ASSESSING PROJECT MANAGEMENT SUCCESS: FROM "IRON TRIANGLE" TO "STEEL TETRAHEDRON"

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JEL classification:	Abstract:
E24, O15, O31	The project management (PM) plays an important role in achieving project success. Conventionally PM success is evaluated using the 'iron triangle' approach that judges whether the project is within budget, meet scope specification and delivered on time. This paper argues that transmitting from conventional measure ('iron triangle') to new measure ('steel tetrahedron') is essential for PM success. By providing a review of both approaches, the paper suggests that a framework of PM success measurement should involve not only objective-based criteria, but also outcome-based criteria.
Keywords:	
motivation, compensation, monetary reward, human resource management, individual performance	

1. Introduction

The project management (PM) plays an important role in achieving project success. Several studies (e.g., De Wit, 1988, Munns and Bjeirmi, 1996, Lim and Mohamed, 1999 and Cookie-Davies, 2002) have argued that scope of PM success is much narrower than scope of project success[3]. For instance, project stakeholders' interests differ widely, thus different stakeholders differently evaluate project success at different times (De Wit, 1988 and Lim and Mohamed, 1999). The nature of stakeholders' interest forms their views about whether a proposed project ended up 'successful'. Zwikael and Smyrk (2011) propose a general framework for measuring success relating to projects that involves distinguishing successes regarding to PM, ownership, and investments.

Conventionally, PM success is evaluated using the 'iron triangle' approach that judges whether the project is within budget, meet scope specification and delivered on time (De Wit, 1988 and Atkinson, 1999). However, the 'iron triangle' assessment narrows the focus away from the outcomes attributing to the project manager, hence

[3] Project success is judged against the project objectives whereas PM success is judged the project team's capability to effectively manage the project, thus the expected results (i.e., scope or quality) are produced while managing cost and time (Toor and Ogunlana, 2010).

limit the role of PM (Ebbesen and Hope, 2013). For instance, projects that meet the conventional criteria may not necessarily be successful from the perspective of project stakeholders. Despite the simplistic nature of the 'iron triangle' approach, scholars and practitioners have identified weaknesses of the approach and considered additional sets of criteria for measuring PM success (e.g., Munns and Bjermi, 1996, Qureshi et al., 2008, Ebbesen and Hope, 2013, and Zwikael and Smyrk 2011)[4]. Zwikael and Smyrk (2011) propose an alternative approach that deals with the weakness by considering undesirable outcomes attributable to the PM as an additional criterion. The resulting approach is so called 'steel tetrahedron'.

This paper argues that transmitting from conventional measure ('iron triangle') to new measure ('steel tetrahedron') is essential for PM success. By providing a basic understanding of key approaches for measuring PM success and their implications for real life projects, this paper potentially takes a positive step toward better equipping PM practitioners to 'correctly' judge PM success.

The remainder of this paper is structured as follows. Section 2 provides a critical review of the 'iron triangle' approach, exposing the underlying weakness in the approach based on evidence of real-life projects, and then explain how 'steel tetrahedron' approach deals with such weakness. The final section is devoted to conclusions.

2. Assessing the PM success: from the 'iron triangle' to the 'steel tetrahedron'

2.1. The iron triangle approach

Regardless of project's size, goal and other characteristics, all projects have the same general 'direct' objectives or goals – achieving the required performance (or scope) on time and within budget. From early literature on the PM, the direct project objectives have been considered as the key determinants of project success or failure (Meridith and Mantel 2009, p.4). Hence, there was a tendency to measure project by PM success (Munns and Bjermi, 1996). However, the current literature on PM provides divergence of project success from PM success. Currently, it is evident that PM success may ultimately affect project success, but the reverse is not held (Ika, 2009). Thus, PM success is defined much narrower than project success.

The conventional test for PM success refers to the 'iron triangle' in which the project delivers outputs subject to triple constraints, namely scope of specifications, timeframe, and cost. Scholars have studied the 'iron triangle' as criteria to measure PM success (as well as project success) since 1960s. The illustration, relationship between project goals and the 'iron triangle', is shown in Figure 1.

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[4] Literature review on project success criteria, given by Shocri-Ghasabeh and Kavousi-Chabok (2009) shows that scholars consider other performance evaluation criteria such as stakeholders' satisfaction, top management support and project contract in addition to the criteria of the 'iron triangle'.

Figure 1

From direct project goals to the 'iron triangle'
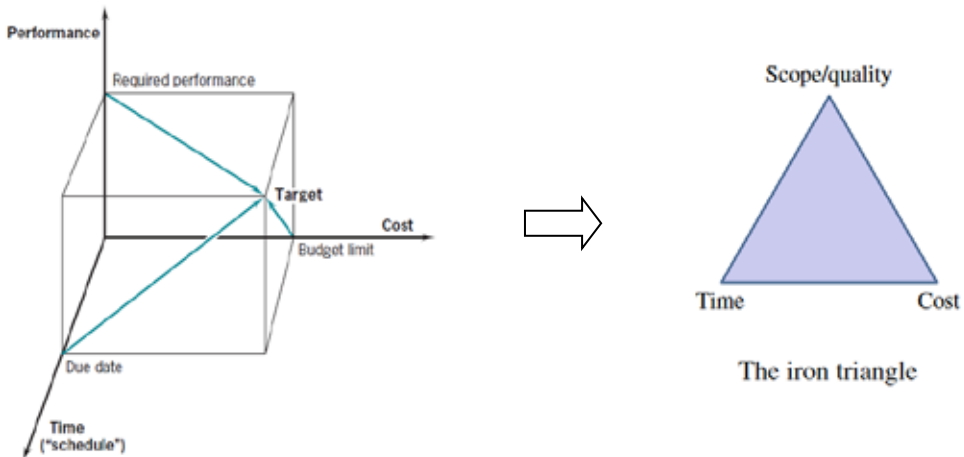
Source: extracted from Meridith & Mantel (2009) and Zwikael & Smyrk (2011).

The basic perception of the 'iron triangle' is the common reliance among the three constrains: change of one side of the triangle is not allowed without affecting the other sides. For example, increasing scope/quality will increase the time needed, which may lead to cost increase (Ebbesen and Hope, 2013). According to the test, a PM is successful if the project is managed on time, within an agreed budget and performed as it was designed to (Scott-Young and Samson 2008). The 'absolute' variant of the iron triangle is considered as a necessary and sufficient assessment for evaluating PM success, where fiasco of any one constraint leads PM failure. However, no trade-offs amongst the three independent criteria may lead to 'wrong' conclusion about the PM. For example, according to the absolute variant, the management of a project, which delivers the procurement outputs before one week from the scheduled timeframe, however, exceeds agreed budget by 0.01%, would have to be declared as a failure. When the iron triangle used in this way, geometric relationships of the triangle are totally disregarded (Zwikael and Smyrk, 2011).

Moreover, the validity of the absolute variant, consisting of the triple constraints have been discussed over academic and industry literature on PM. For instance, a number of studies (e.g., Gardiner and Stewart 2000 and Flyvbjerg 2005, 2007) have shown that though all their surveyed projects were delivered to the required quality, the projects were neither delivered on time and nor within the budget. Results of a survey conducted by Gardiner and Stewart (2000) show that among the surveyed projects only 50% were delivered on time and 80% within budget. The project success analysis, covering 776 projects in 7 industries in various countries, provided in

Zwikael and Smyrk (2011) presents that 12-23.2% of the projects (except constriction sector) on average overrun their scheduled timeframe. Morris and Hough (1987) note that roughly 50 to 65% of their undertaken projects overrun their budget substantially. Well known projects that significantly exceeded their approved budget, addressed by Flyvbjerg (2005, 2007) include the Boston Big Dig (275%), Denver's International Airport (200%), San Francisco-Oakland Bay Bridge (100%), the channel between U.K. and France (80%) and Sydney Opera House (1400%).

To deal with the natural weakness in the absolute variant, scholars also propose another ('trade-off') variant of the triangle, which permits trade-offs amongst the three criteria (e.g., Meredith and Mantel, 2009: p.4). In the 'trade-off' variant, the geometric relationship of a triangle is held well. For instance, if the triangle's any one of three variables (e.g., the achievement of scope/quality) is held constant, many combinations of the other two variables are allowed (e.g., manipulation of time and cost). Therefore, the main task of the PM is to manage these trade-offs. In such sense, the trade-off test is more applicable (however, with time varying levels of acceptable trade-off) since the absolute variant is basically a case of the trade-off variant. However, an excessive tight time schedule could lead to an increase in cost and decrease in quality (Morris and Sember, 2008). Though the trade-off variant has certain desirable feature, both absolute and trade-off variants lack as test for assessing PM success.

### 2.26 The iron triangle approach fails as a test of PM success

A number of scholars (e.g., Hackman, 1987; Scott-Young and Samson, 2008) have identified problems that raise when the 'iron triangle' is applied to test success of a PM, suggesting that it is partial, unsatisfactory and misleading[5]. One of key weaknesses in the conventional approach is that it ignores end effects of a project which are 'unexpected, avoidable and unacceptable'. Zwikael and Smyrk (2011) calls the undesirable end effects "detrimental outcomes" attributed to the PM. A case study of a project emphasizing the weakness, as for example presented in Zwikael and Smyrk (2011), is that the project manager who fulfils the 'iron triangle' criteria, however accomplished this task by putting his team under so much pressure that affects key technical staff to resign just before the end of the project. According to the iron triangle, since all three criteria are met, PM would be evaluated as successful. However, when considering the loss of high performing staff was undesirable, unexpected, avoidable and unacceptable, PM might well declare unsuccessful. This case study evidently suggests that since it is incomplete (e.g., it eliminates the detrimental outcomes), the "iron triangle" is not adequate as a tool for judging PM success.

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[5] Hackman (1987) argues that the 'iron triangle' assessment also discards significant soft outcomes, such as client or intended user's satisfaction, development of employees.

2.3. The steel tetrahedron approach

The weakness in the conventional test (i.e., iron triangle) requires the necessity of an alternative variant. By taking the detrimental outcome into account, Zwikael and Smyrk (2011) propose a general test of PM success that augments the three standard criteria with a fourth (i.e., 'acceptable' detrimental outcomes) and allows trade-offs amongst them. They refer the 'corrected' test with four variables as 'the steel tetrahedron', shown in Figure 2.

Figure 2

From the iron triangle to the steel tetrahedron
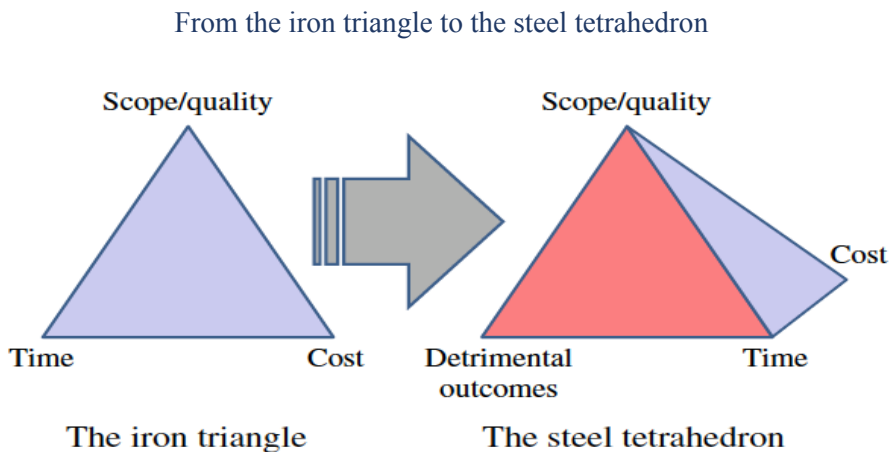
Source: extracted from Zwikael and Smyrk (2011).

However, in the corrected test, the three accepted criteria are measured differently (Zwikael and Smyrk, 2011). The steel tetrahedron variant, involving four success criteria, is also classified as a necessary and sufficient test for success of PM (Zwikael and Smyrk, 2011). For the test, the geometry of the tetrahedron is held in sense that the achievement of scope/quality can be driven by different combinations of timeframe, budget cost and 'acceptable' detrimental outcomes.

It should be noted that only 'detrimental outcomes' that are produced by the PM are applicable to the evaluation of PM success. Furthermore, undesirable outcomes, already identified and anticipated in the business case should not affect PM success. Zwikael and Smyrk (2011) delightfully summarize these ideas as shown in Table 1.

When employing the 'steel tetrahedron' as a test of PM success, a practical question, 'when allowing trade-offs amongst the four constraints, what values should be used as reference levels?' raises. One possible choice is the values set in the business case. However, if one considers that all four parameters will be subject to continuous change, the state becomes less apparent. Thus, practical way is to use the values provided in the last approved baseline document (Zwikael and Smyrk, 2011).

Table 1

Impact of undesirable outcomes on PM success

Actual level of undesirable outcomes, compared to the business case	Is the difference attributable to the project manager?	
	Yes	No
Greater	Negative impact↓	No impact↔
As expected	No impact↔	No impact↔
Less than	Positive impact↑	No impact↔
New (not identified in the business case)	Negative impact↓	No impact↔

Source: extracted from Zwikael and Smyrk (2011).

3. Conclusion

The performance measurement, one of key aspects of PM, should be carried out for each project. However, gauging project success is challenging since project success means different things to different stakeholders. Therefore, it is important to distinguish PM success, project ownership success and investment success. This paper focuses on 'iron triangle' and 'steel tetrahedron' approaches for measuring PM success. Though the 'iron triangle' has been widely accepted as a test for measuring PM performance, the traditional performance criteria cannot be the sole determinant of PM success. Since the conventional approach ignores the detrimental outcomes caused only by the project manager, the 'iron triangle' fails as a test of PM success. By filling the gap, the 'steel tetrahedron' approach considers the detrimental outcomes of PM as an additional criterion to traditional three criteria, and therefore can deal with the weakness in the 'iron triangle'.

By providing a review of both approaches, this paper has suggested that a framework of PM success measurement should involve not only objective-based criteria, but also outcome-based criteria, relevant with the project manager. In such frontier, PM practitioners need to consider 'steel tetrahedron' approach for measuring the PM success.

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