



# Large-scale Software Critical Success Factors: Watch Them Live!

Wajdi Aljedaibi<sup>1\*</sup> & Sufian Khamis<sup>1\*</sup>

<sup>1</sup> Faculty of Computing and Information Technology, King Abdulaziz University, Jeddah, SAUDI ARABIA.

\*Corresponding Author (Email: [Waljedaibi@kau.edu.sa](mailto:Waljedaibi@kau.edu.sa), [smkhamis@kau.edu.sa](mailto:smkhamis@kau.edu.sa))

**Paper ID: 12A40**

**Volume 12 Issue 4**

Received 09 July 2020

Received in revised form 25

January 2021

Accepted 03 February 2021

Available online 08

February 2021

## Keywords:

Large-scale software systems (LSS), Critical Success Factors (CSF), Goal/Question/Metric paradigm (GQM), C#, Measurement, CSF Live, Data Accuracy (DA), Top Management Support (TMS); Project Management (PM).

## Abstract

Large-scale software systems (LSS) are complex and large due to the number of applications and services they provide. These systems work in different environments in which influential factors exist, termed as Critical Success Factors (CSFs). The implementation is always costly and time-consuming and requires a lot of effort, as it is difficult. Consequently, dealing with large-scale software systems is not easy. We innovated a new method to measure and monitor the critical success factors during the implementation of large-scale software systems. Our measurement method is based on the Goal/Question/Metric paradigm (GQM) which yields a flexible framework enabling the measurement of one or more of the critical success factors during a particular implementation. Therefore, we need to measure these factors. Measurement allows for direct monitoring and controlling the progress of the project by preventing any derailment early. Measurement is an important tool to support the decision-making process in which projects can be monitored and controlled. It can answer questions; identify the strengths and weaknesses of many aspects of the implementation. Therefore, in this paper, we have created a software tool (CSF Live) that will support the measurement method. CSF Live is developed to collect, analyze and display CSF measurements based on GQM metrics. CSF Live that we developed is applicable for all eighteen CSFs.

**Disciplinary:** Computer Science and Engineering (Software Engineering).

©2021 INT TRANS J ENG MANAG SCI TECH.

## Cite This Article:

Aljedaibi, W., and Khamis, S. (2021). Large-scale Software Critical Success Factors: Watch Them Live!. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies*, 12(4), 12A40, 1-7. <http://TuEngr.com/V12/12A40.pdf> DOI: 10.14456/ITJEMAST.2021.78

## 1 Introduction

This work develops a tool to enable live tracking and monitoring the performance of critical success factors (CSF) during large-scale software system implementation. CSF Live will help project managers and project sponsors to discover problems earlier and directly using the critical success

factors that we designed. Consequently, this will help for early intervention and immediate treatment for these implementation-related problems. We discuss the implementation of the critical success factors measurement tool (CSF Live). In addition, we explain how CSF Live works and explain the results. CSF Live was developing in the C# language. CSF Live reads input data from excel and then provides the user with many functionalities for processing and visualization. The following sections explain the details of different parts of the CSF Live.

## 2 Literature Review

### 2.1 Large Scale Software Systems

Large-scale software systems are huge and difficult to deal with in all aspects of project management, requirement analysis, design, implementation, testing, and maintenance [1]. Each of these steps needs to be handled separately and differently by competent persons. Enterprise Resource Planning Systems (ERP) [2] is a common example of large-scale software systems. An ERP is a business management software that a company can use to collect, store, manage, and interpret data from many business activities including administrative, functional, financial management, procurement, and warehouses in companies and institutions [3].

### 2.2 Critical Success Factors

Several studies and research discussed [2, 4, 5] how many ERP implementations have failed or faced serious delays. Many of the problems and obstacles appeared in the performance of these tasks within the ERPs [6]. It was observed that during such projects several factors led to such final results and that gave rise to what is known today as the Critical Success Factors (CSFs) of large-scale software systems [2].

### 2.3 Measurement

We measured the Critical Success Factors (CSF) in terms of data accuracy [7], top management support [8], and project management [9].

We applied the following steps on all CSFs [7,8,9,10] :

1. Writing goal by using GQM model.
2. Writing a set of questions to determine the goal of the project.
3. Set of metrics (answers) associated with every question.
4. Working GQM model hierarchical structure (Figure 1)
5. Data collection.
6. Data analysis and writing formulation, which presents the result in a measurement, model for a particular CSF.
7. Creating a software tool (CSF Live) by use C# language, which displays CSFs measurements.

When we measure the goals, these goals should be determined and defined in an understandable track and should be clearly structured [11]. The goal is defined by filling in a set of values for the various parameters in the template, It includes purpose (what object and why), perspective (what aspect and who), and the environmental characteristics (where).

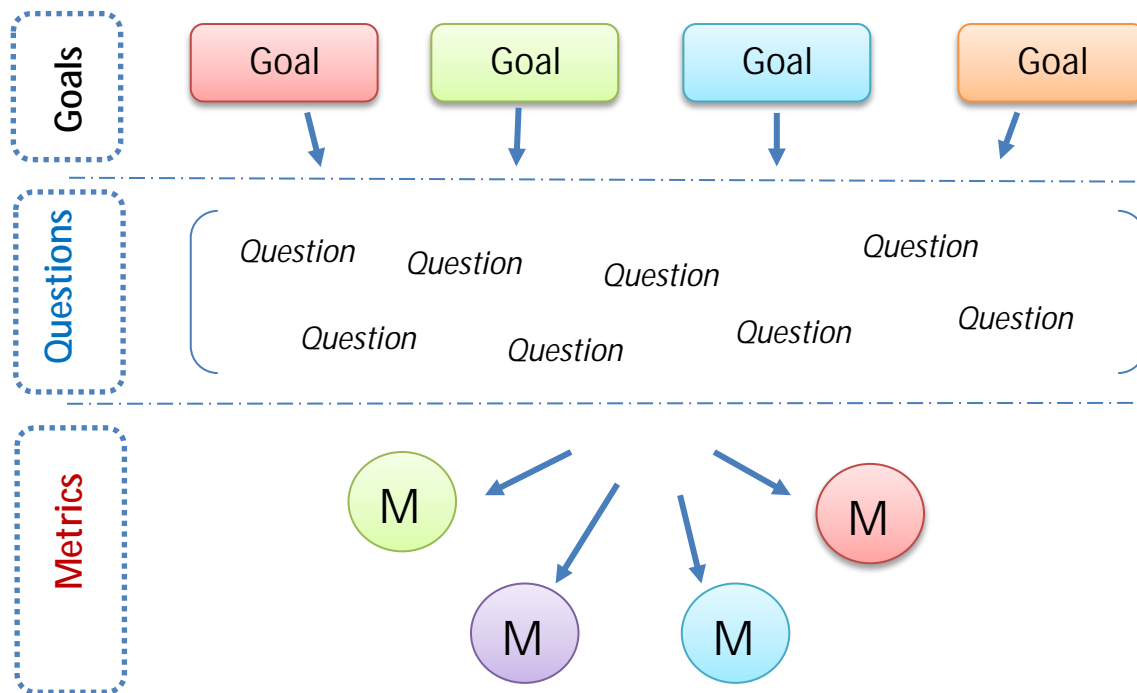


Figure 1: GQM Model Hierarchical Structure [10]

## 2.4 CSF-Live Method

We present a study of the previous research that focuses on developing a method (CSF-Live) that represents our proposed framework for measuring CSFs [10]. The purpose of the CSF-Live method is to measure, track, monitor, and control the critical success factors during the implementation of large-scale software systems by using the Goal/Question/Metric (GQM) paradigm. The CSF-live method has six steps as shown in Figure 2 [10].

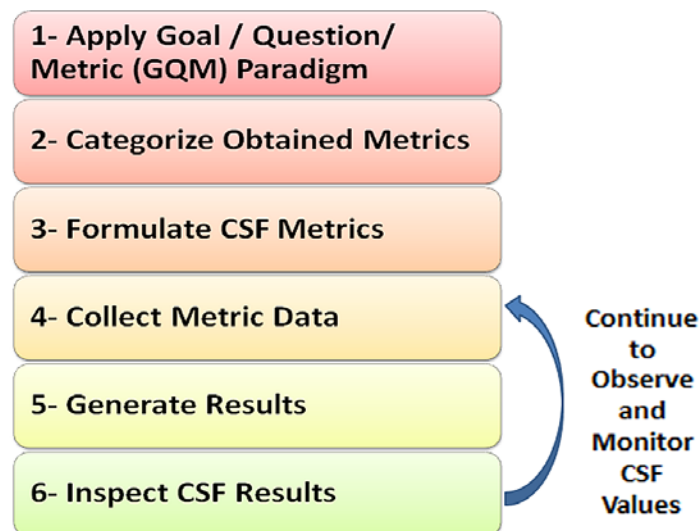


Figure 2: Steps of Framework for Measuring CSFs [10]

### 1- Apply Goal / Question / Metric (GQM) Paradigm

A prerequisite for applying the GQM is to read and understand the GQM paradigm and its components. After that applying the GQM involves the following steps:

- a) Construct (a) goal(s) that encompasses a single Critical Success Factor (CSF).
- b) Ask questions about how to achieve the goal(s).
- c) Identify metrics that quantify the goal(s).

The outputs of step 1 are a set of metrics.

2- Categorize Obtained Metrics

If more than one metric can be combined in a complex metric or mathematical formulation, we combine such metrics using the correct mathematical formula.

3- Formulate CSF Metrics

We write a suitable mathematical formulation for each of the metrics to measure the CSFs using GQM analysis.

4- Collect Metric Data

We collect and validate data for a specific time interval. This data is used in the mathematical formula for each metric, e.g. "number of ....."

5- Generate Results

We here put numbers calculated from the data (step 4) in the mathematical formula of the CSF (step 3) to generate results for a particular CSF.

6- Inspect CSF Results

We analyze and review results and check the numbers and their meanings and then we write recommendations.

Finally, steps 4 to 6 are repeated every specific time interval (e.g. every week) in order to continue observing and monitoring the CSF values during the implementation of the large-scale software systems.

### 3 Graphical User Interface (GUI) of Data Accuracy (DA), Top Management Support (TMS) and Project Management (PM).

CSF Live reads input data from the excel sheet and displays charts that indicate measurement of each of the critical success factors: data accuracy (DA), top management support (TMS) and project management (PM) over a specific number of weeks.

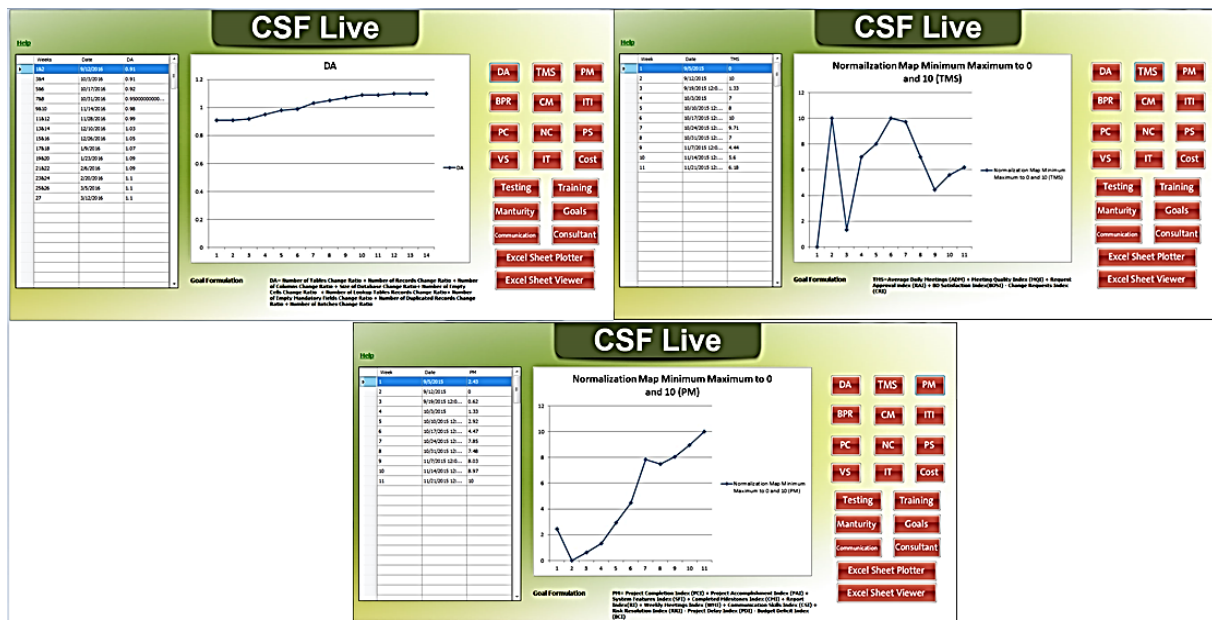


Figure 3: DA, PM, and TMS.

To prepare the Excel file to be readable by CSF Live, the following steps have to be followed during the data entry in the Excel file:

1. Create a new Excel file that has values of each of the critical success factors, one file for each critical success factor. Therefore, we have three files (DA.xlsm), (TMS.xlsm) and (PM.xlsm).

2. Column (A) in each file should contain the number of weeks that the values were measured in. For example, the value 3-4 refers to the third and fourth week.
3. Add a date in the second column (B).
4. Insert the value of the critical success factor in the third column (C).
5. Put the goal formulation in the fourth column (D) so CSF Live will read it and display it below the chart for illustration purposes.
6. Insert in the columns (E), (F)...etc. The partial values were used to calculate the final value for the critical success factor in column (C).
7. Save each chart in each Excel file in an image file with the names (DA.jpg), (TMS.jpg) and (PM.jpg). To save these images use the Macro shown in Table 1.

**Table 1: Macro Code of saved Data Accuracy chart**

```

Sub DA_CHART()
Application.ScreenUpdating = False
Sheets("hh").Select
ActiveChart.Export
Filename:="C:/Users/0000000/Desktop/Query_DataAccurecy/Tool/DataGridView_Import_Excel/DataGridView_Import_Excel_CS/Pictu
re/DA.jpg", _
FilterName:=".jpg"
End Sub

```

## 4 Using the GUI to Analyze Other Critical Success Factors

This section describes steps for how we display charts that indicate the measurement of the Project Champion, Testing, BPR, Number of Customization, Goals, Package Selection, Consultant, Vendor Support, Change Management, Training, Communication, IT Infrastructure, Maturity, Implementation Team and Cost critical success factors.

To prepare the Excel file to be readable by CSF Live, the following steps have to be followed during the data entry in the Excel file:

1. Create a new Excel file that has values of critical success factor, one file for critical success factor. For example, (Training.xlsm).
2. Column (A) in the file should contain the number of the weeks that the values were measured in. For example, the value 2 refers to the second week.
3. Add a date in the second column (B).
4. Insert the value of the critical success factor in the third column ©.
5. Put the goal formulation in the fourth column (D) so CSF Live will read it and display it below the chart for an illustration purpose.
6. Insert in the columns ©, (F)...etc. The partial values were used to calculate the final value for the critical success factor in column ©.
7. Save chart in Excel file in an images file with the names. For example, (Training.jpg). To save these images use the Macro shown in Table 2.



**Table 2: Macro Code of save Training chart**

```
Sub DA_CHART()  
Application.ScreenUpdating = False  
Sheets("hh").Select  
ActiveChart.Export  
Filename:="C:/Users/00000000/Desktop/Query_DataAccurecy/Tool/DataGridView_Import_Excel/DataGridView_Import_Excel_CS/Picture/Training.jpg", _  
FilterName:=".jpg"  
End Sub
```

In the case of not implementing some or all of the previous steps, the following message will appear when the user clicks on any of the buttons corresponding to any of the critical success factors as shown in Figure 4.



**Figure 4: Training.**

After that, we run CSF Live and click on a button of specific critical success factors which reads input data from the excel sheet and displays charts that indicate the measurement of the critical success factor over a specific number of weeks. In addition, CSF Live displays below the chart the goal formulation that has been used to generate the values used to plot the chart. The data displayed on the left panel shows the values of the critical success factor over the weeks.

## 5 Conclusion

We designed a GUI application tool (CSF Live) to track the performance of the critical success factors during the large-scale software system implementation. CSF Live is developed to collect, analyze and display CSF measurements based on GQM metrics. We created it by using the C# language to chart CSF values. CSF Live will help project managers and top management for any organization to discover problems earlier and directly using the critical success factors that we designed. We explained how CSF Live works. In addition, we mentioned the steps on how we can apply CSF Live on all the Critical Success Factors.

## 6 Availability of Data and Material

Data can be made available by contacting the corresponding authors.

## 7 References

- [1] Bar, A. A., et al. "An Analysis of the Contracting Process for an ERP system.", SEAS-2013, Computer Science Conference Proceedings in Computer Science & Information Technology (CS & IT) series, Dubai, UAE, 2013
- [2] Ahmad M., "An Empirical Study of Critical Success Factors for ERP Software System Implementations in Saudi Arabia", Master thesis, 2016.
- [3] Bauer, R. Just the FACTS101 e-Study Guide for Introduction to Chemistry. Cram101 Textbook Reviews, 2012.
- [4] Fang, Li, and S. Patrecia. "Critical success factors in ERP implementation." 2005.
- [5] Allen, D., T. Kern, and M. Havenhand. "ERP Critical Success Factors: an exploration of the contextual factors in public sector institutions." System Sciences, 2002. HICSS. Proceedings of the 35th Annual Hawaii International Conference on. IEEE, 2002
- [6] Bar, Adnan Al, et al. "An experience-based evaluation process for ERP bids.", arXiv preprint arXiv:1311.2968 2013.
- [7] Aljedaibi, W., and S. Khamis. "On the Measurement of Data Accuracy During Large-Scale Software Systems Implementations". Biosci. Biotech. Res. Comm. Vol.12(1), 2019.
- [8] Aljedaibi, W., and S. Khamis. "Top Management Support during Large-scale Software Systems Implementations: Implementations: Important Issues in Management Process". Indian Journal of Science and Technology, Vol 12(25), DOI: 10.17485/ijst/2019/v12i25/145744, 2019
- [9] Aljedaibi, W., and S. Khamis. "Towards Measuring the Project Management Process During Large Scale Software System Implementation Phase". ISeCure 11.3 (2019).
- [10] Khamis, S. and W. Aljedaibi. A framework for measuring critical success factors of large-scale software systems. International Journal of Computer Engineering and Technology, 7:71-82, 2016.
- [11] Esteves, Jose, Joan Pastor-Collado, and Josep Casanovas. "Monitoring business process redesign in ERP implementation projects." AMCIS 2002 Proceedings (2002): 125.
- [12] Basili, V. R. "Applying the Goal/Question/Metric paradigm in the experience factory." Software Quality Assurance and Measurement: A Worldwide Perspective (1993): 21-44.
- [13] Melia, D. "Critical Success Factors and performance Management and measurement: a hospitality context." 2010.
- [14] She, Wei, and Bhavani Thuraisingham. "Security for enterprise resource planning systems." Information Systems Security 16.3 (2007): 152-163.
- [15] Somers, T. M., and K. Nelson. "The impact of critical success factors across the stages of enterprise resource planning implementations." System Sciences, 2001. Proc. the 34th Annual Hawaii International Conference IEEE, 2001.



**Dr. Wajdi Aljedaibi** is an Associate Professor in the Department of Computer Science at the Faculty of Computing & Information Technology, King Abdulaziz University (KAU). He is Dean of Information Technology at KAU, which provides IT services to over 200k beneficiaries. He was awarded the Ph.D in Information Technology – Software Engineering and MSc. in Software Systems Engineering both from George Mason University, USA. His research interests are Software Measurements, Software Architecture, and Open Source ERP systems.



**Sufian Khamis** is a Ph.D. candidate in Computer Science at King Abdulaziz University. He holds a BSc and an MSc in Computer Science (Software Engineering). He has been working as a Software Developer in the Deanship of Information Technology at King Abdulaziz University.