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RE-ASSESSING THE IMPORTANCE OF NECESSARY OR SUFFICIENT CONDITIONS OF CRITICAL SUCCESS FACTORS IN IT PROJECT SUCCESS: A FUZZY SETTHEORETIC APPROACH

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Abstract

Despite more than fifty years of intensive effort, the issue of IT project failure remains unresolved. It has been suggested that conventional approaches may be misdirecting project management effort and moreover research shows top management support to be of critical importance (e.g. Young and Jordan 2008; Tichy and Bascom 2008). However, existing empirical evidence may have a strong reliance on selective exemplary cases of top management support and they do not account for counter-examples and counterfactuals. This paper lays the foundation for further research to resolve this issue by reassessing the original research using a more systematic approach: fuzzy-set analysis. The main contribution of the paper is methodological. In overcoming the numerical limitation of multiple case study research it provides a standard approach to compare large numbers of case studies. Researchers and practitioners are provided with an approach to compare and reconcile diverse project experiences and unambiguously determine the critical success factors that are the most important for project success.

Keywords: project failure, critical success factor, top management support, fuzzy set analysis.

1 Introduction

Despite more than fifty years of intensive effort, the issue of IT project failure remains unresolved. (Sauer 1993, 1999; Reich and Sauer 2008; Tichy and Bascom 2008). If the widely cited Standish statistics are to be believed, the failure rate has actually deteriorated in the last eight years (Standish 2003; Standish 2009). In addition to this, many are starting to realize that the problem is not isolated to IT projects. Lovallo and Kaheneman (2003) are cited by the Australian Institute of Company Directors to illustrate disappointing results with all types of large capital projects in areas as diverse as manufacturing, marketing, and mergers and acquisitions (AICD 2009).

The conventional wisdom to reduce project failure is to focus on project methodologies, user involvement, top management, high level planning and high quality project staff in that order. However, recent research has revealed that the conventional wisdom may be misdirecting effort (Young and Jordan 2008).

One major problem with the conventional wisdom is the focus on project management success (on-time on-budget on-quality) rather than project success (realization of expected outcomes) (de Wit 1985; Baccarini 1999; Cooke-Davies 2002). Project management success does not automatically lead to project success (Markus, Axline et al. 2000). The widespread use of project methodologies has not provided the expected results with as few as 10% of projects actually delivering all of what is promised and fewer than a third of projects delivering any business benefits at all (Willcocks 1994; Clegg, Axtell et al. 1997; Young 2006). The Project Management Institute (PMI) has not been able to demonstrate that project management adds value (Thomas and Mullaly 2008). Methodologies such as PRINCE2 or PMBOK have been found to be mature but ineffective without project governance and top management support (Sargeant 2010).

Evidence is building that top management support is more important than the traditional approaches. It seems projects will not succeed without the active involvement of top managers in some kind of project governance process. However, the evidence for this is based mainly on five case studies and still relatively weak (Young and Jordan 2008). Top managers in general still do not consider projects to be a matter of direct concern (Crawford 2005). It may be difficult for them to differentiate the new advice from past advice which was little more than lip-service or exhortation (Schmitt and Kozar 1978; Izzo 1987; Lederer and Mendelow 1988; Emery 1990; Jarvenpaa and Ives 1991). In addition to this, there are counter-examples where top management involvement hindered rather than helped some projects, thus suggesting top management involvement may not always be useful (Keil 1995; Collins and Bicknell 1997; Mähring 2002).

This paper will lay the foundation for further research to resolve this issue by using a more systematic analysis technique: fuzzy-set analysis. The technique will firstly be applied to re-assess the importance of each critical success factor CSF described in Young and Jordan's (1998) original five case studies. The contribution of the paper will be to provide a methodological approach to overcome the numerical limitation of multiple case study research. With a rigorous way to analyze large numbers of qualitative case studies, researchers and practitioners will be able to compare and reconcile diverse project experiences and determine conclusively the importance of critical success factors for project success. Effort can then be redirected as necessary to overcome the long standing problem of IT project failure and project failure in general.

The structure of this paper is as follows. The literature is summarised in the next section. In Section 3, we describe the research methodology adopted for this research, then the present an analysis of the data collected and the results in Section 4. The discussion and conclusions are presented in Sections 5 and 6 respectively.

2 Summary of Relevant Literature

Much of the research on project success and failure is characterized by surveys of project managers to identify critical success factors (Lucas 1975; Lyytinen and Hirschheim 1987; McGolpin and Ward 1997; Schmidt, Lyytinen et al. 2001; Cooke-Davies 2002). The list of failure factors produced by the Standish Group (1996) could be considered the conventional wisdom because they are widely cited and are consistent with academic research.

Unfortunately the "dimensions thought to be important have [had] no consistent impact on the success of computing" (Kraemer and King 1986). An enormous number of largely untested methodologies have been proposed and adopted (Checkland 1981; Strassmann 1995; Clegg, Axtell et al. 1997) but half to two thirds of projects are still abandoned or implemented without any perceptible benefits (Willcocks and Margetts 1994, Standish 1999, 2003). Despite this, the number of success stories reported are almost twice the number of failures (Falconer and Hodgett 1999; Rocheleau 2000) and the conclusion after fifty years of intensive research is that IT success/failure remains a poorly understood phenomenon (Sauer 1999, Tichy and Bascom 2008; Reich and Sauer 2008).

Young and Jordan (2008) argue that progress is being held back by our concepts due to the number of possible factors involved. It has been noted that few had progressed beyond the early insight that project success or failure might be attributable more to organizational than technical or project management issues (Lucas 1975). Their research recognized that the conventional wisdom must be incomplete and they redirected effort to look for major areas of neglect rather than to improve existing approaches. To make the search more manageable, they took the Standish critical success factors as a proxy for conventional wisdom and condensed them into five major categories. These categories are summarized below in the order of importance when project success is considered the primary objective. The original weightings based on responses of project managers in the Standish studies are also presented in Table 1 for comparison.

SF category	**Critical Success Factors (*weightings from Standish 2006)***	**Conventional weighting (Standish 2006)**	**Importance for project success (Young & Jordan 2008)**
Top Management Support (TMS)	Top Management Support (16)	16	1
User	User involvement (19) Ownership (6)	25	2
Project Methodologies	Clear statement of requirements (15) Proper planning (11) Smaller project milestones (6)	32	3
High Level Planning	Realistic expectations (10) Clear vision & objectives (3)	13	4
Staff	Competent staff (8) Focussed and hard working (3)	11	5

Table 1 Critical success factors for project success (Source: (Young and Jordan 2008)

If the above findings are correct and top management support is the most important CSF, there is a problem because prescriptions for top management support (TMS) are not well developed (Bassellier and Pinsonneault 1998). Some advice imposes very demanding requirements simply to improve goals of little direct interest to top managers such as technical quality or user satisfaction (Brandon 1970; Dinter 1971; Doll 1985; Izzo 1987). Other prescriptions for communication, enthusiasm, involvement and participation appear to be little more than exhortation (Schmitt and Kozar 1978; Izzo 1987; Lederer and Mendelow 1988; Emery 1990). And, as noted earlier, there are counter-examples suggesting top management involvement may not always be useful (Keil 1995; Collins and Bicknell 1997; Mähring 2002).

Resolving the issue of the nature and importance of TMS is difficult because it is an organizational phenomenon where the boundaries between the phenomena and context are not clearly evident. Case study research provides a distinct advantage over alternatives such as surveys, archival research, historical analysis and experiments because there is a 'how' or 'why' question being asked about a contemporary set of events over which the investigator has little or no control (Yin 2003). However, case study research becomes unwieldy when there are more than 10-15 cases. This is a significant limitation because more than 10-15 cases may be needed to convince top managers and the project management community that a significant change in practice is required.

This paper will address this issue by applying a fuzzy-set theoretic based methodology to case studies developed using qualitative techniques. In doing so, the paper will demonstrate how to overcome the numerical limitation for the analysis of multiple case studies. In overcoming the numerical limitation of multiple case study research *r*esearchers and practitioners will be provided with an approach to compare reported and directly experienced projects, and unambiguously determine the critical success factors that have critical importance for success. The foundation will therefore be established to resolve with confidence the issue of which CSF has the highest importance, and therefore discover whether the conventional approaches to project management are misdirecting effort.

3 Methodology

In this section, a conceptual orientation to fuzzy-set comparative method for case-oriented research will be introduced. In this particular study, the analysis is based on set relations, which is to identify commonalities across a number of cases (Ragin and Rihoux 2004). This method is particularly useful if the focus is on a relatively small number of purposely selected cases (Vaughan, 1986). It is important to see the distinctive contrast between set-theoretic and correlation approaches. The key difference is that correlation approach is symmetrical by design, and the set-theoretic perspective is fundamentally asymmetrical. This distinction is important because set-theoretic analysis, like qualitative research, more generally focuses on uniformities and near uniformities, not on general patterns of association between study factors and outcome (Ragin 2008).

3.1 Qualitative Comparative Method

The qualitative comparative method in social science is a technique first pioneered by Charles Ragin in 1987 for solving the problems caused by making causal inferences on the basis of only a small number of cases. The original goal of this technique was to 'integrate the best features of case-oriented approach with the best features of the variable-oriented approach' (Ragin, 1987, p.84). Hence, this approach could provide an avenue to produce some level of generalization from data gathered from different in-depth cases. Although the qualitative comparative method is in essence a case-sensitive approach, it also embodies the strengths of the quantitative approach. According to Rihoux (2006), the key operations of this technique rely on Boolean algebra, which requires that each case be reduced to a series of variables (conditions and an outcome) and hence, allows replication.

We develop conditional claims in our analysis through two forms of conditions: necessary and sufficient conditions. The difference between necessary and sufficient conditions depends on the implicational relationship between statements. The formulation of necessary and sufficient conditions provides a way to understand the meaning of conditional claims. A necessary condition or factor (A) must be satisfied for an outcome (O) to be true (i.e. $O \subseteq A$). For example, if we claim "A is a necessary condition for O," we claim that if we don't have A, then we won't have O. Note that A is a necessary condition for O does not mean that A guarantees O. On the other hand a sufficient condition (A) is a condition that if satisfied, assures the outcome O (i.e. $A \subseteq O$). For example, if we claim that "A is a sufficient condition for O," we claim if we have A, O must follow. In this case, A guarantees O.

3.2 Importance of Conditions

To assess the "importance" of conditions for an identified outcome, Geortz (2003) adds two central questions to assess the importance of necessary or sufficient conditions. Conditions may be assessed as necessary or sufficient, but this will not describe the relative importance of the factor. To make this assessment, it is important to understand the concept of trivialness and relevance.

3.2.1 Trivialness of Conditions

According to Downs (1989), for any phenomenon there are an infinite number of necessary conditions. For example in order to pass an exam we need to satisfy the many conditions such as gravity, electricity, pen, etc. In this case gravity is a trivial necessary condition because it is constant across all cases. (Geortz and Braumoeller 2000) extend this idea and argue that a trivial necessary condition is a condition that is always present in every single case across the universe. It is obvious that the more trivial a condition gets, the less important it becomes, because it is constant across all cases. Consider the following examples of both necessary conditions (A_1 and A_2):

(a)	¬A_1	A_1
O	0	10
¬O	10	0

(b)	¬A_2	A_2
O	0	10
¬O	5	5

Table 2 Trivial Necessary Conditions in 2x2 tables

Both examples in table 2, conditions A_1 and A_2 satisfy the conditional claim of necessary condition described in the previous section, i.e. if we don't have A_i then we won't have O (or $P(A_i|O)=1$). However, the difference between (a) and (b) is that there are less cases of ¬A_2. The (¬A, ¬O) cell of a 2x2 table is the "trivialness cell" providing us with insight into the relative necessity of a condition.

In contrast to necessary conditions, A is a sufficient condition for O if $A \subseteq O$. This is conceptually the inverse of trivial necessary conditions, i.e. conditions are trivial because they are easy to attain. Consider the following example in Table 3:

(a)	¬A_1	A_1
O	0	10
¬O	10	0

(b)	¬A_2	A_2
O	5	5
¬O	10	0

Table 3 Trivial Sufficient Conditions in 2x2 tables

Both conditions A_1 and A_2 in Table 3 satisfy the conditional claim of necessary condition described in the previous section, i.e. A_i guarantees O (or $P(O|A_i)=1$). However, as illustrated in Table 3, as more cases move from the ¬A to the A cell, the importance of the sufficient condition goes up.

3.2.2 Relevance of conditions

Geortz (2003) describes the idea of relevance as simply, "more important". In Table 2, A_1 is more relevant to the outcome or O because it is less trivial. On the other hand A_2 is less relevant to O because it is more trivial. Consider the example in Table 4:

(a)	¬A_1	A_1
O	0	10
¬O	10	0

(b)	¬A_2	A_2
O	0	5
¬O	10	5

Table 4 Relevant Necessary Conditions in 2x2 tables

In Table 4, the cases move from O to ¬O in the cases between A_1 and A_2, i.e. A_2 is less relevant. This is also called the "sufficient effect" of a necessary condition: the extent to which the presence of a necessary condition A helps produce O (Goertz 2003). As shown in table 4, as more cases move from the ¬O the O cell the importance of the necessary condition goes up. This permits the insight into the (A, ¬O) cell of a 2x2 table or the "relevance cell" for necessary conditions. This cell also provides information about counter-examples to the proposition of A is sufficient for O. Hence, intuitively the support for sufficiency hypothesis increases as the number of counter-examples decreases.

As discussed previously, a relevant necessary condition is also considered sufficient. To analyze a relevant sufficient condition, we need to invert the notion that relevant sufficient condition is also considered as necessary condition. This is illustrated in Table 5.

(a)	$\neg A_1$	A_1
O	0	10
¬O	10	0

(b)	$\neg A_2$	A_2
O	5	10
¬O	5	0

Table 5 Relevant Sufficient Conditions in 2x2 tables

In Table 5, as more cases move from the O the ¬O cell, A becomes less relevant. In summary, for the relevance of necessary conditions, we observe the changes of O in column A. The part (a) of Table 5 demonstrates the A_1 is necessary and sufficient condition. As cases are moved from (¬A, O) cell to (¬A, ¬O) cell, the level of necessity of A decreases, i.e. $P(A_i|O)$ decreases from (a) to (b).

3.3 Measuring the Importance of Conditions with Fuzzy-Sets

Understanding the importance of sufficient and necessary conditions is vital for understanding the relationship between factors and outcome. Normally researchers describe necessity or sufficiency in an absolute or perfect sense. The advantage of fuzzy-set theory is that degrees of necessity and sufficiency can be evaluated rather than having to assume a perfect relationship.

Fuzzy sets were first introduced by Zadeh in 1965 and the key concept is that elements or objects belonging to a set can have different degrees of membership (Zadeh 1965). This is an extension of classical set theory by allowing continuous values between 0 and 1 instead of dichotomous values. The fuzzy logic "membership score" is considered as a continuous value of the condition (A) or outcome (O) variable. Considerations of length prevent a complete exposition of why in fuzzy logic when A is necessary for O, the fuzzy logic value of A is greater than or equal to the fuzzy logic value of O. Basically the set theoretic notion of containment becomes the relationship of less than: in an important sense a number which is less than another is contained in the larger number. The following are the equations to measure the four dimensions of importance developed by Geortz (2003).

The measure of trivialness of necessary condition A (given $O \subseteq A$ or $O \le A$), T_{nec}, is the average distance from a_i to 1.00 standardized by how far o_i is from 1.00, i.e.

$$T_{nec} = \frac{1}{N}\sum(1 - a_i)/(1 - o_i). \quad (1)$$

The larger the value of T_{nec} the more nontrivial and more important the condition A becomes. When T_{nec} is zero the condition is completely trivial and when T_{nec} is one, the condition is not at all trivial.

The measure of relevance of necessary condition A, R_{nec}, can be written as:

$$R_{nec} = \frac{1}{N}\sum(a_i / o_i). \quad (2)$$

The larger the value of R_{nec} the more relevant of necessary condition A becomes. The combined measure of T_{nec} and R_{nec}, TR_{nec} gives the absolute importance of a necessary condition:

$$TR_{nec} = (T_{nec} + R_{nec})/2 \quad (3)$$

The measure of trivialness of sufficient condition A (given $A \subseteq O$ or $A \le O$), T_{suf}, can be written as:

$$T_{suf} = \frac{1}{N}\sum(o_i / a_i) \quad (4)$$

The measure of relevance of sufficient condition A, R_{suf}, can be written as:

$$R_{suf} = \frac{1}{N}\sum(1 - o_i)/(1 - a_i) \quad (5)$$

The combined measure of T_{suf} and R_{suf}, TR_{suf} gives the absolute importance of a necessary condition:

$$TR_{suf} = (T_{suf} + R_{suf})/2 \quad (6)$$

The combined measure of TR_{nec} and TR_{suf}, $TR_{nec+suf}$ gives the absolute importance of a condition:

$$TR_{nec+suf} = (TR_{nec} + TR_{suf})/2 \quad (7)$$

One can view $TR_{nec+suf}$ as a correlation measure in statistical sense. We apply the above measures of absolute importance in relation to trivialness and relevance for necessary and sufficient conditions in the next section.

4 Data and Analysis

The analysis was applied to the five cases studies originally developed Young and Jordan (2008) which used a multiple-case study design following a replication logic (Yin 2003). The unit of analysis was a single IS project in the context of the benefits delivered to an organization. Vignettes of the five case studies are summarized below. The full version of these case studies are available as a publication from Standards Australia (Standards Australia 2006).

4.1 Summaries of Cases

Case 1 (Tech-Serv): The objective of this project was to integrate the core operational systems. The result was to integrate the systems but lose two vital functions. This caused revenue to drop by 25% for several months until the problem was solved. The high level plan was clear and sensible but the project was affected by arguments between different managers and no one taking responsibility as a sponsor. Staffs were motivated and raised issues a number of times but the project manager and the senior manager neglected the issues till they became a crisis. Users were not very involved and the project methodology was weak.

Case 2 (Tech-Media): Tech-Media successfully upgraded to an ERP system in one of the fastest implementations of this ERP in the world. However, only half of the promised benefits ($3M of $6M) were realized. The CFO was not an active sponsor and was replaced. The CEO and new project sponsor made regular visits to the project room. Issues relating to process change had not been addressed properly and user acceptance was delayed because of technical problems. The project plan was very comprehensive, being based on a consultant's methodology, and followed in detail. The project team was chosen very carefully based on their expertise.

Case 3 (The ABS): A new project management framework was implemented. However the project lost momentum after the sponsor left and retired. This was a new leading edge project and it was felt that there was not much value in soliciting extensive user involvement. Nonetheless, they had a well customized methodology and they also had realistic expectations even though they did not have a formalized high level plan. The project staff knew why the project was being done and they showed a great deal of interest.

Case 4 (The Agency): The project was an implementation of an ERP system to meet a government mandate. The high level plan was realistic but little interest from the CEO or the majority of the organization. The sponsor and project manager were determined to make the project a success. However they needed to overcome internal conflict between warring factions within the organization and even an accusation of probity issues. They tried to follow a consultant's methodology but it wasn't customized to reflect project understaffing with junior staff members. The project eventually met the primary objective of senior management team but did not meet all the objectives.

Case 5 (SkyHigh): An implementation of a new ERP system was done to overcome a risk experienced by a competitor – losing market confidence due to poor quality reporting. The project finished on-time on-budget and delivering all the benefits that were promised. The top managers showed a lot of interest and worked through issues to gain IT's satisfaction as well. They had strong sponsors and an active CEO. The methodology they chose worked well and they also had detailed realistic project planning. The staffs were carefully selected after 100 interviews and they also had high levels of user involvement.

4.2 Calibration of Critical Success Factors and Outcomes

A truth table will be created by assessing the relative success of each case and the degree to which each critical success factor (CSF) was adequately addressed. By analyzing the details of each case study, we score every project based on how well the outcome of that project was realized.

Outcome variables: The focus of measuring outcome is on the realization of the expected benefits (rather than traditional emphasis on on-time, on-budget). The relative success of the outcome of each project is than mapped to a fuzzy score between 0 and 1 according to description of the cases (0.1 is given to very weak outcome, 0.3 to weak outcome, 0.5 to medium, 0.7 to good, and 0.9 to Strong).

Conditions (CSFs): There are 5 critical success factors identified in the five cases. They are top management support (TMS), project methodology, user involvement, high level planning and adequacy of staff.

1. The assessment of adequacy of TMS will be based on factors such as commitment, sustainability of top manager's position along projects life and speed of response to issues.
2. The assessment of adequacy of Project methodology will be based on whether they have adopted any project management methodology, if they have customized the selected methodology to fit their requirements and also on how much they have followed the particular methodology.
3. The assessment of adequacy of user involvement will be based on how much the users have been involved with the project starting from the initiation phase, the quality and quantity of communication and whether the project manager has taken the users feedback into account.
4. The assessment of the adequacy of high level planning will be assessed on having realistic expectations of the outcome and the clarity of understanding of the expectations.
5. Assessment of the adequacy of Staff will be assessed on whether they are motivated focused and hard working.

Truth Table: The values in the truth table (Table 6) were assessed by the authors independently. Their results were compared and discrepancies discussed until consensus was reached. The following truth table was derived based on discussion and consensus between the authors.

Projects	Relative Success (O)	TMS (A_1)	User involvement (A_2)	Methodology (A_3)	High level planning (A_4)	Staff (A_5)
Tech-Serv	0.1	0.1	0.3	0.1	0.9	0.7
Tech-Media	0.3	0.3	0.3	0.9	0.7	0.9
ABS	0.5	0.5	0.3	0.9	0.7	0.9
Agency	0.7	0.7	0.5	0.3	0.7	0.3
SkyHigh	0.9	0.9	0.9	0.9	0.9	0.9

Table 6. Fuzzy-set scores of relative success and adequacy of each CSF. (Criteria: Very weak=0.1, Weak=0.3, Medium=0.5, Good=0.7, Strong=0.9)

4.3 Results

To determine the relevance and the trivialness of each CSF, we compare the value assigned to each CSF with the value assigned to the outcome (decision) in the truth table (Table 6). We apply the questions derived in section 3.3 to measure trivialness and relevance of conditions based on the assigned fuzzy scores between each CSF and outcome. Our results are shown in Table 7.

	TMS (A_1)	**User involvement (A_2)**	**Methodology (A_3)**	**High level planning (A_4)**	**Staff (A_5)**
T_{nec}	1.00	1.17	0.94	0.63	0.80
R_{nec}	1.00	1.08	1.04	0.65	0.87
T_{suf}	1.00	1.26	1.45	2.95	2.65
R_{suf}	1.00	0.92	2.89	3.00	3.29
TR_{nec}	1.00	1.12	0.99	0.64	0.84
TR_{suf}	1.00	1.09	2.17	2.97	2.97

Table 7. Evaluation of the CSF's

Geortz (2003) mentioned that most researchers apply statistical analysis on different factors in order to understand the relevancy between them. However, he believes that less attention has been given to the trivialness of those factors. This paper has used R_{nec} and R_{suf} in order to measure the relevance and uses T_{nec} and T_{suf} in order to measure the trivialness of them. The closer T_{nec} and T_{suf} get to one, the less trivial (more important) it becomes and the further away it gets from one, the more trivial it becomes.

From the results in Table 7 it is safe to conclude that because TMS has a score of one for both T_{nec} and T_{suf}, it is the least trivial. On the other hand high level planning is the most trivial factor among all five. The same concept as above applies for R_{nec} and R_{suf}. The closer the number is to one, the more relevant it becomes. It is clear to see TMS has the perfect score of 1 for all measures (including TR_{nec} and TR_{suf}). Such result suggests that TMS is not only necessary but also sufficient condition for project success. Our results have arrived to the same results produced by the researchers (Yung and Jordon 2008) who provided the cases.

For the remaining four CSFs, we compare each CSF based on the four measures of Trivialness of Necessary Condition (T_{nec}), Relevance of Necessary Condition (R_{nec}), Trivialness of Sufficient Condition (T_{suf}), Relevance of Sufficient condition (R_{suf}).

We have found that high level planning (A_4) is found to be the most trivial necessary condition (T_{nec}=0.63), the most non-relevant necessary condition (R_{nec}=0.65), and the most trivial sufficient condition (T_{suf}=2.95) as it measures (T_{nec}, R_{nec} and T_{suf} are most deviated from 1). Adequacy of staff (A_5) is found to be the most non-relevant sufficient condition (R_{suf} =3.29) as its R_{suf} is the most deviated from 1. Methodology (A_3) is found to be an important necessary condition as both importance measures for necessity are relatively closer to 1 (T_{nec}=0.94 and R_{nec}=1.04). Hence, the combined measure TR_{nec} for Methodology is 0.99 which can be considered as a near perfect necessary condition for project success. User involvement (A_2) is found to be an important sufficient condition as both importance measures for sufficiency are relatively closer to 1 (T_{suf}=1.26 and R_{nec}=0.92). The combined measure TR_{suf} for user involvement is 1.09 which is also a significant sufficient condition for project success.

5 Discussion

In this section, we further combine the two dimensions (TR_{nec} and TR_{suf}) in order to quantify the absolute importance of the factors. In Table 8 $TR_{nec+suf}$, the "absolute importance" is shown along with the ranks reported for the same CSF from earlier studies.

	Results from this paper				Importance for project success (Young 2008)	Conventional weighting (Standish 2005)
	Necessity TR_{nec}	**Sufficiency** TR_{suf}	**Absolute Importance** $TR_{nec+suf}$	**Rank**		
TMS (A$_1$)	1.00	1.00	1.00	1	1	3
User involvement (A$_2$)	1.12	1.09	1.11	2	2	2
Methodology (A$_3$)	0.99	2.17	1.58	3	3	4
High level planning (A$_4$)	0.64	2.97	1.81	4	4	1
Staff (A$_5$)	0.84	2.97	1.90	5	5	5

Table 8. Rank of CSF's according to their importance for project success

In column 4 of table 8, we have used the composite measure of $TR_{nec+suf}$ (recall: a measure of averaging between the two measures of importance of necessary (TR_{nec}) and sufficiency (TR_{suf})). Mathematically, $TR_{nec+suf}$ is actually measuring the correlation between the study factor (A_i) and the outcome (O), i.e. A=O. Based on the column showing $TR_{nec+suf}$ for each CSF, we have found TMS to be the most important CSF. Form the correlation perspective, the findings of this paper are consistent to Young and Jordan (2008) with both studies finding. This is unsurprising as they are based on the same case studies.

The special feature of this paper is to gain insights into each CSF from a more micro-level perspective. By using the two TR measures of importance TR_{nec} and TR_{suf}, we have identified several interesting observations.

First, in addition to TMS, only the relation between User Involvement and the outcome factor of success was found to be following a correlation pattern as the two TR measures deviated more or less symmetrical from 1 (TR_{nec} value is 0.12 above 1 and TR_{suf} is 0.09 above 1). In contrast, the other three CSF (consisting Methodology, High level planning and Adequacy of Staff) do not follow the similar correlation pattern with the outcome factor of success. For example, Methodology has, on one hand, near perfect TR_{nec} with the value of 0.99 (i.e. near perfect importance in necessity), but on the other hand its TR_{suf} is 2.17 which is significantly departed from the perfect measure of sufficiency. □□□□□□□
success.

Second, when we compare between two important factors in necessity TMS and Methodology, we are able to gain insights in the asymmetric relationships between each CSF and the outcome factor. Although both CSFs are equivalent in importance in the necessity dimension, their importance of sufficiency are very different (TR_{suf} for TMS is 1 and TR_{suf} for Methodology is 2.17). These comparative measures have provided us with the insight to speculate that Methodology can only provide the necessary condition for success but it is insufficient to guarantee success.

Third, the interesting insight derived from this paper is the asymmetric effects of certain factors on project success. We have found that only two factors (TMS and User Involvement) seem to have followed a symmetric relationship with the outcome factor. Hence these two factors are perhaps easier to be identified by traditional statistical analysis (like correlation). Furthermore, the asymmetric relationships of the three CSFs (particularly Methodology) with the outcome factor have indicated that the factors that provide necessary conditions for project success can be different from the factors that provide sufficient conditions for success. We have found that our results can be partially explained by the 2-factor organizational theory developed by Herzberg (1968). In Herzberg original 2-factor theory (also known as motivation-hygiene theory), it describes a situation where factors that are affecting one dimension of motivation could be quite different to the other dimension. These factors are unlikely to be detected by traditional statistical methods and detection of these forms of relationships may not be improved by increasing in sample size (in the form of number of cases).

6 Conclusion

The paper applied the fuzzy set analysis to a set of existing cases previously presented in Young and Jordan (2008). The contribution of this paper has been to provide a systematic approach to analyze case studies and to re-assess the CSFs in project management in the existing literature. It is clear from past research that top management support is not always a panacea to project failure and it is important to understand when and how it contributes most significantly to success. The paper also provides a technique to analyze case studies in more detail to identify which CSFs actually contribute(s) to project success. Our findings indicate that the set of factors that affect positively to project success can be different from the set of factors hindering success. We conclude that factors that positively affect project success do not necessarily have a reverse effect when they are reduced or removed. It appears that some factors have asymmetrical effects on project outcome.

The way is now open to reach consensus on whether the current practice emphasizing project methodology is a misnomer and whether effort should be refocused to overcome the problem of IT project failure. This is a pressing issue with large social and financial implications. Many suggestions have been provided over the past fifty years to overcome the problem of project failure. Time has shown that these approaches have generally not reduced the project failure rate CITE. This paper has introduced fuzzy-set analysis, a systematic qualitative-quantitative method to address the problem. Five case studies were analyzed using the technique to identify the most important CSFs. The results reconciled very well with qualitative studies of these same five cases. This has been the first attempt to use fuzzy-set analysis to IT success cases and has laid the foundation for future studies to identify and refine our understanding of the most important CSFs for project success?. Researchers and practitioners, using this methodology, will be able to compare and bring together various project experiences and determine conclusively the most important critical success factors for project success.

The major limitation of this research is the calibration of the fuzzy scores for the CSFs and outcome factor. It is due to the small number of people involved in deciding the fuzzy scores. Although the fuzzy scores were given independently by the authors, bias could not be avoided. Authors are aware of the limitation and plan to include more cases and consensus of more experts involved in deciding the fuzzy scores in the future studies.

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