

Research Article

Identifying and Classify Factors for Evaluating the Success of Software Developed by COTS Components

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Abstract

Software has become the backbone of every organization. The benefits achieved by using it are tremendous but at the same time it has made mankind dependent on it. Literature suggests that software crises have been a matter of concern among the researchers. Every business has got some parameters which are essential for its success and they are known as Critical Success Factors (CSFs). These parameters vary from business to business. In this work, we have tried to identify and categorize the CSF for software developed using COTS components. The identified parameters are categorized into five different factors - **Organization Factor, People Factor, Vendor Selection Factor, Cost Factor and Technical Factor**. Each factor further contains the sub-factors which are relevant to it. A detailed analysis is performed in order to identify critical success factors for software developed using COTS.

Keywords: Critical Success Factors, COTS, Component based software system, COTS Evaluation and selection.

Introduction

Software is used in every organization and has a variety of applications ranging from artificial intelligence (AI) software, scientific software, real time software etc. During the first NATO Software Engineering Conference in Germany in 1968 the term Software Engineering was coined (Naur and Randell, 1969). The problems related to software crises has been addressed by Brooks (1975, 1987, 1995). Software has become the backbone of every organization. The benefits achieved by using it is tremendous but at the same time it has made mankind dependent on it. Literature suggests that software crises has been a matter of concern among the researchers. Lot of studies has been done in the past on software failure. In 1994, Standish Group reported data from IT projects, revealed success rate of 16% of software projects. The fail percentage of projects was 31% and 53% of projects overrun cost, time and impaired functionality. According to Sauer and Cuthbertson, 2003 a study was conducted by the Oxford University (UK) in collaboration with Computer Weekly reports that only 16% of the IT projects finished on time with agreed functionalities and within estimated budget. This situation has not changed much today. Software development projects are known for being completed far over budget and behind schedule (Gray and Larson, 2008).

Research Questions

There is a paradigm shift in the software development process. Now-a-days the software are developed using readymade components called Commercial off the shelf (COTS) components. With the help of COTS we can reduce the maintenance cost, time and efforts needed to produce the software. However by using COTS there is an extra burden on COTS evaluation, familiarization, assessment and vendor interaction. Every business has got some parameters which are essential for its success and they are known as Critical Success Factors (CSFs). These parameters vary from business to business. Research studies have been done in the past to identify the critical success factors related to IT and software projects (Standish Group, 2010; Sauer and Cuthbertson, 2003; Taylor, 2000). All these studies were specific to one country. Later in 2011 Nasir and Sahibuddin did a comprehensive study on different project sizes and in multiple countries. The critical success factors for Enterprise Resource Planning implementation projects have been discussed by a number of researchers (Bingi, Sharma and Godia, 1999; Cantu, 1999; Holland and Light, 1999; esteves and Pastor, 2000; Bernoider and Koch, 2001; Nah, Lau and Kuang, 2001; Somers and Nelson, 2001; Zhang, Lee, Zhang and Bangerjee, 2002; Buyukozkan et al., 2004a; Botta-Genoulaz et al., 2005; Marnewick and Labuschabne, 2005; Sumner, 2006; Ngai et al., 2008). Researchers have not till date proposed the critical success factors for Component Based Software System

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developed using COTS components. In this work we have tried to identify and categorize the CSF for software developed using COTS components. The identified parameters are categorized into five different factors - **Organization Factor, People Factor, Vendor Selection Factor, Cost Factor and Technical Factor**. Each factor further contains the sub-factors which are relevant to it. A detailed analysis is required in order to identify critical success factors for software developed using COTS. The research questions which have motivated the investigation are:

Research Question 1 (RQ1): What factors, as identified in the study, have a critical impact in determining the success of software system developed by assembling COTS?

Based on the findings from RQ1, we can formulate another research question such as:

Research Question 2 (RQ2): To what extent does the sub factor effects the success of software system developed by assembling COTS?

Materials and Methods

A field study was conducted with software companies dealing with the software developed using Commercial off the shelf (COTS) components. The size of the

companies varies from medium to large scale. The method of questionnaire was used to collect the data.

The responses were gathered using personal interaction and E-mail. The questionnaire seeks opinions from the Consultants, Experts, Vendors and Developers for determining the impact of Critical Success Factors (CSFs) on software developed using *Commercial off-the Shelf (COTS) components, also known as pre-packaged software* components. Software developed by assembling *packaged software* components are known as Component Based Software Systems (CBSS). The success factors used in the questionnaire are based on research study done in literature. The critical success factors are grouped into five broad categories which are further sub-divided into factors for deeper understanding of the contribution made by them.

The questionnaire was divided into three sections. The first section collects the demographic information of the respondent which includes the profile of the respondents, project size, team size, etc. The second section solicits the software product specification for the software developed/implemented/supported by using COTS components. The third section represents COTS software evaluation which contains the critical success factors which are important for developing component based software system by assembling COTS software products.

Table 1: Respondent’s Demographic information

Role of respondent in the Organization	Number	Percentage
Senior Project Managers	72	62.6%
Project Managers	43	37.4%
Project Experience (Years)	Number	Percentage
< 2	32	27.8%
3 to 5	41	35.7%
6 to 8	34	29.6%
8 or more	8	7.0%
Team Size	Number	Percentage
< 10	61	53.0%
10 - 19	25	21.7%
16 - 20	7	6.1%
21 - 25	22	19.1%

The respondents based on their experience and expertise in developing Component Based Software Systems (CBSS) by assembling COTS software product were asked to rate the Critical Success Factors on a 7 point scale ranging from Strongly Disagree to Strongly Agree with the statement. The 7 point scale was chosen for this study as with it the respondents get complete flexibility to express their views as they probably agree with some of the statements and disagree with others, to varying extents.

After seven weeks of survey period a total of 173 people responded by accessing the online survey and 115 respondents filled the complete form. Table 3 displays the role, experience and team size of the respondents respectively.

The questionnaire was developed keeping in mind that it will gather information directly from the people involved in development of component based software systems using COTS. It represents a complete list of Critical success factors (CSF) which are of utmost

importance for the success of software which is developed using CBSS approach.

Discussion

The complete Critical Success Factors (CSF) model based on our findings consists of five major CSFs. The prominent five different factors are **Organization Factor, People Factor, Vendor Selection Factor, Cost Factor and Technical Factor.**

The individual CSFs are further sub-divided into factors for deeper understanding of the contribution made by them. The following sections highlights the detailed findings resulted from the survey.

Organizational Critical Success Factor

Top management of an organization must provide a continual support in terms of its interest, engagement and should have strong commitment towards software development using component based approach.

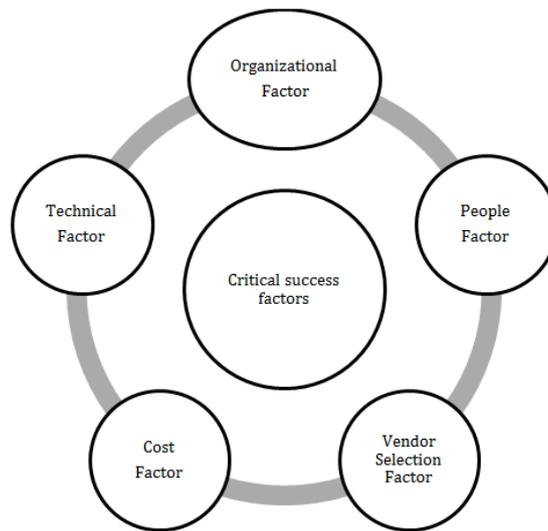


Figure 1: Categories of Critical Success Factors

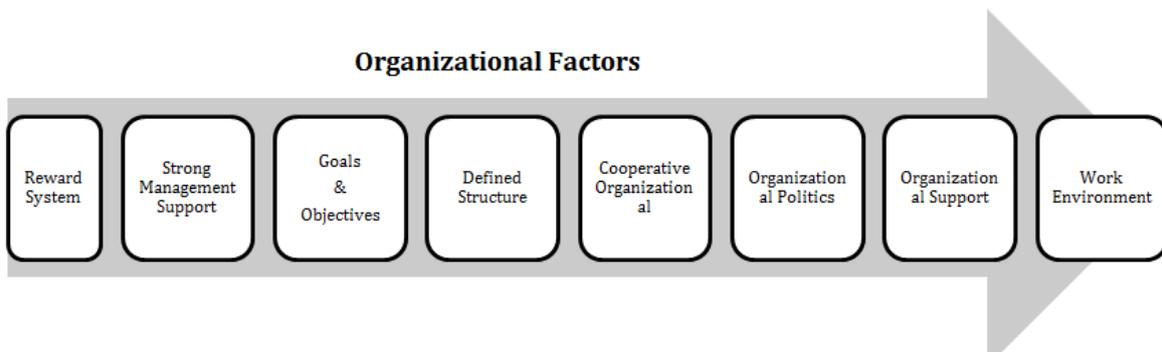


Figure 2: Comprehensive list of CSFs - Organizational Factor

Table 2: Survey Results for CSFs - Organizational Factor

Critical Success Factors - Organizational Factor			
S. No	Parameter	Mean	Std. Dev.
1	Goals & Objectives	5.92	1.109
2	Work Environment	5.83	1.062
3	Defined Structure	5.74	1.001
4	Organizational Politics	5.65	1.25
5	Strong Management Support	5.57	1.117
6	Reward System	5.48	1.447
7	Cooperative Organizational Structure	5.44	1.272
8	Organizational Support	5.43	1.068

Our survey findings indicate that this CSF should take into account that a strong management support is essential for the organization which are in the business of software development using COTS. It is also necessary that the goals and objectives of the organization must be clearly defined by the top management. The organization should have a well-defined organizational structure. The performance of the employees is affected by the organizational politics. The organization should provide proper facility and work environment for its employees. A proper reward system should be followed in the organization for the benefits of the employees.

The statistical analysis for the Organizational Critical Success Factor shows that clear goals and

objectives followed by work environment, well defined organizational and presence of organizational politics were on the top consideration for the success of software developed by COTS components.

People Critical Success Factor

This is another critical success factor as it involves selection of personnel who can successfully handle and deliver software projects. Their commitment towards their work and hence organization is important. On the other side, clients’ involvement and expectations, for whom, the organization is developing a software system are also important parameters of People factor.

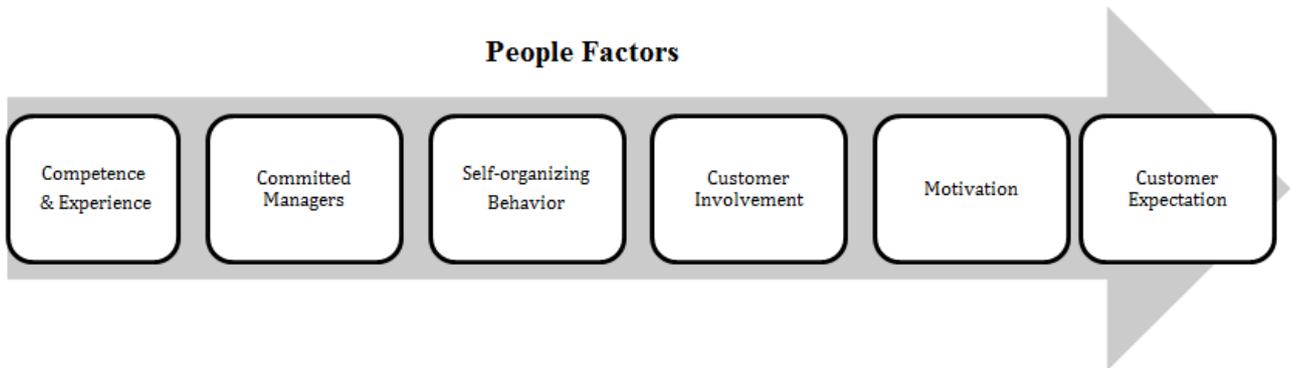


Figure 3: Comprehensive list of CSFs - People Factor

Table 3: Survey Results for CSFs - People Factor

Critical Success Factors - People Factor			
S. No	Parameter	Mean	Std. Dev.
1	Committed Managers	5.62	1.105
2	Customer Expectation	5.55	1.201
3	Motivation	5.37	1.071
4	Customer Involvement	5.32	1.315
5	Competence & Experience	5.30	1.131
6	Self-organizing Behavior	5.18	1.302

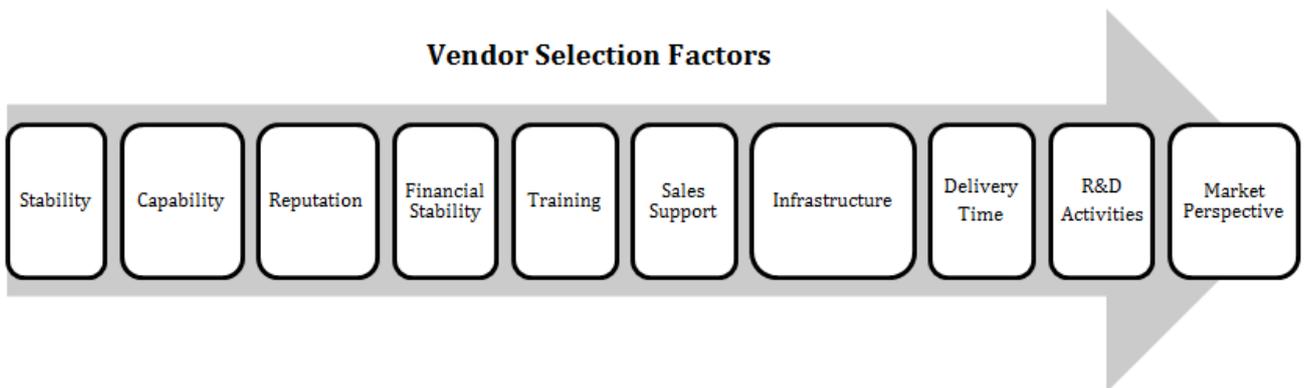


Figure 4: Comprehensive list of CSFs - Vendor Selection Factor

The survey indicates that it is true that in components based software development the project teams must be formed with members having high competence and experience. It is also stated that committed manager or team leader play a vital role in successfully completing

the projects. The team members should have coherent self-organizing behavior. The team members should work with great motivation. It is also suggested that the customer involvement is essential during the software development process. The final product

Table 4: Survey Results for CSFs - Vendor Selection Factor

Critical Success Factors - Vendor Selection			
S. No	Parameter	Mean	Std. Dev.
1	Reputation	5.63	1.165
2	Delivery Time	5.60	0.989
3	Sales Support	5.58	1.100
4	Infrastructure	5.57	1.109
5	Capability	5.52	0.985
6	Training	5.52	1.111
7	Market Perspective	5.44	1.272
8	R & D Activities	5.39	1.137
9	Stability	5.37	1.037
10	Financial Stability	5.31	1.119

should be developed keeping in mind the customer expectation.

The survey indicates that the committed managers or team leaders are responsible for successful implementation of the projects. The organizations which are sensitive towards customer expectation is given second priority in the list followed by work with great motivation and customer regular involvement.

Vendor Selection Critical Success Factor

Since we are focusing on software development by *integrating pre-packaged software products* which can be bought from the vendors in the software market, it is essential for a development team to evaluate and select the best vendor. The following paragraph put light on some of the parameters on the basis of which we can evaluate the vendors.

The survey result shows that while evaluating the vendor we should consider vendor stability, capability,

reputation and financial stability. The training to be given by the vendor about the pre-packaged software, plays an role for decision making towards buying of that component. After sales support, delivery time of the product and involvement of the vendor in R & D activities also plays a vital role in vendor selection.

The survey analysis indicates that vendor reputation when buying pre-packaged components for the development of CBSS plays a vital role followed by delivery time of COTS product, sales support and vendor support infrastructure.

Cost Critical Success Factor

There are certain types of cost which are associated with the pre-packaged software products. These costs vary from vendor to vendor. These sub-factors are of great importance while selecting the pre-packaged software products during software development.

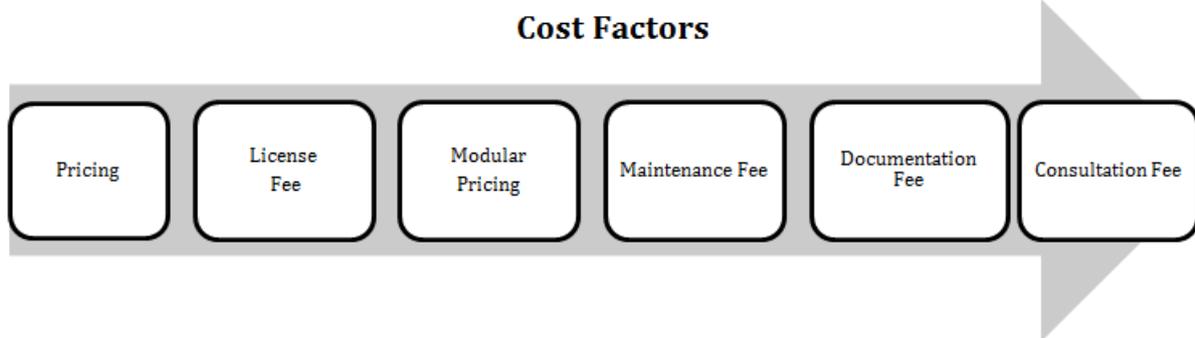


Figure 5: Comprehensive list of CSFs - Cost Factor

Table 5: Survey Results for CSFs - Cost Factor

Critical Success Factors - Cost Factor			
S. No	Parameter	Mean	Std. Dev.
1	Pricing	5.63	1.188
2	Maintenance Fee	5.50	1.195
3	Modular Pricing	5.37	1.157
4	License Fee	5.32	1.315
5	Consultation Fee	5.01	1.328
6	Documentation Fee	4.94	1.441

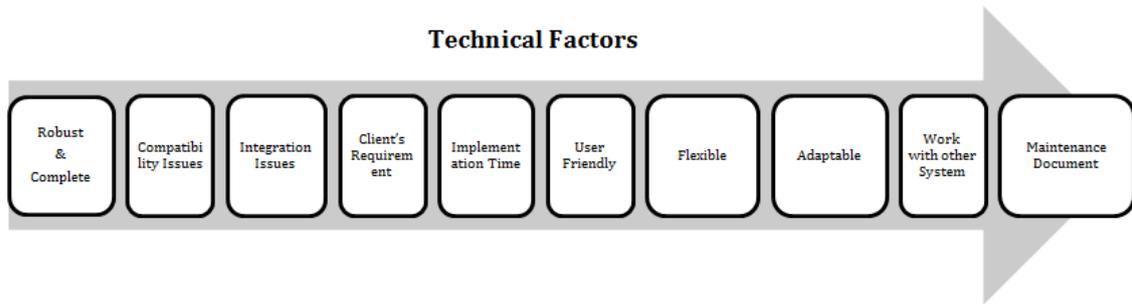


Figure 6: Comprehensive list of CSFs - Technical Factor

Table 6: Survey Results for CSFs - Technical Factor

Critical Success Factors - Technical Factors			
S. No	Parameter	Mean	Std. Dev.
1	Maintenance Document	5.73	1.095
2	Flexible	5.72	1.128
3	Adaptable	5.66	1.213
4	Work with other System	5.63	1.087
5	User Friendly	5.58	1.076
6	Compatibility Issues	5.56	1.179
7	Integration Issues	5.51	1.224
8	Client's Requirement	5.46	1.103
9	Robust & Complete	5.37	1.157
10	Implementation Time	5.31	1.280

The survey findings indicates that the pricing, license fee, modular pricing, maintenance fee, documentation fee and consultation fee are important factors when selecting and buying them from multiple vendors from the software market.

The survey result shows that pricing of pre-packaged components is the most important factor when selecting and buying from multiple vendors from the software market. Maintenance fee and modular pricing is the next in line parameters for purchasing the COTS components.

Technical Critical Success Factor

Last but not the least technical factor is one of the critical success factors for any kind of software development project. Without this factor the study will be incomplete.

The survey result shows that the software developed using COTS should be robust, complete, user friendly, adaptable and compatible with other systems. The product should have shorter implementation time and it should be close to the client's requirements. A proper maintenance guidelines should be given to the customer along with the product.

The survey findings also indicates that there is need to issue a proper maintenance document to the clients. This is followed by flexible changes as per the business requirement. Adaptable, work with other system and user friendly were also rated very important by the implementers.

Results

In this section we present the findings with regard to the research questions presented in the research question section. To answer RQ1 and RQ2 we need to analyze the result of Tables 2 to 6. The factors are listed in ascending order in all the tables along with their mean and standard deviation. The result of the survey indicates that the clear goals and objective followed by proper facility and work environment for its employees were rated on top consideration for the organization factor. For the people factor committed managers or team leaders followed by the organization which are sensitive towards the customer's expectation were rated as high factors. In the vendor selection category reputation of the vendor and delivery time of the COTS product were rated at the top. Pricing of the pre-package components and maintenance fee topped in the list in the cost CSFs. In technical factors maintenance document and flexible to changes got the maximum rating.

Conclusion

In this research study we have developed a questionnaire for assessment of impact of critical success factors on success of software developed by COTS components. The questionnaire was divided into three sections. The first section contains demographic information of the respondent, the second section seeks the details of the software product developed by the respondent and the third section solicits the reaction to each statements by placing a number

according to the given scale. The factors in the third section was divided further into five broad categories. The aim of this work was to evaluate and scrutinize the evaluation and selection practices which are used while developing the software using COTS components. This study has highlighted and ranked various factors which are considered by software industry houses while developing the software using COTS. The various parameters were ranked in ascending order based on their mean and standard deviation. In future work the authors will try to propose a framework for COTS selection and evaluation.

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