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Systems Engineering to improve the governance in complex project environments

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Abstract

Projects delivered in complex environments are often late, over-budget and provide fewer benefits than what were originally expected. Systems Engineering is the emerging paradigm in complex project environments to transform the governance from "project based" to "system based" and thereby increase the chance of holistic success. Systems Engineering is a multidisciplinary approach to enable the successful delivery of systems in complex environments through a comprehensive set of approaches, techniques and tools, initially developed in the USA after the Second World War. This paper focuses on how Systems Engineering can transform the governance from "project governance" to "system governance", improving the performance of projects delivered in a complex environment. This paper presents Systems Engineering tools and techniques focusing, in particular, on the most relevant for project management, project governance and stakeholder management. At the end it provides a rich research agenda for further studies.

Keywords: Systems Engineering; Project governance; Complex project environments; Transforming governance

1. Introduction

1.1. Defining project success with the Systems Engineering perspective

Systems Engineering (SE) is the discipline developed to deliver successful projects (and systems) in complex environments (INCOSE, 2010). The definition of success is quite different from the historically first definitions based on "cost, time and quality" (the so called iron-triangle). According to the iron-triangle, a project (e.g. building an airport) was considered a success if the project manager was able to deliver it respecting time and budget constraints as well as the customer's specifications written in the contract. While many practitioners, in particular project managers of small organizations working on small projects, still agree and adopt this definition, the literature and large organizations working in complex project environments have moved away. For instance Atkinson (1999) presents an organic view of another three sets of success criteria in addition to the iron-triangle: the information system, benefits for the organization and benefits for the stakeholders' community. In other words the airport, once completed, should make people travel quite smoothly.

Terminal 5 at London Heathrow airport was a project delivered on time and budget, with all the physical and electronic infrastructures built according to the specifications. Nevertheless, because of the imperfect commissioning, integration and untrained workforce, once opened, the systems immediately collapsed, with thousands of bags failing to travel with their owners, and over hundreds of flights canceled. It took months to recover the situation and achieve smooth operation (Davies et al., 2009). "*The surgery was a success, but the patient died*" is an old adage

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similar in many languages and cultures. It is an analogy presenting the difference between a successful process (the surgery perfectly performed–the airport perfectly built) and the achievement of the final result (to recover the patient–to have people traveling).

There is still a lot of confusion about this difference. Ika (2009) in his paper reviewing the definition of project success stressed this point, elaborating the idea of Shenhar and Dvir (1996), "*In our journey toward a comprehensive understanding of project success, one should not confuse any more between project management success and project success. Semantically, project management success refers to efficiency, an internal concern to the project team, and project success embraces concerns for efficiency and effectiveness—in other words, all concerns, whether internal or external, short-term or long-term*".

Aaron et al. (2001) present four major distinct success dimensions: (1) project efficiency, (2) impact on the customer, (3) direct business and organizational success, and (4) preparing for the future. They stress the importance of using these success dimensions to tailor the definition of project success according to the characteristics of the project itself. These ideas are further elaborated by Han et al. (2012) presenting a taxonomy of project success according to project life cycle, success category, macro-dimensions and micro-dimensions. It presents a clear long term view of benefits, for both the organization and its customers, including: "*Fulfilling customer's needs, Customer is using product & expresses satisfaction, Immediate revenue and profits enhanced, Larger market share generated, Will create new opportunities for future, Will position customer competitively etc.*".

SE is exactly the discipline developed in the last 60 years to enable the delivering of successful projects in complex project environments according to this broad view. SE is strongly focused on the Project Governance (PG), which is the key factor to achieve project success (Müller, 2009).

1.2. Project governance and project success

A recent report (Project Management Solutions, 2011) states that 37% of projects fail. For other authors the number is even higher, e.g. Morris (2008) reports as between 60% and 82% of projects fail. Cantarelli et al. (2012) relaying on a database composed by 806 large projects delivered worldwide have an average cost overrun of 35.5% and very heterogeneous performance (standard deviation of 56.3%). Moreover once completed the projects provide fewer benefits than expected, e.g. Flyvbjerg (2006) shows that in transportation projects rail passenger forecast is −51.4%, with 84% of all rail projects being wrong by more than ±20%. For roads, average inaccuracy in traffic forecasts is 9.5%, with half of all road forecasts being wrong by more than ±20%. Considered the definitions of project success previously provided, it makes sense to ask "Why projects fail?"

A major contribution to understanding the reasons for cost and time escalation as well as poor benefits delivered in complex project environments has to be acknowledged according to Flyvbjerg and Van Marrewijk. In particular Flyvbjerg et al. (2003) claim that project organization and its governance (see Section 2.1) are responsible for cost overruns, delays in schedules and poor benefits. In his work Flyvbjerg (2006, 2012) explains that the PG makes projects fail because of two sets of reasons: (1) Psychological-optimism bias and (2) Political-economic: Strategic misinterpretation, rent-seeking behavior, and misaligned incentives. He proposes a methodology called "reference class forecast" to improve the quality of estimations.

Focusing on governance and complexity Van Marrewijk (2005) and Van Marrewijk et al. (2008) argue that project failures are caused by (1) uncertainty in the way projects must be governed, (2) scope ambiguity, (3) technical complexity and (4) involvement of a large number of partners with different cultures and different ways of work. According to the author, it is possible to improve project performance with a better PG and a better definition of the responsibilities of the key stakeholders involved. In particular, he refers to the so called "control versus commitment dilemma". When the project organization exercises dominant control, the partners lose micro-management commitment to the project. They feel that they do not have autonomy to make decisions and consider their role focused only on accomplishing tasks they are put in charge of. However commitment is fundamental in order to achieve success, so it is necessary to find an optimal compromise between control and freedom.

Many projects delivered in complex environments are characterized by a high degree of uncertainty, as well as a mixture of jointed organizations and sub-contracting. It is impossible to control all phases and all single elements of the project with a strictly hierarchical method. In complex project environments, the partners are heavily involved in decision making since they have specific competencies essential for the project execution; this increases the complexity in delivering the project (Van Marrewijk, 2004). Van Marrewijk et al. (2008) suggest that further studies should be focused in this direction, since the optimal form of governance has not yet been identified.

In conclusion, Van Marrewijk and Flyvbjerg agree that poor project performance is mainly due to poor project planning and poor project initiation. However regarding on how to cope with this issue Van Marrewijk has a quite different view to that of Flyvbjerg. Flyvbjerg suggests a unique project organization, which strongly control most of the activities, whereas Van Marrewijk supports resolving the "control versus commitment dilemma".

1.3. Systems Engineering to transform the governance in complex project environments

As seen in the previous section, even today, despite the progress of project management (PM) tools and techniques, many projects still register poor performance. Underperforming projects are often delivered in a project environment characterized by:

1. rapid changes of technologies; shortened technology cycle time; increased risks of obsolescence (Hanratty et al., 2002);
2. increasingly interoperable and interdependence systems (Jaafari, 2003);