Abstract

There is a growing body of knowledge on project tradeoff models; meanwhile, there are concerns about the models’ applicability. The contemporary research on tradeoffs is mainly based on the time-cost models in planning, which do not provide a proper basis for tradeoffs in other contexts. This paper is aimed at shedding some light on the theoretical and practical deficiencies of tradeoff models through comparison of their fundamentals with the results of other related studies. It highlights the deficiencies of current models and draws attention to the necessity of exploring the real problems’ characteristics and methods’ capabilities prior to model development.

Keywords: Project management; tradeoff model; project tradeoff; project decisions; project success

1. Introduction

The remarkable growth of project-based organizations has become a strong driver for project management’s (PM) academic development through numerous researches on its different knowledge areas (Winter et al., 2006; Berggren & Söderlund, 2008). Meanwhile, there is a growing concern about applicability of the research outcomes and soundness of the developed theories due to the large number of stories on project failures, (major project failure studies addressed in Williams, 2002). Hence, detachment of PM from the real world of projects has become one of the major concerns for a number of field scholars. Project tradeoff as the core of the most critical project decisions is one of the areas criticized for its detachment from the real project world (Williams, 2002; Clough et al., 2000).
Modern-days’ project environments are marked by the increasing interconnections between numerous internal and external factors and their particular dynamics. These have added to multiplicity and complexities of projects and consequently their decisions. Hence, it is expected that decision making area in PM and tradeoff in particular be capable of dealing with the requirements of this new era.

Nonetheless, tradeoff models do not appear to reflect the realities of such environments so are not commonly applied in practice on one hand; despite their growing number and complexity have not been updated proportionate to the theoretical developments of their related contexts on the other. Due to the significance of decisions and their embedded tradeoffs in projects’ success/failure (e.g., Babu & Suresh, 1996; Atkinson, 1999) and the amount of research and publications dedicated to the subject, improvements in this area could have substantial effects on the associated theory and practice.

This paper, tries to shed some light on the theoretical and practical deficiencies of tradeoffs’ concepts and models. It initially reviews tradeoff definition; then provides a review of the tradeoff’s contexts in PM literature. Developments of the related contexts and critiques on some of the tradeoff fundamentals are presented afterwards. Whether tradeoff models have been affected by these developments and critiques is discussed in the discussion section followed by Future work and conclusions.

2. Definition of Trade-off

Traditionally, ‘tradeoff’ term in PM refers to the decisions on making and keeping a balance between project’s ‘time’ and ‘cost’. De et al. (1995, p.225) define the problem as: “… the project duration can often be compressed by accelerating some of its activities at an additional expense. This is the so-called time-cost tradeoff problem which has been studied extensively in the project management literature”. Soon after, Babu and Suresh (1996) put forward a noticeably broader definition: “Successful project management insures the completion of project in time, within budget, and to the project specifications. It is facilitated by the identification and successful application of methodology for trade-off analyses.” The definition pushed the borders of planning to success area. Besides, as they stated, this was the first time the necessity of adding ‘quality’ to tradeoffs was highlighted.

Since then, adding quality has become a line of research in developing the models and the main elements of tradeoffs have remained time, cost and quality. Nevertheless, there are very different perceptions of the nature of these elements as they are said to be: constraints (Dobson, 2004; PMI, 2004; Gardiner, 2005; Kerzner, 2009); objectives or goals (Barnes, 1988; APM, 2006; Cleland & Ireland, 2007; Lock, 2007); factors, criteria, parameters or variables (Nokes et al., 2003; Turner, 2008); and success criteria (Babu & Suresh, 1996; Atkinson, 1999; Williams, 2002).

Despite the addressed variations, the common consent on the existence and necessity for addressing the tradeoff issue signifies that the ‘balancing’ function or the ‘concept of tradeoff’ in the abstract exists in projects and is unavoidable.

Suggested tradeoff resolutions cover a wide range of mathematical methods including linear programming (LP), integer programming (IP), fuzzy logic, net present value (NPV), to name a few. A number of papers such as De et al. (1995), Brucker et al. (1999), Vanhoucke & Debels (2007) and Kim et al. (2012) provide good reviews and classifications of the methods. There are also other simple to normal normative approaches suggesting a few general steps or recommendations for prioritizing the tradeoff elements (e.g., Nokes et al., 2003; Dobson, 2004; Gardiner, 2005; Pollack-Johnson & Liberatore, 2006; Lock, 2007; Kerzner, 2009; Virine & Trumper, 2008).

Tradeoff is discussed in a few other areas of PM besides planning, scheduling and control which will be clarified in the next few sections.
3. Framework for Assessing Tradeoff Models

For the purposes of this study, the main components of a tradeoff model are: elements; methods; participants (decision makers). These features/elements distinguish one model from the other and more or less have been the bases for tradeoffs’ classifications, except for participants. These are used here as the main themes for assessing and discussing the different approaches to tradeoff modeling.

A consistent and practical tradeoff model should be able to consider as many influencing problem elements as possible; should be able to involve as many influential participants as required; and should be able to use a proper method to incorporate those elements and participants throughout the balance. These could be achieved if the model/modeler has the right perception of the specific circumstances and complexities of the tradeoff context.

The underlying assumption here is that theoretical soundness and practicality of a model depend on the recognition of problem features and the model’s capabilities to satisfies the problem’s requirements.


In spite of its origin in planning, tradeoff is frequently addressed in the wider contexts of PM, notably project success and decision making in projects. Usually tradeoff models are classified based on the models’ elements or methods, as was cited before, but the following provides a more general classification based on the tradeoff concept in different contexts.

Despite the differences, traditionally, all the contexts share the common bases for tradeoff elements; i.e., ‘time, cost, and mainly quality’. Needless to say, these are the corners of the well-known project Triangle. Invented in 1969 (Barnes, 2006), the Triangle was initially meant to highlight the necessity and significance of integrating the three elements in order to improve ‘project control’ activities. However, it soon captured both the academia and practice of PM and the idea was extended to other areas such as success and project decision making and formed an inseparable part of their theoretical foundations. As will be seen, it has also become the basis of tradeoff discussions in these areas. Overall view of every context, its critiques and deficiencies are explained in the following.

4.1. Trade-off in Planning, Scheduling and Control

The origin of tradeoff discussions in PM traces back to the late 1950s (Pollack-Johnson and Liberatore, 2006), the era of dominance of planning, scheduling and control as the main concerns of project managers (Belassi & Tukel, 1996). Hence, ‘time’ and ‘cost’ comprised the components of the methods with their balance in form of tradeoff models as the researchers’ principal concern.

Discussing tradeoffs in the context of planning and scheduling is still one of the main lines of research in PM with numerous models developed dominantly based on mathematical methods. In this growing field, researchers frequently extend and improve the existing models or suggest new ones. Though, generally the elements and the common perceptions of the problems’ features remain untouched.

There have also been researchers that their main criticism of the models is the necessity of considering further elements such as quality, performance or risk in the methods. Klein (1993), Riggs et al. (1994), Babu and Suresh (1996), and Pollack-Johnson and Liberatore (2006) are examples who have critiqued the absence of ‘quality’ and/or ‘risk’ elements in the models. Kim et al. (2012) provide a list of several developed methods during 1961-2009 classified based on inclusion or exclusion of quality.

Despite these improvements, there have been concerns about the models’ applicability. A close involvement in the practice of PM confirms that the models are not normally even known in the practice; a review of the literature shows signs of questioning their practicality. Williams (2003, p.9) states: “…
you would struggle to find any papers describing any practical implementation of these methods”. Clough et al. (2000) disapprove the application of time-cost based computerized methods in construction projects due to their ‘oversimplification’ of ‘trade-off reality’. Relying on human judgment and intuition are stated as the consequences of the limitations and failures of these methods (ibid.).

4.2. Tradeoff, Project Manager’s and Project’s Success

Keeping the balance and making the tradeoff between the original Triangle elements -or its slightly different versions replacing ‘quality’ with performance or scope- is frequently stated in the literature as the main task and continuous responsibility of project managers (Williams, 2002; Nokes et al., 2003; Gardiner, 2005; Turner, 2008; Kerzner, 2009). Due to Turner (2008) and Gardiner (2005) making tradeoffs and successfully balancing the elements is the basis for judging project manager’s performance.

The balance between the triple elements is also known as a facilitator for project success (Babu and Suresh, 1996; Atkinson, 1999; Schuyler, 2001; Williams, 2002). Belassi and Tukel (1996) include the project manager’s ability to do tradeoffs as one of the project success factors. Shenhar et al. (2001) emphasize project success criteria as the ‘baseline’ for project tradeoffs; however, they do not limit the success criteria to the triple (Turner et al., 2010).

4.3. Tradeoff and Project Decision Making

Tradeoffs are implicitly or explicitly discussed in general decision making in projects and not limited to specific types of planning decisions (e.g. Barnes, 1988; Riggs et al., 1994; Williams, 2002; Dobson, 2004; Gardiner, 2005; Lock, 2007; Virine & Trumper, 2008; Kerzner, 2009;). Virine and Trumper (2008, p.114) refer to decision analysis “as an art of making tradeoffs”. Barnes (1988) and Gardiner (2005) link improved project decisions with identification of the relative significance and priorities -the basic functions in making tradeoffs- of the Triangle elements. Dobson (2004, p. xii and p. 16) positions the Triangle at the center of the project’s ‘crucial decisions’ and a help for analyzing project tradeoffs. He associates improved decision making with having a clear idea of project objectives and their priorities. Kerzner (2009) intertwines decision making and tradeoffs analysis process. He addresses the Triangle of constraints as the basis of project tradeoffs; nevertheless, he later states that there are several other internal and external factors affecting project tradeoffs.

Project decisions and tradeoff are specially discussed together when the multi-objectivity of projects and their decisions are considered. For instance, Virine and Trumper (2008) indicate: “Projects can have several objectives and therefore a number of decision-making criteria. To select a viable alternative, decision-makers have to make a number of tradeoffs”. They further pinpoint the ‘subjectivity’ of tradeoffs, and merge the decision analysis procedure with making tradeoffs.

Although in PM, tradeoff dominantly is referred to as a certain type of decision; the researchers have used and would be able to use a wide range of OR or other methods for their modeling and resolution. Decision making and OR resources do not address tradeoff as a widely known category of decisions. Nevertheless, they have the concept of tradeoff embedded and referred to in decision making procedures, specifically when decisions involve a number of people with different objectives and criteria (e.g., Saaty, 1995). Saaty (1995, p.4) states: “To deal with unstructured social, economic, and political issues, we need to order our priorities, to agree that one objective outweighs another in the short term, and to make tradeoffs to serve the greatest common interests”.

Ramesh Vahidi / Procedia - Social and Behavioral Sciences 74 (2013) 71 – 80
5. Developments and Critiques of Related Issues and Contexts of Tradeoff

There have been studies on or related to the identified contexts which could have substantially affected and improved the tradeoff models in terms of their main elements, methods, participants. There have also been some fundamental criticisms of the most common bases of the models which could have informed the studies. These are outlined in the following:

5.1. The aspect of tradeoff elements

The Triangle which plays a fundamental role in all contexts has been subject to growing critiques due to its deficiencies in reflecting modern PM complexities (e.g., Atkinson, 1999; Gardiner & Stewart, 2000; Frame, 2002; Vahidi & Greenwood, 2009; Turner et al., 2010). The criticisms vary from a suggestion to slightly changing its elements or shape to the necessity of radically revising its concept. Nevertheless, quick look at the most recent papers would show these have not extensively affected the tradeoff models and still at most the triple or its variations are the most used common bases.

In the success field, a growing body of knowledge has been formed for about 45 years identifying several success criteria in different categories (Jugdev & Muller, 2005; Turner et al., 2010). This is in contradiction with the sufficiency of the Triangle as the success criteria (e.g., Belassi & Tukel, 1996; Shenhar et al., 2001; Jugdev & Muller, 2005) and respectively as the elements of their related tradeoffs.

Decision making in PM has also been subject to developments though studies are very limited compared to other fields. Increasing complexity, interconnections and strategic significance of modern projects demand considering a wide range of elements in project decisions. The undeniable effects of multiple stakeholders leading to variety of project objectives and criteria (Schuyler, 2001; Virine & Trumper, 2008) have increased the multiplicity of project decisions. The significance of intangible or non-measurable criteria such as safety, environment, and customer relations have been recognized in project decisions (Williams, 2003; Virine & Trumper, 2008; Saaty, 2008); as well as the impacts of external and internal factors in tradeoff decisions (Kerzner, 2009). Limiting the tradeoffs, as the core of the projects’ critical decision, to a few elements means overlooking a major part of the reality.

Another significant and probably one of the most ignored issues was addressed in tradeoff definition section. This was the lack of agreement on the nature of the most fundamental tradeoff elements, i.e. whether time, cost and quality are objectives, criteria, constraints, or success factors. Any of these bear a meaning, have certain position, and play a specific role in a decision; however, there seems least sensitivity in PM to interchangeable use of these elements.

This is more crucial regarding the ‘objective’ element. It has been frequently stated that the Triangle corners are every project’s objectives, which is not only contrary to the uniqueness of projects but also contradicts the inclusive range of project types and their potential purposes. Interestingly, giving different names to the triple can be even seen throughout a single reference and even in the bodies of knowledge, i.e., APM (2006) repeatedly refers to the Triple as objectives while at times attaches a broader meaning to the objectives. PMI (2004) calls them ‘project constraints’ but frequently refers to them as objectives.

5.2. The aspect of tradeoff methods

There is a rather normative approach to tradeoff resolution methods from very simple procedures or recommendations to very complex combinations of a few mathematical models. This noticeably wide range indicates the variety of perceptions of the tradeoff problems. This raises two questions. First, one might ask, if an experienced project manager can have “predetermined tradeoffs in reserve” as Kerzner (2009, p.682) suggests or can resolve the issue through a simple graphical method (ibid.), why (s)he
should go through complex numerical methods (e.g., Pollack-Johnson & Liberatore, 2006). Second, whether there is any fundamental theory of the tradeoff problem or whether one could be defined with this level of disparity.

On the other hand, the traditional OR models as the most commonly applied methods in modeling tradeoffs, are unable to tackle problems with social, political and technical complexities, rather than mathematical complexities, in modern projects. In a comprehensive review of contributions of OR in PM, Williams (2003) highlighted the increasing gap between the two fields and consequently impracticality of the models like time-cost tradeoff. This is associated with the changing characteristics of projects and emergence of new paradigms in PM. He addressed soft OR as more viable source of methods (ibid.).

5.3. The aspect of tradeoff participants

It was stated that the main situations necessitating a tradeoff were caused by the conflicting objectives of the stakeholders. The significance of the stakeholders’ roles and involvement in projects is commonly accepted in modern PM (e.g., Turner et al., 2010). However, tradeoff making procedures dominantly do not aim at or do not facilitate involvement of the potential stakeholders, as decision makers. This is again of significance as decisions could rarely be made by individuals without affecting the acceptability of their outcomes. It is also stated repeatedly that project parties might have different perceptions or values for project element (e.g., Turner et al., 2010). For instance, Bryde and Robinson (2005) highlighted the differences between contractor and client’s success criteria and Woodward (2003) pinpoints their different understandings and valuations of time and cost. Models with single entries for each factor do not reflect the real dynamics of the problem.

Recognition of all the varieties mentioned above would be possible through an appreciation of real projects’ dynamics and their inevitable interaction with their external environments. Projects are not closed systems and their problems cannot be solved through isolating and dealing with a few predefined and selected factors. This recognition can affect the development of tradeoff models. The limited and closed sphere of current models does not demonstrate the effects of such insights from the wider context.

6. Discussion

The publications on trade-off models in PM generally disregard the significance of discussions on method selection and justification; consequently, the essential compatibility between method capabilities and problem characteristics is overlooked in the majority of studies. The selection of wide range of methods from very simple to very complex and with very different capabilities could be an indication of the variations of researcher’s perceptions of the problem’s characteristics and requirements.

Nevertheless, the ‘common bases’ for developing the models and the developer’s perceptions are implicitly embedded in their choice of methods. It can be argued that these commonalities have formed some ‘myths’. The main ones, regardless of the context, are that the tradeoff elements are limited to time, cost and at most few others and any tradeoff can be solved by their optimum quantification. Besides, as the models do not leave a space for multiple participants, it can be inferred that the assumption is: the modelers’ views suffice and the final figures could be acceptable by all the affected stakeholders.

The popularity of the myths might have been the reason why contemporary research mainly focuses on extending or improving the existing methods rather than radically revising or going through a method selection and justification phase. The myths have basically originated from the early days of PM when ‘planning’ and ‘scheduling’ of fairly simple projects were the main temptations of theory and practice.
Nonetheless, the critiques on the Triangle; the further studies and extensions of the tradeoff elements and methods; the cause-effect relation between stakeholders and tradeoff situations and the complexities of modern PM reveal a gap between those common bases and the realities of tradeoff problems.

Lack of applicability and the models’ narrow views raises arguments about the driver behind method selection. I.e., whether the driver is the real problems’ features or the modelers’ field of expertise and technical mastery; or whether (Vahidi & Greenwood, 2009, p.7): “the tradeoff methods are chosen based on their capability to deal with the real factors, or the tradeoff factors are chosen based on the capabilities of the available methods?” In latter cases, Pidd (2009, p.20) has warned the modelers of this first danger of modeling: “… if the only tool you have is a hammer, then you tend to treat everything as it were a nail.”

The variety and distinction of the purposes, the interconnections, and the requirements of different tradeoff contexts have not been properly scrutinized in the literature so there is a blurred border and confusion between the concepts. Consequently, the developments and critical studies of the success and decision making areas have not properly affected their tradeoff models. It can be argued that although the project success and project decisions in PM are much broader areas than planning, their tradeoff discussions and models have dominantly originated from planning. Indeed, they inherited the limitations on elements, methods, participants and recognition of the project context. Nevertheless, these problems are even more magnified here due to the expected coverage from success and decision contexts.

7. Future work

This paper is based on the partial findings of a research on project tradeoffs in the context of decision making in projects. In the body of the main research, different aspects of the tradeoff concept in critical project decisions have been explored from the practitioners’ points of view as well. Furthermore, a suggested framework in case study form is being conducted in a project environment.

Further research is suggested in form of an empirical study on the applications of time-cost tradeoff models in practice, specifically by project planners. It could also be explored whether planning decisions are independent from other project decisions in practice and whether they are or can be made regardless of overall project circumstances, specifically in projects with strategic value for organizations.

8. Conclusion

Questioning the validity, applicability and effectiveness of the common bases of tradeoff models were one of the starting points for the current research. It was revealed that the bases, specifically when discussed in project success and general decision making in PM are detached from the findings of the other related researches and are incapable of dealing with the realities of modern project environments.

To improve the relevance and applicability of tradeoff models, the necessity of going through a model justification phase aiming at compatibility between models’ capabilities and problems’ characteristics were emphasized. Deep and sound recognition of the real project environments’ dynamics, interconnections and challenges would lead to the selection of tradeoff methods with the ability to deal with as many significant elements as possible and involve as many influential participants as possible in their procedure.
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