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A New Model to Identify and Evaluate Critical Success Factors in the IT Projects; Case Study: Using RFID Technology in "Iranian Fuel Distribution System"

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Abstract

Many organizations use Information Technology (IT) to improve their performance in the business and operations. But, most of the IT projects suffer from a high risk of failure when implemented. Recently, many studies have been attended on the concept of critical success factors (CSFs) in order to affect the rate of success, but a little effort has been focused on developing strong models to facilitate the CSFs extraction and evaluation processes. We found that there are remarkable cultural, managerial, industrial differences and also, a considerable business atmosphere gap between the developing countries like Iran and the developed countries. Therefore, the related CSFs in the developed countries may not be directly applicable by Iranian project managers and they need to be adapted. Furthermore, it has been repeatedly reported that there are some limitations related to CSFs identification methods such as Rockart's methodology. In this paper, we have offered a new developed model to extract and evaluate the CSFs of IT projects. This model has brought the theoretical backgrounds, the experts' views and the AHP technique's benefits together and it may be applied as a means to improve the IT project management ability. Thereafter, we have used our model to identify and evaluate CSFs of an important IT project, known as: "using RFID technology in Iran Fuel Distribution System". The most important CSFs were identified and prioritized as: Support from senior management; Hardware substructure; Technology sanction; Pilot project; Beneficiary's participation and Data management.

Keywords: Information Technology, Project Management, Critical Success Factors, RFID, Rockart's Methodology.

Introduction

Information Technology is a fast growing technology around the world. But, despite of its vast benefits, it is suffering from high risk in the implementation. For many organisations, the history of IT projects indicates significant challenges in successfully attaining to return of investment or in gained expected results. Based on Standish group's reports, as a reliable reference in declaring statistic of success in IT projects, for

period of 1994-2008, the rate of successfully completed IT projects has been less than 40 percent. In other word, most of IT projects fail and or encounter to considerable challenges in view of their initial estimated time, cost and or customer's requirements. For background, the literatures in the field of information technology management were studied. By reviewing the literatures, we specified that most of project managers didn't have enough consideration on the main areas of their activity which lead their projects toward the success. The critical success factor (CSF) methodology is a means for identifying those important areas of activity that are essential to accomplish project successfully.

The concept of CSF was originally developed by John F. Rockart and his colleagues (1979-1982) to align information technology planning with the strategic direction of an organization. In the early 1980s, managers found themselves as plunged in the huge amount of different information which must be analysed and decided. Rockart (1979) recognized this fundamental challenge that the managers still lacked the information essential to make the kinds of decisions necessary to manage. As recent researches (2000-2007) states, the concept of CSFs is known as a very powerful and useful means to handle main challenges being presented in the management area such as strategic planning, risk management etc. Our research has been focused on the project management area as well. According to a study by Esteves (2004), the CSF concept has been considered in project management area recently. So that, the CSF concept and its applications now have become hotly-debated issues in the design, development and implementation of IT projects. It is because of many unsightly experiences which force project managers to pay high value. CSF concept effectively helps project managers to guide, direct, and prioritize their activities. Therefore, many project managers and consultants use it in order to being sure of gaining success. In this paper, CSFs basically define those sustaining activities that a project manager must perform well over the time to accomplish project’s mission.

The CSFs will come from many different sources. To provide an accurate picture of a project’s overall key performance areas, it is important to identify CSFs from each of these sources. Yourdan (2004) showed that the serious problems are not just due to technological reasons, but they may arise from cultural, political, local and economical areas as well. Rockart (1979) recognized five main resources of critical success factors as: “the industry in which the projects exist; the general project’s environment; temporary problems, barriers, or challenges to the project; managerial elements and contesting strategically elements”. Although the main areas of sources may be the same, remarkably different results have been observed and reported frequently, especially when the developed countries and the developing ones are compared. Sampling and direct quotation from other environments are impossible, and we should evaluate the

derivation and reliability results in each environment individually. Each project also has a set of CSFs that it inherits from the particular environment in which it operates. So, the CSFs extracted in the developed countries, are not directly applicable to Iranian managers.

Limitation of Rockart's Methodology

Every project already has a set of CSFs which may not be obvious. CSFs are actually derived from the existing reality rather than created. It is important to identify them by trusty and correct methodology. Experienced project managers may call this their". However these managers determine CSFs by tentatively and intuitively ways, a right trustable methodology must make such sixth sense that result to accuracy and reliability of results.

Nowadays, Rockart's methodology variously is used in the field of IT management including project management to extract CSFs. But Rockart's methodology suffers from some obvious limitations. In this methodology, CSFs are directly extracted from document reviewing and interviewing within a continual process. This approach is susceptible to serious limitations which arise from human errors, such as:

- Applying qualitative and deductive analysis approach,
- High dependency on prejudgment,
- The quality of judgment may change within the process,
- There is no priority for identified success factors,

For instance, during interviews most of interviewees represent a list of the latest problems which they are recently encountered to, instead of top level essential factors. All these problems can reduce accuracy and reliability of final results.

Later, other scholars have suggested different methods to overcome those limitations and improve Rockat's methodology. Caralli (2004) provided a step by step approach for deriving CSFs. He used five steps: defining the scope; collecting data; analyzing data; deriving CSFs and analyzing CSFs. As he and other scholars have shown, structural models will result in more reliability in final results. By reviewing the literature, we found out that although there are many studies on the CSF concept, extracting its methodology, benefits and limitations, there are little efforts focused on developing a strong model to extract and evaluate critical success factors.

Developing Model

We mentioned some limitations from Rockart's methodology. Most of them are occurring when raw data convert to CSFs by a direct derivation process. It is due to the humanely nature that affects the judgment and causes extensive instability when data analysing. By considering the Caralli's experiences (2004) and with consider to

Rockart's methodology (1979), we tried to develop a new model which has ability to extract and evaluate critical success factors, in more constant and reliable approach. Our approach was largely based on the work of Rockart and his colleagues (1979-1982). We structured analysing, deriving and evaluating CSFs within our model. The structure of model and the relations between different elements has been gently formed during a wide research study.

Firstly we were looking for raw data which may obtain from the document reviewing as well as interviewing selected persons to find critical challenges in the project. In the next step, we tried to analyse data and convert them into statements that represent those key activities that managers perform or more importantly, should be performing. Then, these statements compared and placed into specific familiar groups from which the CSFs are derived. At the last step, we evaluated derived CSFs in order to decide which is more important. We structure our model by four basic processes. Each of them, along with the related necessary activities, is provided in the following steps:

- Step 1: Defining mission and purposes of project,
- Step 2: Collecting raw data,
- Step 3: CSFs deriving, including continues activities as: general contexts decompose to basic concepts(fundamental elements), fundamental elements form specific groups (cluster), clusters unify to make some limited basic concepts (theme), themes compare to extract CSFs,
- Step 4: Evaluation CSFs.

Step One: Defining the mission and purposes of project

Each project has a specific mission that is reason for the presence of that project and also has some purposes (goals) which should be reached in finale of project. We do not provide additional explicit guidance for this step due to this fact that it is an important part of project management. CSFs exist in different layers of management in each project. Therefore, level of CSFs (i.e., organizational or operational level) can be considered and discussed when reviewing the project's mission and purposes.

Since nature of CSF in each project is dependent to define those two basic concept, for making a equal insight in all of individuals who will be interview, we need to be sure of their comprehension and grasp about project's mission and purposes.

Step Two: Collecting raw data

The data collection process includes two main methods: Document reviewing and conducting interviews with selected persons such as managers, technical specialists, contractors etc. Document reviewing is effective method in order to gain an

understanding of the focus of the project and its organization. This documentation reflects what is important or critical to managers and can include of the followings: CSFs of similar projects; the documented mission of the project; performance metrics that have been gathered against any stated goals and objectives; internal auditing reports or relevant subject matter; the stated purposes (goals) and objectives, etc. Because of this reality that for most projects these documents are not available, therefore, the most important data collection activity will be conducting interviews. The interactive nature of the interview process provides opportunities for clarification the areas that might be considered.

To provide an accurate overall picture of related critical factors, it is important to consider each of probable sources separately. Each source must be discussed in more details within interviewing and a series of constant questions can be asked to help interviewees to find about what is important in their specific domain and discussing about the barriers that they encounter in achieving success in the project.

There is no particular order to interview. But there are considerations that must be noted before any interviewing such as: interview etiquette, order of interviews, interview team. For instance, it is recommended that all interviews took place within limited time to avoid discussion or collaboration between colleagues that might have affected the content. Or, simply asking such question: "*what are your critical success factors?*" will be useful only if the interviewees know the CSF concept from before. Thus, several open-ended questions can be posed to help interviewees to think about those areas that are most important and must be done well in the project. Rockart (1981) provides a series of questions that can be used at this step. Other data collection methods can be used, such as questionnaires and surveys, but these techniques can introduce bias and impede dialog and thus are not recommended. Although we can use different research techniques at second step, but the nature of intercourses of personal interview will provide required opportunities to unfolding the CSF in better way. The figure 1 shows the relation between first and second steps.

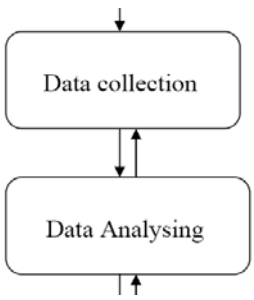

Figure1- The relation between first and second steps in our developed model.

Step Three: Data analysing and CSFs deriving

Document reviewing and interviews provide raw data for analysing process. All of prepared notes that have been collected during second step must be review and organize to facilitate the analysis process. This step forms core section of model. The main purpose is to transform raw data to the CSFs. The preformed steps as shown in figure 2 including different activities.

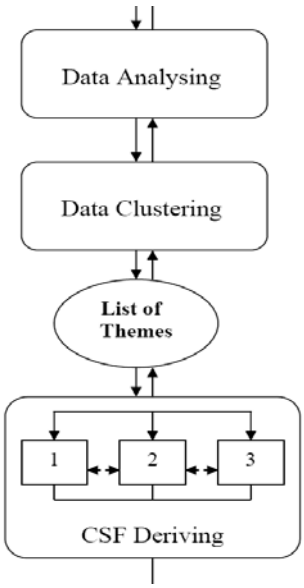

Figure 2- Different activities at third step of our developed model.

1- General concepts and their main purports decompose to "*fundamental elements*".

2- "*Fundamental elements*" gradually make "*clusters*".

3- After refining, limited main clusters create "*theme*s".

4- With regard to Rockart's quintuplet sources along with mission and goals, "*CSFs*" extract from "*theme*s".

At this model, we have created three important concepts including "*fundamental elements*", "*clusters*" and "*themes*" In order to better understanding of methodology. We also apply a well known data structural technique known as "*data clustering*". They are explained in continue:

-fundamental elements

General concepts and their main purports decompose to initial pieces of context which are attained during the analytical process. In fact, "fundamental elements" are those meaningful identity pieces so that they are no more dividable. All of gathered raw data must be reviewed and decompose to these initial pieces of context. Then they have to be listed separately for next uses. Thus, they can interconnect to the original source which they have been related. Generally "fundamental elements" reflect in process

activities and or important activities which should be performed in the future. Although it is possible for an interviewee to identify CSF directly during interviewing, this may take place prior to making a judgment.

Here is a real sample to clarify about the matter: in answering to this question that *"what are determining the most important elements in breakage of RFID technology installation process?*" One answer was as: *"Worries related to system's correct action and security concerns made us pay attention to the installation of a sample and provide required security to act correctly in all parts such as executives, personnel and instruments"*. After decomposition and analysing this context, we may distinguish several "fundamental elements" as:

-Costs is not preferred to security and trust ability,

-Importance of the suitable choice of instruments,

-Importance of pilot's execution,

-Right action by individuals,

-Data clustering:

Data clustering is a common technique for statistical data analysis. It is a type of organizing based on similarities between elements. So that, elements in one cluster has more similarity to other elements in the same clusters. Various algorithms are available for data clustering. Because of expected results, we adopted related concepts with algorithm Agglomerative Hierarchical Clustering Method. Figure 3 schematically shows this type of algorithm.

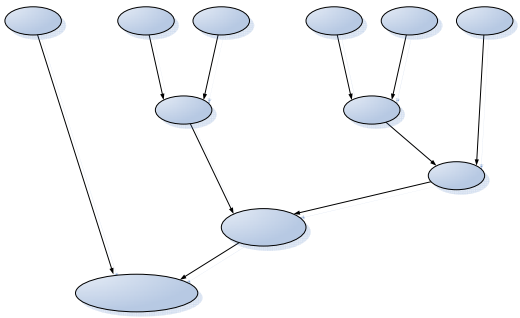

Figure 3- A schematic view of Agglomerative Hierarchical Clustering Method.

The most similar "fundamental elements" should individually be considered and be placed in the same "cluster". Meaning, purpose and context similarity in each of "fundamental elements" are the suitable guidelines for decision making. This comparison should be performing for all "fundamental elements" and determined clusters continuously. In other hand, primary clusters should be examined. The similar ones may merge into each other. For those "fundamental elements" which are in none of

categories or clusters, we should examine them again. They maybe gathered in a new "cluster" or they may not be compatible at all and therefore, it may omit.

- Themes:

Each "theme" represents a completed meaningful "cluster" which has been obtained from data clustering process. Of course we should note relation between "clusters" and "themes" is not a one by one relation. Developing "themes" can be easy or hard process, and this is dependent to data clustering process. Sometimes, "themes" are unfolded easily. In other cases, they should be derived and they may need re-clustering again. This may explained by an example. During our case study, "*cluster No. One*" was included below "fundamental elements":

- Importance of data security and maintained is equal to project's importance.

- Success or failure of project is dependent to data safety.

- Trusting to data is basis of trusting to this technology.

- In any probable problem, data should be maintained and not be destroyed.

- Data shouldn't be accessible or falsified.

- Regarding high mass of data, information system should work correctly, without any misadventure.

After completing the process, it resulted in two main "themes" as: *1- data accuracy* and *2- data security*.

- CSFs derivation:

After comparing natural similarities between "themes" and summarizing them to the general limited context, CSFs derivation is happen. We can compare them based on Rockart's quintuplet sources and also regarding general purposes (goals) and project's mission. For this purpose, we need enough knowledge about those matters and also its internal and external situations to understand the original reality of those elements and perform correct analysis. In the previous example, we can derive one specific CSF as: *data management.*

There is no steady relation between number of "themes" and CSFs. CSF can be derived from several similar "themes" or even one specific "theme". Basically, "themes" can be applied as good guidance for CSFs derivation. When two past steps have been done by correct way, "themes" will be good explanatory for deriving the right CSFs. Regarding the close meaning between "theme" and "CSF", there is some helpful questions in order to being sure about the quality of identified CSFs:

-Was there any "theme" that has same meaning and or covering another one?

-Did "theme" define and explain project's environment and terms properly?

-Did correct and suitable and acceptable dealing of themes in quintuplet resources have been done?

Step Four: Evaluation CSFs

One of the key steps in our model that differentiates it from other similar efforts is performing preference of CSFs based on determined criteria by applying the analytic hierarchy process (**AHP**). We proposed AHP technique because it is an efficient means of multi criteria standard decision making (**MCDM**). Generally, AHP technique is used for decision making and choosing an option between various similar options, regarding decision maker's determined criteria.

By creating pair comparison tables and comparing options, we can perform required analyse and finally do necessary preference. AHP technique converts evaluations to numerical values. A numerical weight or priority is derived for each options of the hierarchy, allowing diverse and often incommensurable options to be compared to one another in a rational and consistent way. By this capability, we can control unrelated judgments and possible errors, which cause more reliability in results. This capability differentiates AHP technique from other decision making techniques and enrich our developed model in view of reliability.

The procedure for using AHP technique in our model can be summarized in four activities.

1- Model the subject as a hierarchy containing the identified CSFs and the criteria for evaluating the CSFs. Because our study area is focused on IT project management, our evaluating criteria should be related success indexes. These indexes are determined and confirmed in literature. We found out them as: *the beneficiary's satisfaction; system's quality; quality of information; timing* and *budget* which were most accepted indexes in order to measure the successful IT projects.

2- Establish priorities among the indexes of the hierarchy by making a series of judgments based on pair wise comparisons of the indexes. Synthesize these judgments to yield a set of overall priorities for the hierarchy, would combine the selected expert's judgments. For instance about quality, cost and timing for CSF X, Y, and Z into overall priorities for each

CSF. Generally, there are some useful software to conclude the results instead of doing various complex numerical calculations.

3- Check the consistency of the judgments based on a specific index named as incompatibility index (normally more than 0.2) and determines which must be replacing again.

4- Making final decision based on the results of this process.

The steps which we defined and applied to develop model are codified in the flowchart.

In each of above mentioned steps (1-3), we perform analyzing process to find natural simulations between similar cases and eliminate repetitive of “fundamental elements” and or “clusters”. So that, huge mass of primary raw data, will extract to some limited "themes" which will lead to extracted CSFs. Figure 4 shows the steps for deriving CSFs in proposed model methodology in this research.

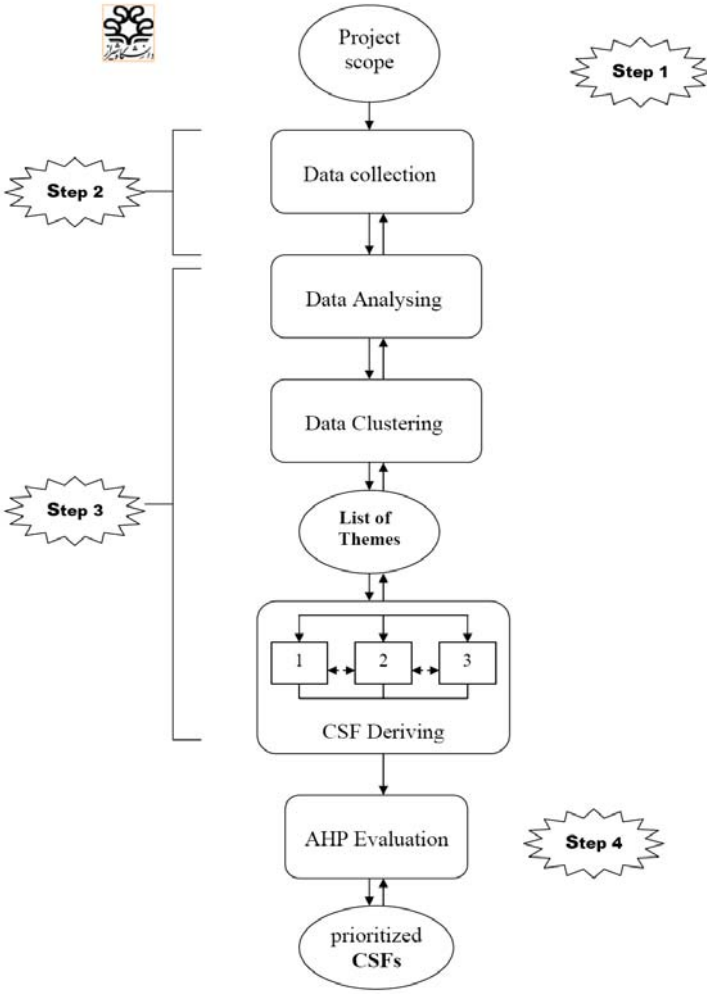

Figure 4- A schematic view of our developed model

Case Study

This case study represents the application of our developed model in an IT project, known as: using RFID technology in “Iran Fuel Distribution System” during 2008-2009.Basically, “Iran Fuel Distribution System” (**IFDS**) is established by government in 2007 in order to manage and control the fuel consumption in Iran. This system is one of biggest IT projects including more than 12 million users, in which a useful technology

called Radio Frequency Identification (**RFID**) is applied to eliminate some problems of the traditional system. In spite of so many advantages of applying RFID technology, due to the variety in social, economical, technical and even political effects, any change in distribution system requires precise attention to the critical elements bringing success as well as failure risks.

In 2008, "National Iranian Oil Distribution Company" intended to increase its controlling power to improve fuel assumption and prevent graft in their distribution networks. Therefore, they considered the possibility of vehicle identification using RFID technology. Considering these challenges, "Shiraz University" is involved in preliminary studies with regard to application of RFID technology in "IFDS". It was including some researches such as: *Pilot Project, RFID Network Designing, RFID Network Security Risks* and also *CSFs identification* to ensure about the success of RFID implementation in "IFDS".

After reviewing the RFID specification and mission of this project, we used interview process for integrating required data in our case study. During the review of the latest studies we figured out that a predefined statement might be effective in result's reliability, therefore we standardized a distinct protocol in order to secure the accuracy and co-ordinance of different interviews. Our questions in interviews were compatible with the subject of study and were selected based on Rockart's methodology. Of course we had some open questions during the interview process which were based on the received answers. To choose interviewees, we used 21 individuals who have had key roles in "IFDS" or they had enough experience and knowledge about installing RFID technology, preferably from Iranian specialists. We offered guidance to prepare interviewees before interviewing meetings. During interviews we gathered and documented all ideas and comments. Finally at the end of each interview, important notes and ideas were repeated to be corrected or completed if necessary. Based on our model, we first obtained 76 samples of "fundamental elements" consisting traits, qualities, general goals and expected performance. 71 elements were clustered to 19 "cluster" which resulted in 6 "themes" according to our model processing. Some of "fundamental elements" and "cluster" were not used at all. We repeated data analysing several times to ensure about the quality of results. With consider to mission of project and also internal and external terms of project, emerged "themes" were compared and finally, we identified 6 CSFs as: *Pilot project; Data management; Hardware substructure; Technology sanction; Support from senior management; beneficiary's participation.*

Later, we used AHP technique to prioritize those identified factors. We created comparing tables for CSFs based on selected indexes for measuring success in IT projects including: *beneficiary's satisfaction; system's quality; quality of information;*

timing; budget. Then, we selected 45 different experts from RFID specialists; individuals (who had direct responsibility in "IFDS") and suppliers (who were providers of RFID solutions) to send prepared questionnaire. They completed and then returned the questionnaire including comparing tables. The results were analyzed by well known calculating software called *Expert Choice* to complete complex calculations. From 42 completed questionnaires, we recognized 11 discordant answers (incompatibility index was more than 0.2), which relapsed and asked to be completed again. Finally, the 9 identified CSFs were prioritized as shown in table 1.

Table 1: The final results of model processing related to case study

priority	Critical Factor
CSF No. 1	Support from senior management
CSF No. 2	Hardware substructure;
CSF No. 3	Technology sanction;
CSF No. 4	Pilot project;
CSF No. 5	beneficiary's participation;
CSF No. 6	Data management;

All CSFs related to this case study arise from Iranian's expert ideas and real existent terms in environment and suitable with time of research.

Conclusion

The CSF concept attempts to find those activities that can make project successful. The method of extraction is important due to this fact that the critical success factors exist inside the context of project and they could not be created or made. Basically, Rockart's methodology is a subjective process; hence it is prone to deviation as well as human errors which may decrease the reliability of final identified CSFs. Similar concerns have been announced in the literature. In addition, the limitations in sources like time and budget should be taken into account to prioritize CSFs. All of the above-mentioned reasons highlight the importance and necessity of using improved models.

In this paper, we introduced a new developed model to avoid Rockart's limitations and as a useful applicable means to extract and evaluate the critical success factors for project managements' skill. This model is based on the work of Rockart et al. in the area of critical success factors, as a basic concept. Briefly, advantages of our developed model in identification and evaluation methodology of CSFs are as following:

-Model is using a series of repeatable and consistent processes to transform raw data into the CSFs, instead of relying on simultaneous judgment that causes some instability.

-We believe these processes give a better shape to raw data by normalization activities. In addition they provide self-correcting mechanism so that, we will be able to re-examine results in each process.

-Data analysis will be done with the least momentum judgments and effects from environment, tendency and zealotry.

-Model provides a touchable decision making basis that is applicable in most fields and is suggested as a general roadmap. All managers can use our developed model and its specific approach to make their project successful and avoid failure risk.

- We can control unrelated judgments and possible errors. This capability arises from the AHP technique comparing with other decision making techniques and enriches the model in view of reliability.

In addition, we believe that with slight modifications, our approach may be extended to similar applications in IT management. This research has been performed in "Shiraz University" during 2008-2009.

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