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Evaluating and prioritizing the failure factors and cause of delays in IT projects using FMEA: Towards project continuity

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Abstract

Today, the use of information technology and software applications in organizations is inevitable. To maintain competitiveness, companies need to define different projects in IT areas and also need to keep the risk level of the defined projects at an acceptable level. In this paper, it has been tried to develop a framework for assessing the readiness of IT projects by using the relationship between concepts of business continuity management and project management. Therefore, by reviewing the literature on causes of delays and failure factors in IT projects, as well as interviews with some experts and business continuity consultants, essential criteria for delaying and failing IT projects are selected, and the impact of these criteria on each of the five phases of IT project development are checked and prioritized. By presenting the extended formula to calculate the weighted risk priority number according to the Failure mode and effect analysis approach, a framework has been provided for assessing readiness based on the priority level of these criteria.

Keywords: Project management, information technology, business continuity, failure analysis, risk analysis, systems risk management.

1-Introduction

Today, the use of information technology (IT) and software applications in organizations is inevitable (Bahli and Rivard, 2005). The role of IT systems in rapid responding to business challenges is increasingly perceived (Tan et al., 2017). Therefore, the correct implementation of IT projects is one of the most important goals of managers. Since the achievement of various financial and economic benefits is one of the main reasons for the implementation of IT projects, organizations are encountering the rising pressure of justifying IT financial investments (Tan et al., 2017), (Anandarajan and Wen, 1999). Furthermore, defining success factors at the beginning of the project as well as identifying and managing risks and the way they can be tracked are essential requirements for the IT project's success (Liu and Wang, 2014). Meanwhile, identification of the important risks of IT and their measurement plays an essential role in managerial decisions (Liu and Deng, 2015).

By considering the necessity of carrying out numerous projects in this field, the implementation of these projects is faster, cheaper, and more reliable than before. Nevertheless, costs, complexities, and IT project's risks are still on the rise. Research conducted by the Standish Group in 1994 suggests that a large percentage of IT projects have been failed before completion or, if completed, at a higher cost than the initial estimate (Standish Group, 1994).

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One of the main reasons for software project failure is the lack of appropriate assessment and risk management in projects (Aloini et al., 2007).

Hence, the identification and management of IT risks have turned out to be more important. Failure in managing these risks is often considered as a contributing facture in IT project failures (Nuijten et al., 2018). Also, organizations increasingly recognize the importance of business continuity management (BCM) because the objective of BCM is to ensure the uninterrupted availability of key resources required to support critical business activities in case of disruption and accelerating return of business to normal condition. Also, the proper use of project management processes according to best practices can lead to improved project performance, which ultimately leads to increase speed and quality, reduce error rates and costs due to non-rework, and reduced delays in Projects and better use of time with the increase of customer satisfaction (Milosevic and Patanakul, 2005).

Hence, meeting the requirements and key success factors of IT projects based on new standards and approaches such as agile methods as well as BCM and the integration and application of them, can empower organizations to achieve goals and developed strategies. Because of BCM survey the organizational ways for preparation, overcoming, and reducing the impact of incidents (Niemimaa, 2017). It was found that identified cause of delays and failure factors of IT projects were less relevant to the business continuity parameters, and were not presented in a comprehensive and categorized list as well as less attention to the impact of delay causes in different phases of software development life cycle (SDLC). Although different methods have been used, such as AHP and Failure mode and effect analysis (FMEA), they do not pay attention to the weight of factors based on their importance in a project or their impact on the development phases. Therefore, in this research, it has been tried to propose a framework for assessing the readiness of IT projects by using the relationship between concepts of the BCM and project management, based on WFMEA in each stage of the SDLC.

The structure of the paper is as follows. In section 2, the literature review including the theoretical basis of project management, success, and failure of IT project management, BCM and IT, and success factors, as well as failure causes in IT project management, are discussed. The research methodology and proposed algorithmic framework are applied for real-world, and their stages are shown in section 3. Also, the numerical result and findings are presented in section 3. Finally, section 4 is devoted to the summary and concluding remarks.

2-Literature review

2-1-Project management

All organizations need to define different projects in order to respond rapidly to customer requirements and rigorous global competition (Jafari, et al., 2011). Since they are dependent on changing their products, services, environments, and organizations, therefore, project management is an executive tool for managing these changes. Doing the projects leads to increase sales, reduce costs, improve quality, and increase customer satisfaction.

Various definitions have been used for project management. The project is a temporary endeavor undertaken to create a unique product, service, or result. A project is temporary in that it has a defined beginning and end in time, and therefore defined scope and resources (PMBOK Guide, 2017). Also, the project can be referred to as a set of activities with specific objectives and specifications that have a defined start and end point, with human and non-human resources such as money, equipment, and infrastructure. They have investment restrictions as well as they are multidisciplinary (Kerzner and Kerzner, 2017).

2-2-BCM and IT

Today, business environment, especially the economic and financial sector, has become increasingly dependent on IT. This is due to the fact that many of the critical activities and processes of the organizations are possible through IT tools and systems. Due to the greater dependency of organizations on the technology-based infrastructure and information and communication with exterior networks, the

risks of business interruption have increased in recent years. One of the most important activities of modern organizations is the implementation of effective and efficient BCM that has been considered by many IT experts as a critical factor of competition.

BCM is an inevitable output of business development in the information life cycle (Xiao et al., 2011). The conceptual cycle of BCM in organizations begins by identifying and assessing the risks and the impact of hazards on organizations. Then, by defining continuity strategies, BCP has been developed, the criteria for measuring business continuity are set, and ultimately, performance monitoring and improving the effectiveness of business continuity are carrying out.

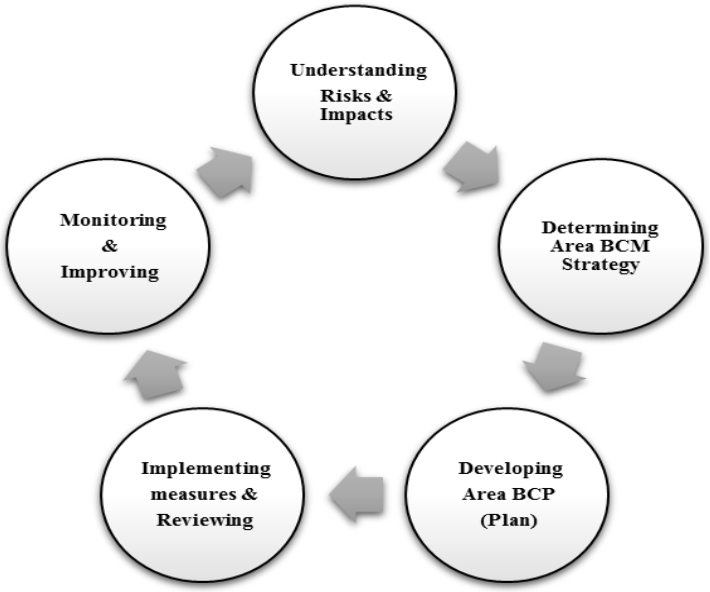

Fig. 1. Area BCM cycle (Baba et al., 2014)

Considering that the first step of the BCM cycle (figure1), Baba et al., (2014) begin with identifying and assessing risks, this paper presents a framework for identifying, categorizing and prioritizing the factors of failure and delay in IT projects. Hence, identification and assessment of project risks are facilitated, and thus, the first step towards the creation and implementation of business continuity strategies will be taken.

2-3-Success factors and failure causes in IT project management

One of the areas studied in project management is the success and failure factors that the importance and measurement of this success rate were studied at the Project Management Institute (PMI) and it has been discussed in the various literatures .The most common combination of criteria for measuring the success of projects is the completion of projects in terms of estimated cost, time and quality (Savolainen et al., 2012). Some of the researchers believe that the success and failure of a project with the failure of project management are two different concepts (Rodriguez-Segura et al., 2016), (Jugdev and Müller, 2006), (Crawford et al., 2006) and (Dvir et al., 2003). The success of project management depends on the completion of the project in the range of specified time, cost, quality and expected performance, while project success goes further, focusing on longer-term and customer-oriented results (Papke-Shields et al., 2010) and (Mollaei et al., 2018).

The successful IT projects must be completed at a pre-defined cost, within the deadline, and with the delivery of required functionality (Alami, 2016). Two of the main criteria and objectives for evaluating the success of projects are time and Cost (Abdi et al., 2018). There are some other factors of projects such as Incompetence project manager, lack of clear communication between the project team, lack of technical knowledge of the project manager and non-commitment to the project have been considered as

the main factors behind the failure of IT project (Munns and Bjeirmi , 1996). The most important failure factors of IT projects are as follows (Montequin et al., 2014):

1) Inaccurate, incomplete or unclearly defined customer requirements
2) Continuous changes to initial requirements
3) Inaccurate time and cost estimations
4) Not or inaccurately defined specifications from the beginning of the planning phase

Lack of communication among stakeholders, project manager, and team members with different specializations will cause serious problems in the project. The most important causes for the failure of IT projects are a weakness in communications. Lack of planning, in particular, the lack of accurate scope definition, is the most important cause of IT project's failure (Ramos and Mota, 2014). Another major cause of IT project's failure depends on the organization, in particular management and leadership. spoken and written communication skills, ability to solve interpersonal problems and conflicts, solving existing ambiguities as well as correct management of changes; is more important than the level of education, experience or professional background of the project manager, and they are essential for achieving the project's objectives. Murray (2009) provided the following cause of IT project failure:

1. Unrealistic project scope definition according to the available resources and expertise
2. Improper management of scope creep, the continuous expansion of the project scope
3. Lack of infrastructure and critical technology preparations for the project
4. Failure to analyze the issues of the organization.

3- Methodology and algorithmic methodology

In this research, the literature on delays and failures of IT projects has been studied. From the literature reviewed and interviews with some experts on IT projects, 38 criteria out of the most important criteria of delay and failure of IT projects, were extracted as selected criteria, and also the impact of these criteria on each of the five phases of planning, analysis, design, implementation, maintenance, and support, as well as evaluating these criteria for assessing the readiness of the projects has been surveyed. These criteria were categorized into 13 main groups based on their nature as well as the view of the researchers. Then, by using the questionnaire and experts' opinion, after assessing the validity and reliability of the questions, and the FMEA and applying the RPN, as a risk assessment method, the criteria were ranked and prioritized. In general, the steps of this research are shown in figure 2.

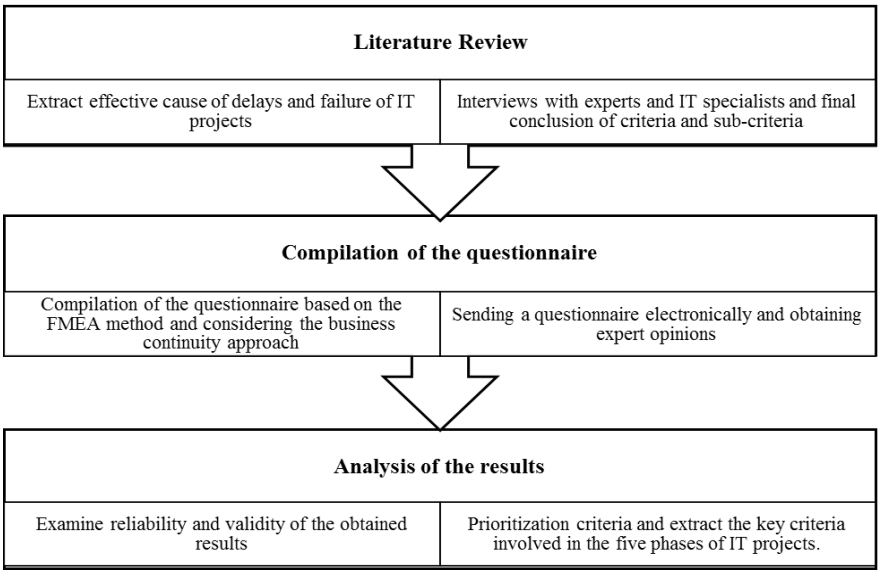

Fig 2. Research methodology

3-1-Sampling and data collection

The study population comprised of BCM and IT project executives and experts in Iran. In this research, it has been tried to use different views, and experiences of experts in the field of project management, especially IT projects, in order to investigate and validate the extracted failure causes of IT projects. Also, in order to further verification to the results, the bachelor's degree as the minimum level of education and the minimum of five years working experience has been considered as an initial qualification of experts. For this purpose, an online questionnaire was created using the google doc's tool and was sent to 30 experts in project management in the field of IT that has direct experience of IT project management. Twenty questionnaires were answered. 65% of these respondents have a degree in industrial engineering, 20% in the field of IT, and others have a degree in management education. Due to the need for knowledge and direct experience of IT project management for responding to the questionnaire, the work experience of these respondents was also checked, and it was found that the average is 13 years. After collecting the experts' responses, the validity and reliability of the questions were analyzed using SPSS software, and then the causes of delays were ranked by using the method of WFME.

3-2-Validity and reliability

Since it is required for researchers to ensure the validity and reliability of the measuring tools before using them, we carried out a methodological study conducted to examine the content validity and reliability of the questionnaire. In this research, in order to obtain the necessary credibility, after a preliminary study of the subject, a questionnaire designed for consulting and interviewing with experts, which should be sufficiently valid and reliable. Hence, the content validity ratio (CVR) method for validity testing and Cronbach's alpha test for reliability testing was used.

Therefore, a questionnaire was provided to IT experts, and they were asked to announce their agreement on each of the selected sub-criterion, as an adequate cause of delays and failure of IT projects, according to the 9-point Likert scale. Therefore, if there is an agreement between experts in the context of the validity, the questionnaire is sufficiently valid.

CVR is calculated for all sub-criteria to determine the validity of the research. (equation 1) According to Lawshe (1975) and as the number of respondents that are 20, the minimum acceptable value for this index is 0.42. Questions which their CVR value is less than the desired level were excluded from the test.

$$\boldsymbol{CVR} = \frac{\boldsymbol{N_E} - \boldsymbol{N/2}}{\boldsymbol{N/2}} \quad (1)$$

N= Total number of experts

N_E= The number of experts identified a sub-criterion as "essential"

According to the categorization of the effective cause of delays and failure of IT projects in the 13 main groups, Cronbach's alpha test was calculated for each of them separately, all of which were above 0.7 indicates suitable reliability. The total of Cronbach's alpha is also 0.968.

3-3-Classification of the failure factors and cause of delays in IT projects

After extracting the main failure factors and cause of delays in IT projects from the literature review, these 38 sub-criteria were classified in 13 groups according to their nature and the researcher's opinion. These 13 main criteria and all their sub-criteria, with consideration of their references, are shown in table 1 till table13.

Table 1. Leadership and sub criteria

Criteria/Sub Criteria	Code
Leadership	**C1**
Lack of leadership's commitment	C1.1
Define unclear roles and responsibilities for the project team	C1.2
Unclear organizational goals and objectives	C1.3

Table2. Manager criteria and sub criteria

Criteria/Sub Criteria	Code
Project Manager	**C2**
Lack of project manager's technical knowledge	C2.1
Poor communication skill of the project manager	C2.2
Project manager with poor knowledge in the project management area	C2.3

Table 3. Project team criteria and sub criteria

Criteria/Sub Criteria	Code
Project Team	**C3**
Lack of project team's technical knowledge	C3.1
Poor communication and team working skill	C3.2
Non-commitment of the project team to the assigned work	C3.3
Assign insufficient human resources to the project	C3.4

Table 4. Stakeholder's criteria and sub criteria

Criteria/Sub Criteria	Code
Stakeholders	**C4**
Poor stakeholders identification	C4.1
Failure to understand, evaluate, define, and manage needs & Expectations of stakeholders	C4.2
Poor communication with stakeholders	C4.3
Inactive stakeholders involvement	C4.4

Table 5. Finance criteria and sub criteria

Criteria/Sub Criteria	Code
Finance	**C5**
Inadequate budgeting	C5.1
Delay in financial payments	C5.2

Table 6. Operation criteria and sub criteria

Criteria/Sub Criteria	Code
Operation	**C6**
Lack of planning for the work process	C6.1
Inaccurate estimation of time, cost, and resources	C6.2
The complexity of the project	C6.3

Table 7. Integration criteria and sub criteria

Criteria/Sub Criteria	Code
Integration	**C7**
Poor change management	C7.1
Poor conflict management	C7.2
Poor knowledge management and lessons learned register	C7.3

Table 8. Measurement criteria and sub criteria

Criteria/Sub Criteria	Code
Measurement	**C8**
Lack of project outputs testing and resolving problems in each phase	C8.1
Lack of quality inspection	C8.2

Table 9. Risk management criteria and sub criteria

Criteria/Sub Criteria	Code
Risk Management	**C9**
Lack of proper assessment of project risks	C9.1
Lack of accurate identification of project risks	C9.2
Failure to define appropriate risk response plans for risks	C9.3
Multiplicity of unknown-unknowns	C9.4

Table 10. Information criteria and sub criteria

Criteria/Sub Criteria	Code
Information	**C10**
Delay in project deliverable's validation in each phase	C10.1
Delay in documentation reporting	C10.2

Table 11. Scope criteria and sub criteria

Criteria/Sub Criteria	Code
Scope	**C11**
Inaccurate, incomplete or not defined requirements collection	C11.1
Poor definition of project scope and deliverable items	C11.2
Instability of political and governmental issues	C13.4

Table 12. Infrastructure criteria and sub criteria

Criteria/Sub Criteria	Code
Infrastructure	**C12**
Poor technology	C12.1
Poor training	C12.2

Table 13. Environment criteria and sub criteria

Criteria/Sub Criteria	Code
Environment	**C13**
The rapid changes in technology	C13.1
Inaccessibility to suppliers	C13.2
The poor performance of sub-contractors	C13.3

3-4-FMEA method

FMEA is a risk assessment method which has been widely applied to examine potential risks and failures in systems, processes, and products for preparing preventive plans or corrective actions. This technique can be influential in processing the information and risky strategic decisions as well (Ardeshir et al., 2018). Traditional FMEA prioritizes risks from the most significant priority number (RPN) to the smallest ones which are calculated as (equation 2). However, one disadvantage of this approach is that it ignores the fact that three factors (S, O, and D) have the different weights in the system rather than equality (Kerzner and Kerzner, 2017). To eliminate this problem, we proposed a new model by multiplying it with a weight parameter, which characterizes the importance of the failure causes within the project.

$$"RPN" = S \times O \times D \quad (2)$$

Where:

Severity (*S*): Result generated from failure factor and cause of delay.

Occurrence (*O*): Opportunity or probability of a failure factor and cause of delay.

Detection (*D*): Opportunity for an unidentified failure because of the difficulty in detection.
The following steps describe the implementation of FMEA-based methodology:

1) Selecting a group of experts with sufficient experience in the field of IT project management;
2) Providing a list of effective failure factors and cause of delays in IT projects extracted from a literature review;
3) Providing a questionnaire to IT experts, asked them their agreement on each of the sub-criterion, as an effective failure factors and cause of delays in IT projects, according to the 9-point Likert scale
4) Asking respondents to score three factors of RPN about the effective failure factors and cause of delays in IT projects
5) Asking respondents to score the *S* of each sub-criterion of failure factors and cause of delays by assigning numbers from 1 to 10 (1 is the lowest and 10 is the highest severity).
6) Asking respondents to score the *O* of each sub-criterion of failure factors and cause of delays by assigning numbers from 1 to 10, according to the experiences and records of the projects carried out or being carried out by them (1 is the lowest and 10 is the highest occurrence).
7) Asking respondents to score the *D* of each sub-criterion of delays and failure by assigning numbers from 1 to 10, according to the experiences and records of the projects carried out or being carried out by them (10 is the lowest and 1 is the highest Detection).
8) Create an FMEA Area chart based on the severity and occurrence of each sub-criterion of delays and failure; categorize them in three areas of "high-risk", "moderate-risk", and "low risk". Then rank them based on their area and RPN.
9) We can describe how to combine multiple failure factors and delays (sub-criterion) into a single one (criterion) using parallel system. Extend the definition of *RPN*, by multiplying it with a weight parameter, which determines the importance of the failure causes (equation 3). CV_{ij} is a coefficient of variation of Expert's consensus about the importance of each *j*th sub-criterion in *i*th criterion, as an effective cause of delays and failure. Following formula is one of the main outputs and contribution of this research.
10) weighted risk priority number for *j*th sub-criterion in *i*th criterion are:

$$WRPN_{ij} = \left(\frac{\mathbf{1}}{\boldsymbol{CV_{ij}}}\right) \times \boldsymbol{RPN_{ij}} \quad (3)$$

$$RPN_i = 1000 \times (1 - \prod_j (1 - Pr(S))) \times (1 - \prod_j (1 - Pr(O))) \times (1 - \prod_j (1 - Pr(D)))$$

$$RPN_i = 1000 \times (1 - \prod_j (1 - \frac{S_{ij}}{10})) \times (1 - \prod_j (1 - \frac{O_{ij}}{10})) \times (1 - \prod_j (1 - \frac{D_{ij}}{10})) \quad (4)$$

$$WRPN_i = IND_i \times \boldsymbol{RPN_i} \quad (5)$$

$$IND_i = \frac{3*\text{High risk level}'s RPN + 2*\text{Moerate risk level}'s RPN + 1*\text{Low risk level}'s RPN}{6} \quad (6)$$

Which, IND_i is the relative index of the expected status of the RPN.

The inverse of CV in RPN is important since the more the expert's agreement is on a sub-criterion, the more important the criterion is, and it requires precise planning and serious respond, and this is also the basis of the direct relationship between the RPN or the importance of the sub-criterion. In other words, the larger the RPN and the smaller the CV, the criterion will be more important.

3-5-IT Product life cycle

As well as other projects, IT projects have a lifecycle and the most common one is known as SDLC. Which is a set of various steps followed for the systematic development, design, and maintenance of the software projects and ensure to meet all the user's requirements with the least amount of resource consumption? (Barjtya et al., 2017). Planning, analysis, design, implementation, maintenance, and support are the five main phases in the lifecycle of IT projects, described below:

Phase 1: Planning

The planning phase involves identifying and solving the problem that led to project management. Planning must be done formally so that the goal, scope, budget, schedule, technology, steps, and methods of system development and tools are well-defined and ready to be used.

Phase 2: Analysis

This phase addresses the problem with more details. For example, the project team can provide documentation of the current system and call it the "as is model". Typically, the system analyst must meet different stakeholders (such as users, managers, clients) and become more familiar with the problem and position. This is necessary to get to know more about current system barriers and problems.

Phase 3: Design

During the design phase, the project team uses requirements and “to be” logical models as inputs to design the structure of the system. This structure should consist of network design, hardware, configuration database, user interface, and applications.

Phase 4: Implementation

The purpose of the implementation phase is the development and construction of the system, testing, and installation. Also, training, support, and documentation should be provided.

Phase 5: Maintenance and support

Although support and maintenance may not be one of the phases of the project, it is still an important consideration. Once the system has been implemented, it means that it is no longer in the production phase. To resolve bugs, changes to the maintenance and support phase must be made in the system, and it may be necessary to provide a call center or help desk for responding or advising users (Marchewka, 2014).

3-6-Ranking the accepted sub-criteria according to WRPN

According to the calculations for evaluating the content validity, the sub-criteria "Unclear organizational goals and objectives", "Poor knowledge management and lessons learned register", "Lack of quality inspection", "Multiplicity of unknown-unknowns", "Delay in documentation reporting", "Poor technology", "Poor training", "The rapid changes in technology", "Inaccessibility to suppliers" and "Instability of political and governmental issues" due to the number of CVRs below 0.42, The following criteria have been excluded from the list. The criterion of "infrastructure" has been omitted from the general category of criteria; due to the removal of its sub-criteria.

After identifying the acceptable criteria by using the FMEA method, as well as the WRPN that is explained in section 3-4, the effective causes of delays and failure of IT projects has been prioritized, in accordance with equations 2 and 3, the results of the calculations in table14 are significant.

Table 14. Ranking EFFECTIVE sub-criteria for delays and failure

No.	RPN	CV	1/CV*RPN	(Risk Level, Rank)	CVR
C11.1	353.13	0.18	1939.83	(H*,1)	0.90
C3.1	355.57	0.20	1764.13	(H*,2)	0.80
C4.2	249.80	0.15	1716.19	(H*,3)	0.80
C1.1	298.80	0.18	1707.33	(H*,4)	1.00
C9.1	341.78	0.22	1554.93	(H*,5)	0.80
C9.2	341.78	0.22	1554.93	(H*,6)	0.80
C11.2	336.11	0.22	1527.16	(H*,7)	0.80
C2.1	296.22	0.19	1524.17	(H*,8)	0.90
C6.1	273.59	0.18	1493.97	(H*,9)	0.90
C6.2	327.32	0.22	1462.44	(H*,10)	0.60
C4.1	196.55	0.15	1291.35	(H*,11)	0.90
C1.2	289.95	0.23	1263.88	(H*,12)	0.80
C10.1	305.34	0.25	1236.36	(H*,13)	0.60
C5.1	307.06	0.26	1188.65	(H*,14)	0.70
C6.3	309.60	0.27	1161.86	(H*,15)	0.90
C5.2	280.32	0.25	1123.67	(H*,16)	0.70
C4.4	250.54	0.23	1101.80	(H*,16)	0.80
C4.3	286.20	0.26	1095.50	(H*,18)	0.70
C9.3	292.60	0.27	1090.83	(H*,19)	0.80
C7.1	283.25	0.26	1076.49	(H*,20)	0.60
C8.1	237.60	0.22	1074.59	(H*,21)	0.70
C13.3	305.69	0.30	1028.24	(H*,22)	0.70
C2.2	255.66	0.26	974.54	(H*,23)	0.80
C3.3	268.71	0.28	960.57	(H*,24)	0.60
C3.2	244.04	0.26	926.59	(H*,25)	0.70
C7.2	248.12	0.30	829.44	(H*,26)	0.50
C2.3	242.75	0.30	801.09	(H*,27)	0.60
C3.4	219.49	0.28	788.41	(H*,28)	0.60

** High Risk*

Since FMEA ignores the fact that three factors of (Severity, Occurrence, Detection) have different weights rather than equality and in order to more focus on the occurrence and the severity of sub-criteria, we used the FMEA area chart to determine the severity of the effective causes of delays and failure of IT projects in the probability of occurrence and divide it into three high risk, medium risk, and low-risk areas. Considering that, as shown in Chart 1, all sub-criteria are located in the high-risk area.

3-7-Ranking the main criteria based on the relative index of the expected status of WRPN

After prioritizing the effective sub-criteria of failure and delay in IT projects and considering the risk area of each of the criterion in FMEA area chart (figure 3), which indicates their severity and occurrence, for prioritizing the main criteria we used a weighted index (equation 6) to indicate the expected status of WRPN. To calculate it we multiply the weighted coefficient of 3 for the sub-criteria in high-risk level, the weighted coefficient of 2 for the sub-criteria in moderate risk level and the weighted coefficient 1 for the low-risk level in an area chart.

Consequently, for each of the main criteria, we can calculate the relative index of the expected status of WRPN considering their sub-criteria's RPN. The result is significant in table 15.

Table 15. Ranking effective criteria for delays and failure

Rank	Criterion Code	Num. of Criteria	Num. of (High, Moderate, Low)-Risk level Criterion	The relative index of the Expected status of the WRPN
1	C4	4	(4,0,0)	2602.42
2	C3	3	(3,0,0)	2219.86
3	C6	4	(4,0,0)	2059.13
4	C11	3	(3,0,0)	1733.50
5	C2	3	(2,0,0)	1649.90
6	C1	2	(2,0,0)	1485.61
7	C9	3	(2,0,0)	1322.88
8	C5	3	(2,0,0)	1156.16
9	C7	2	(2,0,0)	952.97
10	C10	4	(1,0,0)	618.18
11	C8	2	(1,0,0)	537.30
12	C12	2	(1,0,0)	514.12

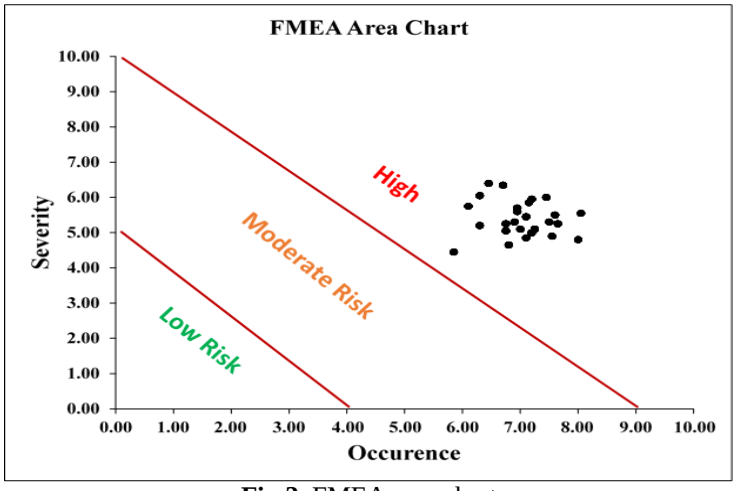

Fig.3. FMEA area chart

3-8-The impact of the criteria on each of IT project development phases

Considering that the effectiveness of each of the sub-criterion for project interrupt is different in the phases mentioned, and identification of this is effective in assessing the readiness of IT projects in dealing with delays and it is important for creating an appropriate risk response plan in the early phases, the impact of these sub-criteria have been questioned by experts and based on the number of expert's opinions in each phase, the of the impact of this sub-criteria on each phase has been calculated. As it is shown in Table14, in the ***planning phase*** of IT projects, and based on expert's opinion sub-criteria of "accurate planning for work process" and "project manager's technical knowledge" and "Project manager with knowledge in the project management area" is recognized as the most important criteria for project success and to prevent related failure in this phase.

In the ***analysis*** phase, "effective communication with stakeholders" and "considering the complexity of the project" and "stakeholder involvement" is classified as three important criteria for the success of the projects. In the ***design*** phase, the "Inaccurate estimation of time, cost, and resources" and "Poor conflict management" and "Lack of leadership's commitment" are considered as three key criteria that should be considered in order to prevent IT projects to be failed. In the ***implementation*** phase, the factors such as "Non-commitment of project team to the assigned work", "Assign insufficient human resources to the project", "The poor performance of sub-contractors", and "Poor communication skill of project manager" is known as the most important delay and failure causes for IT projects. In the ***maintenance and support***

phase, factors such as "delay in financial payments", "Non-commitment of the project team to the assigned work", "The poor performance of sub-contractors" and "Inadequate budgeting" are known as the most important factors in the failure of IT projects.

3-9-An algorithmic framework for evaluating and prioritizing failure criteria due to delays in managing IT projects

One of the main finding of research is to provide an "algorithmic framework" (figure 4) for evaluating and prioritizing criteria due to delays in IT project management including following steps:

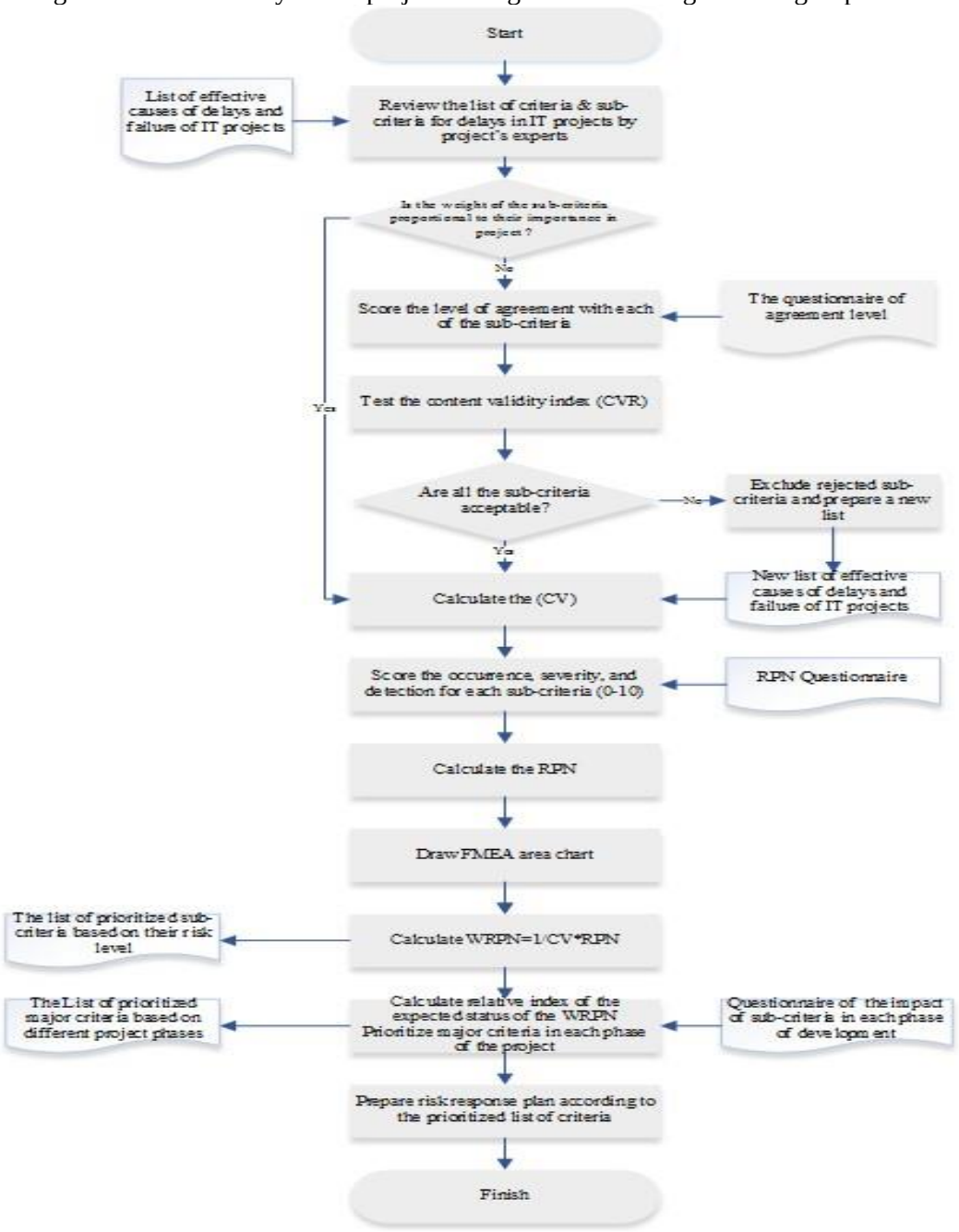

Fig. 4. An algorithmic framework for evaluating and prioritizing failure criteria due to delays in the management of IT projects

***Step 1*:** First, based on the list of the effective causes of delays and failure factors of IT projects and the conceptual model presented, the criteria for delays in IT projects are surveyed by the project experts in the organization.

***Step II*:** Then, the weight of the criteria for delays in the projects in the model presented is commensurate with the importance of them in the current project. If the weight of these criteria in the running project is not proportional to their importance, the reassessment will be made to the extent that they are agreed upon.

***Step III*:** After reviewing and re-scoring, if required, Content Validation will be checked based on CVR, and if this indicator is acceptable for each of the criteria, the benchmark is accepted. Otherwise, it will be excluded from the list, and a new list of criteria will be provided.

***Step IV*:** In this step, it is necessary to calculate the CV of the expert's opinions on the agreement score they had given to each criterion.

***Step V*:** In order to rank the criteria and calculate the RPN, a questionnaire about the (O, S and D) of the criteria will be provided to the project's experts, after calculating RPN, the FMEA area chart classified into three high, moderate, and low risk areas based on the "Occurrence" and "Severity", the WRPN based on the reverse CV multiplication in the RPN number calculated, according to the placement of each criterion In high, moderate and low-risk areas, a list of prioritized criteria for preventive planning and appropriate risk response plans is provided to the relevant organization.

***Step VI*:** In this step, the importance of each criterion in the various phases of the project is questioned from experts, and after conducting the necessary analyses on the response of the experts, a list of priorities for each of the criteria will be available.

4-Conclusion

Given that the first step of the BCM cycle begins with identifying and evaluating risks, this paper presents a framework for identifying, categorizing and prioritizing the effective causes of delays and failure of IT projects which will facilitate identification and evaluation of project risks and thus the first step towards the creation and implementation of business continuity strategies will be taken.

In this research, 38 sub-criteria have been identified and prioritized as critical factors of success and failure in IT projects. These sub-criteria have been categorized into 13 core criteria. The following important results have been extracted from the categorization and prioritization of the criteria:

- The Four following sub-criteria are the most important ones with the highest priority numbers.
  - "Inaccurate, incomplete or not defined requirements collection"
  - "Lack of project team's technical knowledge",
  - "Failure to understand, evaluate, define, and manage needs and Expectations of stakeholders",
  - "Lack of leadership's commitment."
- Three criteria of "stakeholders", "employees," and "operations" have also been found as critical factors in delay and failure of IT projects.
- ***The planning phase*** of IT projects, and based on expert's opinion sub-criteria of "accurate planning for work process" and "project manager's technical knowledge" and "Project manager with knowledge in the project management area " is recognized as the most important criteria for project success and to prevent their failure in this phase.
- In the ***analysis*** phase, "effective communication with stakeholders" and "considering the complexity of the project" and "stakeholder involvement" are classified as three important criteria for the success of the projects.
- In the ***design*** phase, the "Inaccurate estimation of time, cost, and resources," and "Poor conflict management" and "Lack of leadership's commitment" are considered as three critical criteria that should be considered in order to prevent IT projects to be failed.

- In the ***implementation*** phase, the factors such as "Non-commitment of the project team to the assigned work", "Assign insufficient human resources to the project", "The poor performance of sub-contractors", and "Poor
- Communication skill of the project manager" is known as the most important delay and failure causes for IT projects.
- In the ***maintenance and support*** phase, factors such as "delay in financial payments", "Non-commitment of the project team to the assigned work", "The poor performance of sub-contractors" and "Inadequate budgeting" are known as the most important factors in the failure of IT projects

Considering that this research surveyed the critical criteria of delays and failure of IT projects at the macro and general level, a careful survey of success and failure criteria in the specialized IT subdivisions can be considered as a suggestion for future studies.

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