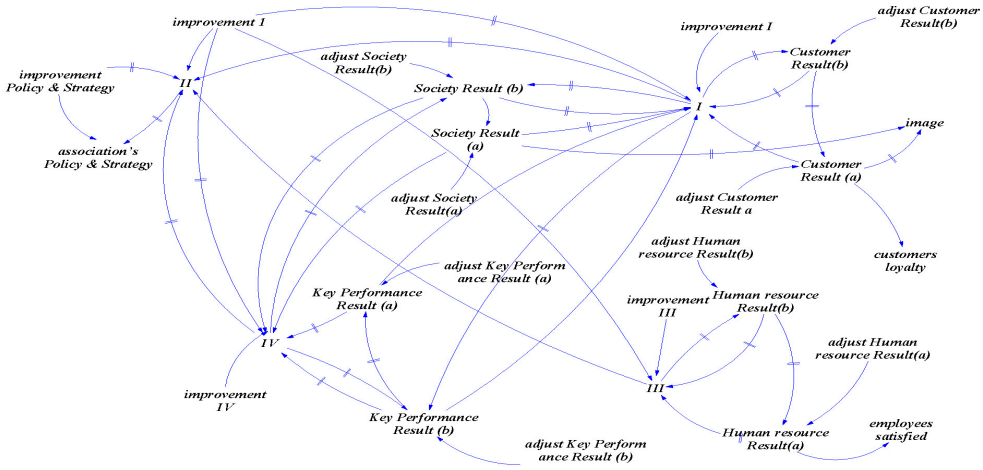

Figure 1. Cause-and-Effect diagram

3.2 Stock and Flow Map Modeling

In this section the quantitative relationships between model variables are defined. Here, the time period is set to one year. The model is executed with Vensim PLE software application. Some of the relationships of the dynamical model are included as appendix. The model is simulated for 10 years beginning from year 2010. Since KMAT and EFQM models evaluate the organization in a specific point of time, all the sub-criteria of the model are of auxiliary variable type.

For the cumulative trend of organizational progress to be evaluated, it is required to define levels in order to show the trend of organizational progress through the time. Based on this it is possible to define some levels regarding all the results indexes which show the progressive business trend during the time window. For increasing the model performance, in this paper level of image, level of customer satisfaction, and level of employee satisfaction, which are achievable from the resultant of model indexes, are defined. These levels help the organization significantly by showing the excellence path, because the make it possible to see the cumulated effects of organization's strategies, systems, and activities through the time, which illustrate the past and current organizational performance. In each time period the image level is resulted from summation of image rate, the inputs of which are outcome indexes of Customer Result (a) and Society Result (a). Moreover, in each time period the level of customer loyalty is the result of summing customer satisfaction rate which has outcome indexes of Customer Result (a) as its inputs. Furthermore, level of employees' satisfaction is achieved in each period by summing up employees' satisfaction rate inputs of which are outcome indexes of Human Resource Result (a).Based on the definitions of dynamical equations and relationships between variables, the dynamical model of figure 2 emerged.

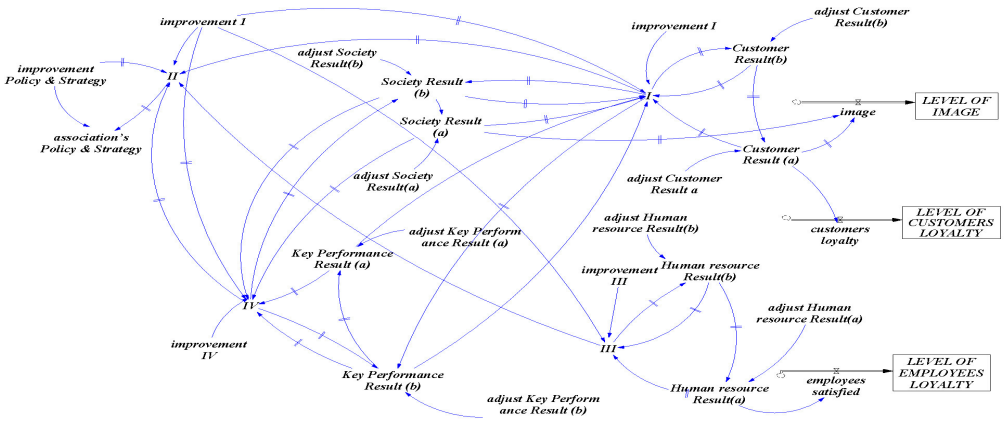

Figure 2: Stock and Flow map

4. Performance Tests of the Developed Model

In this research, diverse types of tests such as units' consistency test, collaborative error test, scope sufficiency test, parameter evaluation test, structure evaluation test, and boundary conditions test are used in order to evaluate the model performance. These tests are described below:

- Unit consistency test: Our model passed this test while all of its units were approved by Vensim PLE software when the Units Check option was active.

- Collaborative error test: the proposed model is independency to time unit. For example, if the time unit is assumed "one year" initially, if it is changed to "Quarter" the model should generate quite similar results. The results indicated

no changes in the behavior of the mentioned variable in different time units as illustrated in figure 3.

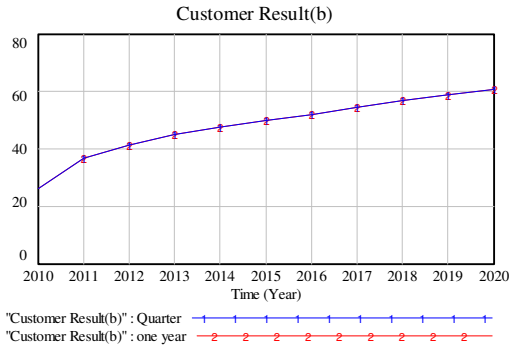

Figure 3. Behavior of Customer Results (b) in different time units

- Scope sufficiency test: This test was passed through further surveying the EFQM and KMAT models, which involve defined criteria, sub-criteria, and indexes.
- Parameter evaluation test: the expert opinion is used in all the variables of the model as an estimation of all parameters.
- Structure evaluation test: This test was passed by the consistency of models behavior with its structure. Because the variables of the model create negative feedback loops, they should be goal-seeking. For example, the goal-seeking behavior of the variable Customer Result (b) is illustrated in figure 4.

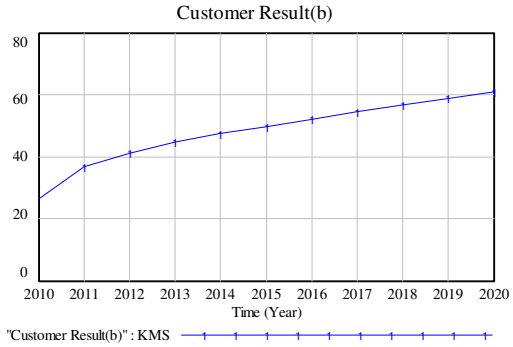

Figure 4. Goal-seeking behavior of variable Customer Results(b)

- Boundary conditions test: This test was conducted for the model and its performance was approved in the boundary conditions. For example, the amounts of policy, strategy, and leadership variables were tested in the boundary values of 0 and 100 and their effect of Customer Result (b) variable was captured. The results indicated no changes in the mentioned variable in the boundary conditions as illustrated in figure 5.

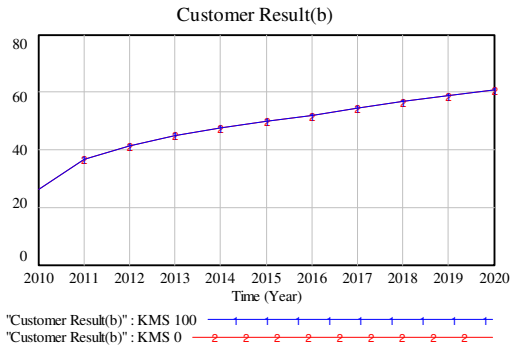

Figure 5. Behavior of Customer Results (b) in boundary conditions

5. Policy Making

For evaluating diverse policies by the generated dynamical model, an 'improvement' index is defined for variables I, II, III, IV, and Association's Strategy & Policy. The amount of improvement is measured for each policy regarding business goals and through the execution of the model for that policy. At the end the best policy is identified. Regarding the resource limitations and the variety of adaptable strategies in the organization, the resource should be distributed amongst all the five dimensions of KM in such a way that the maximum efficiency is achieved through out whole the model in order to have the best trends for customer loyalty level, employee loyalty level, and image. The chief variables selected in this research were customer loyalty level, employee loyalty level, and image. Four policies described below were simulated:

First Policy: This Policy is called "Technology-based KM Approach" and highly attends to technologies required for KM. Technology plays important role in the advance of KM and its effect on result indexes yields in organizational excellence. In this policy the significant variable is variable IV, so the "Improvement IV" variable, indicating the amount of variable IV, is increased 50%.

Second Policy: This Policy takes the "Organizational Culture-based KM Approach" and attends to culture making and its penetration in the organization. Employees are the most valuable resources of an organization who should adapt the knowledge sharing culture. In this Policy the significant variable is variable III, so the "Improvement III" variable, indicating the amount of progress of variable III, is increased 50%.

Third Policy: This Policy is called "Process-based KM Approach" and highly attends to KM processes. Processes play important role in achieving KM goals. This Policy emphasizes variable I, so the "Improvement I" variable, indicating the amount of progress of variable I, is increased 50% in this Policy.

Fourth Policy: This Policy is called "Overall KM Approach" and highly attends to all the three aspects of technology, culture, and KM processes simultaneously. Accordingly in this Policy the significant variables are variables I, III, and IV. In this case regarding the limited resources and the need to hold a trade-off between all the three aspects, the organization should have a slower and equal progress in all of them. So, all the "Improvement" variables are increased 20%.The results of the Policies are illustrated in figures6 to 8.

Figure 6. Trends of employee loyalty level for different policies

Figure 7. Trends of customer loyalty level for different policies

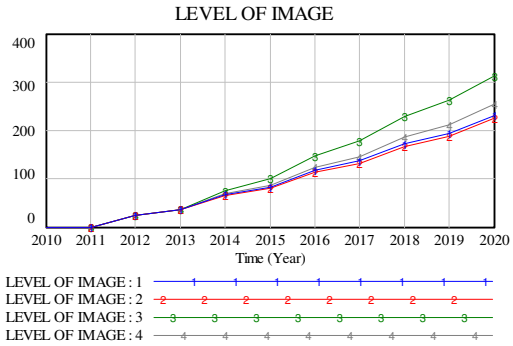

Figure 8. Trends of organizational image for different policies

In figure 6, it could be seen that amongst the four above policies, the second one, “Organizational Culture-based KM Approach”, illustrates the best trend. Accordingly, it could be concluded that organizational culture, amongst the KM aspects, affects the progress of employee loyalty more strongly. After the second policy, the fourth, the first, and the second policies exhibit the best trends respectively.

Figure 7 shows that amongst the four above policies, the third one, “Process-based KM Approach”, illustrates the best trend. Accordingly, it could be inferred that, amongst the

KM aspects, the KM process influences the progress of customer loyalty more strongly. After the third policy, the fourth, the second, and the first policies exhibit the best trends respectively.

In figure 8, the third policy or "Process-based KM Approach", exhibits the best trend. Thus, it could be implied that KM processes affects the progress of level of image more than other KM aspects. After the third Policy, the fourth, the second, and the first Policies respectively show the best trends. Finally comparing all the four Policies it could be summed up that: if the highest priority in the organization belongs to employee loyalty, the KM approach should be based upon organizational culture and if the organization aims at improving customer loyalty and image level, then the KM approach should be pivoted around process.

6. Conclusion

Organizational knowledge is very complex and has multiple dimensions. Several scholars have emphasized the importance of internal and external knowledge and this notion has important implication for knowledge management; the knowledge residing outside the boundaries of organization must be managed along with the internal knowledge. Therefore, organizations need to understand the dynamics of their knowledge capital and knowledge acquisition policies to achieve better organizational out comes. The model suggested in this research demonstrates the relationships between the KM sections and results indexes. Thus, this research was an endeavor to model the effects of KMAT dimensions on EFQM results through system dynamics modeling approach, and finally analyze the change trends for different values of variables. The chief benefits of this model are:

- In the generated model the time distance between the effect of cause and appearance of its effects is mentioned by including delays.
- Applying the "What happens if". This action reduces the risk of program failures before implementing them. In the proposed model four Policies are designed and examined in order to find the best one.

Areas for further research could be:

- Regarding that in this research the KM and business excellence dimensions are considered generally, in the future researches these concepts should be elaborated more in order to improve the relationships.
- Modeling could not be of benefit for organizations solitarily, but it should be conducted along with execution and customization.

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